FROM THE TEXTBOOK TO THE ENACTED CURRICULUM: TEXTBOOK USE IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

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A Marce
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The dissertation study reported here describes how teachers use district-adopted mathematics curriculum materials and other curricular resources. Analysis of survey data, textbook diaries, and classroom observations was used to describe the use of mathematics textbooks by 53 teachers in 11 middle schools. Three teachers from this group were identified for individual case studies to gain more in-depth understanding of the reasons behind the decisions made by the teachers regarding mapping, planning, and enacting the curriculum. These case studies include data from classroom observations and in-depth interviews.

Following work by Remillard (1999); Remillard and Bryans (2003), a model for primary use of textbook is proposed. A model of teacher’s role in curriculum development proposed by Remillard (1999) was used to analyze textbook use by the teachers in the case studies.

The majority of teachers in this study used their textbooks frequently. They used the district adopted mathematics textbook to select tasks and to plan their lessons. Three case studies further inform us about how a teacher’s views of mathematics and mathematics teaching shape his or her use of textbook, as well as their stance toward the textbook they are using.

Two of the teachers in the case studies had had an active role in the textbook selection and adoption process, had a positive view of the textbook and as a consequence were more committed to faithfully implement their textbooks. Their views of mathematics and mathematics teaching matched those represented by their re-
pective textbooks. The textbooks they used were as different as their views of mathematics. Their different levels of mathematics content knowledge and their experiences as learners of mathematics shaped their views of the textbooks they were using. One of them found herself identified with a textbook focused in procedural knowledge and a strong reliance on repetition, while the other had views more closely related to a textbook based on realistic contexts in which students are supposed to reinvent significant mathematics.
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INTRODUCTION

Publishing is a big business —public schools spend over 4 billion dollars on textbooks annually— and gaining a large share of the market is perhaps the most important goal that drives the design and production of textbooks. Often the largest seller for one year serves as the prototype for other publishers to emulate (Reys, 2001). New textbooks come on the market each year, adoptions are made and thousands of teachers begin using a new textbook. Once adopted, textbooks are generally used between five and seven years.

Textbook Adoption and Selection

In the United States, where there is no national curriculum, every state develops its own frameworks and textbook adoption policies. In some states, a review committee examines and approves textbooks, in others, districts or even schools make the final decision (Reys, 2001). In this context, the whole process is naturally susceptible to the influence of a number of factors, including political issues. Besides readability and copyright date, a textbook selection frequently involves criteria related to the breadth of coverage, content congruent with standardized achievement tests, and aesthetic quality (Tyson-Bernstein & Woodward, 1991).

During the early years of the twentieth century, Fuller (1928) viewed the process of evaluating and choosing textbooks as a scientific endeavor that had reached maturity.
To contemplate the last twenty-five years of continuous improvement in the methods used in the evaluation, recommendation, and adoption of books for school use is to gain an inspiring satisfaction. The American teacher, once hampered by his inability to utilize the most superior texts on the market, is now aided by a freer access to the books he needs, and by more highly professional standards and methods of textbook adoption. Politics, stupidity, and venality no longer interfere, as they once did. (Fuller, 1928, p. 1)

The above optimism has been replaced with much more skepticism directed at the selection process. In fact, far from providing an “inspiring satisfaction,” adoption processes are not yet free from political influences. Textbook adoptions have been in the middle of bitter political battles that continue to influence what textbooks are adopted and how textbooks are written (Jacob, 2001; Reys, 2001). As Amit and Fried (2002) stated, some people are opposed to any reform in principle, others are opposed because they don’t understand it, and others understand it but reject the values it promotes.

Some of these objections are rational and some are not, but they all contribute to a heated atmosphere, which the popular media are ever willing to report and which politician and publisher alike cannot ignore. The brunt of these pressures and counter-pressure is largely borne by the publisher... So instead of producing textbooks with a clear strategy and clear outlook, publishers tend to produce textbooks rife with mixed messages (Amit & Fried, 2002, p. 374–375).

At the district level, the textbook selection process has been described as “highly idiosyncratic” (National Research Council [NRC], 2002, p. 43), with funding procedures and availability of resources being closely related to the selection and adoption of textbooks. In the end, the selection process is heavily driven by the market (NRC, 2001; Reys, 2001). Accountability systems, reflected in state and district assessments, influence both what kind of textbooks will be adopted, and how these
textbooks will be used, at least as part of the contextual forces that influence teacher practices (NRC, 2002).

**Teachers’ Use of Textbooks**

More than ten years ago, Freeman and Porter (1989) pointed out that “surprisingly little research has focused on teachers’ use of textbooks.” Quoting Cronbach (1955), they state that research centering on textbooks had been “scattered, inconclusive, and often trivial.” While recent research on this matter cannot be called trivial, it is certainly true that much more needs to be learned about how mathematics textbooks are used.

Kang and Kilpatrick (1992) state that bodies of knowledge are designed to be used, not to be taught, an idea also proposed by Chevallard (1985, 1988). A didactic transposition is what makes knowledge something to be taught and learned. Thus, a textbook is “a very essential point along the route of didactic transpositions in school mathematics” (p. 3). However, Freudenthal (1986) (cited by Love and Pimm, 1996) rejects the view that school text material is a special version of mathematics written for students, for it privileges one kind of mathematics as being the real mathematics.

Van Dormolen (1986) identifies two important pedagogic functions carried by mathematics texts, namely a curricular aspect, or *cursory preparation*, creating a logical mathematical progression, and a conceptual aspect, *conceptual preparation*, embodying the development of cognitive structures in the learner.

In any case, textbooks are directed to students, and usually the authors regard the student as the main reader (Kang & Kilpatrick, 1992). The teacher will mediate between the student and the text in different ways, and this is an assumption made by authors, teachers, and students. According to Love and Pimm (1996),
Even when the assumed reader is a solitary student, texts frequently exist in a wider context of other resources, including teacher guides on their use in class. The teacher is expected to be either before or during the reading, to clarify, expand upon, or smooth out difficulties in the interaction with the text (p. 385).

Thus, the making of a curriculum, from the design to the enactment, is a process of “narrowing down from the universe of possible activities to those considered desirable for use in the classroom” (Bishop, 1988). Bishop argues that the first stages of this process are established by the government, the state, or the school, well before the teacher is able to make any decision.

Schmidt, McKnight, and Raizen (1997) have described in general terms the role of textbooks in the U.S., as “bridges between the worlds of plans and intentions, and of classroom activities shaped in part by those plans and intentions” (p. 53). Further, textbooks determine the range of possible activities for the classroom, thus influencing greatly what teachers are likely to do, even if they do not restrict what teachers can do.

In their study, Schmidt, McKnight, and Raizen analyzed textbooks for the three student populations being tested by TIMSS, and observed that mathematics and science textbooks in the U.S. generally include more topics, which in turn are treated with less depth, than in other countries. They described U.S. science and mathematics textbooks as being “a mile wide and an inch deep” (p. 62). For this reason, teachers make selective use of the textbook contents and rarely cover all of the content in the textbook.

Although American teachers use their textbooks in daily instruction to about the same degree as their Japanese and German counterparts (60% of the time in Germany and the U.S., 70% in Japan), due to the large number of topics, American teachers tend to map their curriculum by deciding what to emphasize and,
mostly, what to skip. Textbooks with a broad range of content are produced because publishers have to consider all potential adopters. State frameworks and local curricular guides map out the content expectations for textbooks. While there is much common content, there are individual differences in both the scope and sequence of the mathematics frameworks and curriculum guides. In order to create a product that can be sold in different states, publishers tend to include mathematical content that satisfies everyone. After all, it is easier for a teacher to skip some sections of a book than to make up for topics not covered. In the same manner, publishers incorporate the topics that reflect the recommendations of reform movements within the field, but often “in an inclusive, unfocused way” (p. 62).

Schmidt et al. (1997) propose the notion of “satisficing” as an idea that might “explain much teacher behavior, especially in their coverage of topics and their use of textbooks” (p. 78). “Satisficing” means that teachers try to “satisfy sufficiently” and make choices that are good enough under the circumstances. Schmidt et al. point out that “teachers’ instructional decisions must be made quickly under demanding circumstances.” If the textbook does not provide enough support, because it is unfocused or does not present prioritized alternatives, then the teacher is more likely to seek only “good enough” options. They further state that “Teachers seem to regard textbooks and curricula as sanctions indicating what is acceptable” (p. 79). Their decisions will then reflect “the unfocused, inclusive natures of the textbooks” (p. 79).

The Role of Textbooks

The importance of textbooks in the mathematics classroom has been recognized for a long time. Recent research has acknowledged the complexity of the issues that determine the actual content taught and the pedagogical approaches used by
teachers. Nevertheless the role of the textbook has been predominant. Fuller (1928) stated it clearly:

The textbook is the most important of the teacher’s tools. In determining the subject matter of the child’s experience, it is more decisive in day-to-day affairs than is the course of study outlined by the school system. In determining teaching procedure the text is more influential from hour to hour than a manual of methods. In fact the total series of textbooks in use by students and teachers are the real course of study and manual of teaching. This is not the usual theory, but it is the actual fact.

Today, the importance of textbooks cannot be overstated. Tyson-Bernstein and Woodward (1991) describe as ubiquitous the role of textbooks in American schools, and as a prominent, if not dominant, part of teaching and learning. This happens in other countries, as well.

Teachers of mathematics in all countries rely very heavily on textbooks in their day-to-day teaching, and this is perhaps more characteristic of the teaching of mathematics than of any other subject in the curriculum. Teachers decide what to teach, how to teach it, and what sorts of exercises to assign to their students largely on the basis of what is contained in the textbook authorized for their course (Robitaille & Travers, 1992, p. 706).

Grouws and Smith (2000) report that in the U.S. the textbook continues to be the base of instruction at 8th grade, although the daily use of textbooks has decreased from 1992. Seventy-two percent of the students in grade 8 in the 1996 NAEP study did problems from textbooks almost every day, as was reported by their teachers, compared with 83% in 1992. In contrast, 16% of the students in 1996 did problems on worksheets almost every day, compared with 12% in 1992. These data suggest that for the majority of mathematics teachers the textbook determines the content taught and how it is taught, while for others it serves as one resource among others.
Ultimately, it is the teacher who determines how the curriculum is enacted in the classroom by making decisions that affect directly the classroom practices (Clandinin & Connelly, 1992; Drake & Sherin, 2002; Love & Pimm, 1996; Remillard, 1999). By interpreting the text, the teacher acts as a mediator between her students and the textbook. The complex web surrounding teachers’ decisions in the classroom has been studied from different perspectives, looking at the teachers’ stated and enacted conceptions, for example. But the ways in which the use of textbooks is shaped by these beliefs and conceptions needs to be addressed more deeply.

Curriculum Reform

The term curriculum has different meanings in the literature. In the TIMSS reports (Schmidt et al., 1997) a distinction is made between the intended curriculum, the one planned for, and the implemented curriculum, the actual classroom practice. In general, these distinctions have been organized (Robitaille, 1992; Schmidt et al., 1997; Travers & Westbury, 1989) according to the level in which the curriculum is examined:

— the intended curriculum, at the level of the system,

— the implemented curriculum, at the level of the class, and

— the attained curriculum, at the level of the student.

More recently, Porter and Smithson (2001) distinguish the intended from the assessed curriculum, and the enacted from the learned curriculum. The assessed curriculum is the one represented by high-stakes tests. The learned curriculum is “the content that has been learned as well as the level of proficiency offered by
test scores” (Porter & Smithson, 2001, p. 3). Whatever the plans or the tests are, however important they might be in determining what occurs in the classroom, the curriculum observed during classroom practice, the enacted curriculum, has an identity of its own. As Porter and Smithson emphasize, “the enacted curriculum is arguably the single most important feature on any curriculum indicator system” (p. 2). From some researchers’ perspective (Ben-Peretz, 1990; Clandinin & Connelly, 1992; Clarke, Clarke, & Sullivan, 1996; Remillard, 1999), teachers are active developers of the enacted curriculum, constituted by the experiences, whether intended or not, which occur within the mathematics classroom. Efforts for mathematics curriculum reform have sought to impact these different levels.

In many countries, the intended curriculum is reflected in a national curriculum. In the United States, in the absence of a national curriculum, the National Council of Teachers of Mathematics [NCTM] (1989; 1991; 1995) published several documents, collectively known as the Standards which called for changes in both content and teaching practices. These documents provided a vision for school mathematics intended to shape content, instruction, and assessment. A basic tenet of these documents was that “what a student learns depends to a great degree on how he or she has learned it” (NCTM, 1989, p. 5). The efforts to reform school mathematics embodied in the Standards documents created opportunities to develop curricula that would follow these recommendations. The National Science Foundation [NSF] funded development projects that have produced new forms of curriculum materials.

More recently, Principles and Standards for School Mathematics (NCTM, 2000) incorporates what has been learned since the publication of the Curriculum and Evaluation Standards for School Mathematics in 1989 together with more recent research in mathematics teaching and learning. Among the six principles stated in NCTM
(2000, p. 14), the Curriculum Principle summarizes the view of mathematics curriculum advocated by NCTM, “A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.”

Amit and Fried (2002) state that one motive for reform has been the needs of the universities, which receive students who are not well prepared for the challenges of college level mathematics. A second motive is the needs and demands of society. For example Sputnik was a major influence for reform in the late 50s. “In the NCTM Standards (1989) the social motive for reform is explicit and immediate,” (Amit & Fried, 2002, p. 359), namely the need to create a workforce productive, creative, flexible, and open to all. A third motive is internal, basically associated with research in mathematics education. In the case of the Standards, a constructivist perspective has been prominent in the different Standards documents.

Reform in mathematics education is an extremely complex undertaking, according to Amit and Fried (2002) for it aims at a systemic improvement of education, its object is not only curriculum or teaching style or learning environments, “but an entire matrix combining content, means, social needs, and values with the populations of students, teachers, researchers, parents, and politicians”(p. 369).

They warn against “pseudo-reform,” in which materials are produced that seem to conform to reform recommendations, but actually they embody the practices that the reform is trying to amend, or teachers who use reform materials in class yet persist in teaching in a way that contradicts the spirit of reform (see also Clarke et al., 1996; Remillard & Bryans, 2003).

The nature of a desirable change in teaching paradigms has been summarized by Cooney (2001):

[A] case can be made that traditional teaching involves a kind of teach-
ing in which the teacher informs students about mathematics through the primary scheme of telling and showing... Traditional teaching, so conceived, allows us to consider a different kind of teaching, one which involves less telling and showing and more creating mathematical communities in which process and communication transcend product. We can call this kind of teaching reform teaching, and we can conceive of teacher change as moving from the traditional mode to the reform mode (p. 11).

Elaborating further on the need for reform, Cooney states that

Although I acknowledge the legitimacy of the empirical nature of connecting learning outcomes to any kind of teaching, I suggest that there remains a philosophical perspective that suggests a reform-oriented classroom is more consistent with the kind of society most of us would embrace. I do so under the assumption that the teaching of mathematics, or any subject for that matter, is ultimately a moral undertaking (p. 11).

The impact of reform in textbook selection can be illustrated by the way guides for choosing textbooks have evolved over the years. Guides for evaluating textbooks have for a long time addressed the pressing issue of choosing the right textbook for a school or district. Close examination of one of the older reports (e.g. Fuller, 1928) shows that the main emphasis was on readability and structure. Some content areas and topics are supposed to be included and the language is not supposed to be beyond the age level of the students who would eventually use the book. This analysis of readability may include the order of magnitude of the numbers used within exercises and problems as well as the actual text narrative. Not so long ago, available guides (e.g. NCTM, 1982) had a similar approach to textbook evaluation, mostly focused on the content of the textbook. It is significant that new curricula, such as those funded by NSF and written in the spirit of the NCTM Standards (NCTM, 1989; 1991) have created the need for more thorough guides for choosing a curriculum (Goldsmith, Mark, & Kantrov, 1998). Now,
recommendations for adopting a curriculum explicitly address the need to think about mathematics teaching and learning in different ways. These new guides place as much emphasis on the content as on the teaching philosophy that is behind the development of each curriculum.

Statement of the Problem

The purpose of this study is to describe and categorize the ways in which middle-school mathematics teachers use their district-adopted textbook. Under this overarching goal, the following questions were investigated:

— How do teachers utilize district-adopted school mathematics textbooks? To what extent do they use them? For what purpose?

— Why do teachers make the instructional decisions they do regarding the use of the district-adopted textbook?

— Are there differences in how the district-adopted mathematics textbook is used between middle school teachers that use standards-based textbooks and teachers that use traditional textbooks?

Standards-based curriculum materials are designed to be used in different ways than traditional textbooks. This study will describe how textbooks are used in sixth and seventh grade classrooms, and search for patterns that are associated with particular types of textbooks.

Definition of Terms

**NSF-funded Curricula.** Middle School mathematics curriculum materials developed to reflect the ideas embraced by the *Standards* documents and funded
by the National Science Foundation (NSF). In particular, Connected Mathematics Project, Mathematics in Context, and MathTHEMATICS.

**Traditional Textbooks.** Commercially generated curriculum materials reflect a learning perspective focused primarily on procedures and direct teaching methods.

**Enacted Curriculum.** “The enacted curriculum refers to the actual curricular content that students engage in the classroom” (Porter & Smithson, 2001, p. 2), “what happens when the lessons are implemented in the classroom” (Drake & Sherin, 2002).

**Standards-based.** Teaching practices or curriculum materials that reflect the view of mathematics teaching and learning represented by the Standards documents (NCTM, 1989; 1991; 1995; 2000).

**Reform-oriented textbooks.** Textbooks inspired by the recent reform in mathematics education. These textbooks are not necessarily based on the Standards documents, but may reflect views compatible with them. The term is not used to identify any particular textbook in this study, but appears frequently in the literature.

**Significance of the Study**

The middle school mathematics curriculum materials funded by NSF, according to Trafton, Reys, and Wasman (2001), “differ in substantive ways from traditional textbooks used in the U.S., which tend to focus on acquisition of skills, to cover many topics superficially, and to be highly repetitive” (p. 259). It is therefore worth investigating, on the one hand, if the use of these NSF-funded curricula is
significantly different from the way in which traditional textbooks are used. On the other hand, more research is needed to describe the complex issues around the implementation of a standards-based curriculum in order to better inform the analysis of student learning that results from these implementation efforts.

Usiskin (1998) notes the need for research that ties textbook use to students’ performance. He also points out that the fact that teachers use textbooks differently should not deter the research community from conducting these needed studies. A deeper understanding of the differences in textbook use, and its relation to different dimensions of teaching and learning will certainly help to give meaning to the evidence on students’ performance.

During the construction process, the numerous decisions that the teacher has to make on-the-spot determine the improvisational nature of teaching. Recognizing that the interaction between teacher and textbook goes beyond planning and providing tasks to pose to the students leads naturally to the recognition of the need to uncover the processes through which teachers make these decisions, and to understand how the textbook actually supports or hinders the process of decision-making. This study further informs our understanding of these issues in the middle school mathematics classroom. It helps illuminate the factors that have to be taken into account for the purposes of teacher education, curriculum development, and curriculum evaluation. Remillard (1997) has pointed out why this approach is needed:

[...] textbooks and curriculum materials present entire lesson plans by indicating tasks to pose to students and the order in which they should be posed. By their very nature, they present curriculum and instruction as fixed and preplanned rather than flexible and responsive. Furthermore, they infrequently acknowledge the need for teachers to attend or respond to students’ understandings (Remillard, 1996). In this way, curriculum materials focus on the finished product of teaching, rather
than on the teaching process. This product orientation denies necessary aspects of the process of teaching and, to some extent, implies that careful planning can eliminate the need for impromptu decision making.

Regarding progress in research in mathematics education Lesh and Lovitts (2000) state that knowledge must accumulate. In particular, they argue that “there should be an enormous return from giving greater attention to the development of knowledge projects whose objectives are the development of materials, programs, and teachers” (p. 59). In regard to projects that focus on the development of curricular materials, Lesh and Lovitts suggest that we should build on the successes and failures of curriculum development projects. We should ask, among other things, with whom does it work and in what ways, when and where does it work and under what conditions. This study has the potential to contribute in important ways in this direction. Our understanding of the complex relations between curriculum and student learning will be deepened when we gain insights into how the enacted curriculum comes to be. As Lloyd and Wilson (1998) point out, “If we are to support teachers in making long-term instructional changes, it is crucial to continue to investigate the process through which the current reform agenda is interpreted and personalized by teachers involved in the implementation of innovative curricula” (p. 272).

Activities related to “curriculum development” account for 4% to 11% of the time of recent graduates of doctoral programs in mathematics education. Those devoting the most time to these activities work in K-12 institutions (Glasgow, 2000). A better understanding of how teachers interact with curriculum materials could enhance the possibilities of these efforts, as they recognize the paramount importance of the teacher’s role in the process.

The whole process of making or designing a curriculum could be brought un-
der a new light, once we acknowledge the dynamic nature of curriculum development as something that occurs in the classroom. As Steffe (1990) has pointed out:

[... ] if we continue to produce an a priori curriculum where the mathematical concepts and operations are prescribed, the teachers will be encouraged only to continue avoiding the responsibility for their own learning and will quite likely remain unmotivated to become active in mathematics and mathematics curricula (p. 398).

In this sense, we could say that while traditional curricula can be regarded as tools for student learning and tools for teaching, reform-oriented curricula have proven also to be tools for teacher learning (Ball, 1988, 1996a, 1996b; Manouchehri & Goodman, 2000; Remillard, 2000). Our knowledge base will be advanced in this area as our understanding of the interaction between teacher and curriculum grows.

Summary

There is a gap between the world of intentions and what actually takes place in the classroom. Politicians and curriculum developers have an important influence, the latter by writing the materials used in the classroom, the former by making policy decisions that directly affect what textbooks will eventually be used. In the end, however, the teachers in the classroom, through their everyday decisions, determine what opportunities for learning mathematics their students will have. Textbooks play a role in teacher decision making—as authority or as a resource—that deserves more inquiry. In the next chapters, we will look at how a group of teachers in 11 schools in six states used their textbooks to teach mathematics in sixth and seventh grade. From these teachers, three cases were selected for a more
in-depth look at their interaction with the textbook to plan and make instructional decisions.
Interest in how teachers use their mathematics textbooks is not new. This chapter reviews some of the history of the research in this area and the more recent literature regarding textbook use is discussed. A brief discussion of literature related to teachers’ beliefs and conceptions of mathematics, and teachers’ mathematical content knowledge, is included, as well as some literature related to the broader issue of the aims of mathematics education. While these reviews are not directly related to the research questions, they illuminate some of the factors associated with the issue at hand. This discussion will lead to the conceptual framework that guided this study.

Use of Textbooks

One of the first studies regarding textbook use (Bagley, 1931) had as its primary concern “the extent to which the textbook still dominates instruction in American schools.” The author examined the results of previous surveys on the matter, from as early as 1898. In most of these studies there was a continuing criticism of what was perceived as an excessive dependence on textbooks. Deficient preparation and lack of guidance and supervision were noted as causes for the situation. “Texts were followed almost slavishly; the curiosity of the pupils was seldom aroused; rarely was an inquiring spirit stimulated by the teacher” (Strayer, 1927, cited by Bagley, 1931). This seems to have been the tone of most of these reports, as in
In Missouri schools, as in most American schools, textbooks are an important part of the machinery of instruction. To a considerable extent they determine both the content and the method of instruction. This is of necessity true when teachers are not well trained; when competent professional supervision is generally lacking; and when reference materials are scarce, unsuitable, and inadequate. In practice the textbook is the course of study in most Missouri schools.

Data were collected from state inspectors and supervisors, as well as local supervisors, principals, and superintendents, who were asked to report on observations done in classrooms from schools in 30 states. Oral recitation, the repetition of definitions and concepts, was found to be a frequent method of instruction. More interestingly, Bagley observed that more experienced teachers tended to depend less on the textbook:

The beginning teacher, whatever his training, seems more likely to depend upon formal textbook methods than do teachers of from two to five years’ experience. Teachers with more than five years’ experience revealed, in our study, the least dependence upon such methods; among them, too, the methods approved by contemporary educational theory prevail in the highest proportions” (p. 25).

In the early 1950s Cronbach (1955) called for current research on teachers’ use of textbooks, “The sheer absence of trustworthy fact regarding the text-in-use is amazing.” Indeed, in spite of earlier evidence that the content taught to students was heavily influenced by the textbooks, the ways in which the textbooks were used had not been properly addressed. As Cronbach (1955) recognized, the issue was hardly a simple one:

No evaluation of texts as they are, or texts as they might be, is possible until we consider how they perform in the classroom. One cannot really judge the functional contribution of the text alone, for the text-in-use is
a complex social process wherein a book, an institution, and a number of human beings are interlaced beyond the possibility of separation. (p. 188)

He added, “The fact that a teacher uses a text in a certain way no doubt indicates that he has an ideology regarding the proper use of the text, for no one consistently follows practices he regards as wrong” (p. 200).

More recent studies have examined some influences on textbook use. Floden, Porter, Schmidt, Freeman, and Schwille (1981) presented hypothetical situations to 66 teachers and asked them to explain how these situations would affect their decisions regarding what to teach. The two most powerful pressures cited were a test (a standardized test whose results would be published in the local newspaper) and the district objectives. The textbook was the weakest of the potential pressures. The methodology can be questioned, because in a real situation these pressures might not be experienced as they were hypothesized. Nevertheless this study was among a growing number of studies that considered factors that could influence the choice of topics for mathematics classes and for other subjects.

Freeman and Porter (1989) identified three styles of textbook use by focusing on the extent to which a teacher’s instruction matched the topics and sequencing that was presented in a mathematics textbook. Four elementary teachers kept daily logs for a year, and their styles of textbook use were categorized as textbook bound, in which the teacher followed the textbook page by page; focused on the basics, in which the teacher taught lessons directly related to basic mathematical concepts and skills and skipped lessons viewed as being unrelated to these concepts or skills; and focused on district objectives, in which teachers followed closely their district’s recommendations on the topics to be taught. Their results showed that the notion that elementary school teachers’ content decisions are dictated solely
by the textbook cannot be supported. They reported differences between the textbook content and the teachers’ topic selection, content emphasis, and sequence of instruction. Further, they questioned the long held conviction that teachers who teach following closely the textbook do not serve their students as well as those who go beyond the textbook. In their study, the teachers who deviated most from the textbook placed a greater emphasis on drill and practice of computational skills, while those who followed the text more closely emphasized applications and conceptual understanding.

Stodolsky (1989) observed six fifth grade teachers to document their use of mathematics and social studies textbooks. A wide range of styles of use were observed, from close adherence to extreme autonomy to the textbook. Some teachers skipped sections and even whole chapters, others changed the sequence, others used mostly worksheets and did not seem to be using the textbook at all. In general, their results support those by Freeman and Porter (1989), namely that what teachers teach is in the books, but they do not teach everything that is in the textbook. Some of the teachers in the study followed the teacher’s guides, but most of them did not, ignoring mostly the enrichment and motivational activities included in the materials.

Sosniak and Stodolsky (1993) looked at four fourth grade teachers to see how robust the textbook use was across subjects (language arts, mathematics, and social studies). They acknowledge that the most common question addressed by previous studies has been to determine the extent to which the textbook determines what is taught, not allowing researchers to learn about textbook use in the context of a total instructional program. Similar to Cronbach, Sosniak and Stodolsky observed that “Researchers who study textbooks and their use in classrooms also have paid insufficient attention to connections between teachers’ thinking
and beliefs about instructional plans and activities and their actual use of materials” (p. 251). They found that, for the teachers in their study, textbooks were not blueprints, they were simply materials available, “tools, props, curricular embodiments” (p. 270). According to their findings, “textbooks do not control the elementary curriculum to the extent ordinarily assumed, and textbook content does not necessarily directly influence what students learn” (p. 272).

The way teachers adapt activities, regardless of their source, has been studied from different standpoints. By using the construct of cognitive demand, the QUASAR project (Quantitative Understanding: Amplifying Student Achievement and Reasoning) (Silver & Stein, 1996) examined how mathematical tasks are transformed by teachers. The QUASAR project included an examination of the nature of the mathematical tasks used by teachers (Henningsen & Stein, 1997; Stein, Grover, & Henningsen, 1996). They described how tasks with a high level of cognitive demand can decline into the use of procedures without connection to meaning or understanding when challenging aspects of the task are removed by the teacher. The cognitive demand can also decline into unsystematic exploration for reasons that include inappropriateness of the task or inappropriate amounts of time allocated to the task. Tasks can decline into no mathematical activity for similar reasons. They noted that:

[T]eachers must know their students well in order to make intelligent choices regarding the motivational appeal, difficulty level, and degree of task explicitness needed to move students into the right cognitive and affective space so that high-level thinking can occur and progress can be made on the task (Henningsen & Stein, 1997, p. 537).

Recently, attention to what influences the decisions that teachers make regarding content and pedagogy has reemerged as an important area of study. Remillard’s (1996; 1997; 1999; 2000) work has led to a model for thinking about textbook
use. Working with two fourth grade teachers during their first year of using a reform-oriented textbook and looking at the interactions of the teachers with the textbook, Remillard proposed a model that integrates research on how teachers construct curriculum in their classrooms and how teachers use curriculum materials. Remillard (1997) states that “the teacher, rather than the text, plays the most direct role in shaping the enacted curriculum.” She questions the view of good teaching as competence with certain technical skills, and proposes greater recognition of the improvisational nature of teaching: “In order to embrace the vision of mathematics teaching inspired by reforms, teachers must also embrace the idea that teaching requires improvisation. Furthermore, they need opportunities to learn to improvise.” She documents how two teachers improvised during their teaching and how the nature of their interaction with the textbook shaped the results of their improvising.

The model of the teacher’s role in curriculum development proposed by Remillard (1999) is characterized by three arenas: the design arena (selecting and designing tasks for students); the construction arena (enacting these tasks in the classroom); and the mapping arena (making choices that determine the organization and content of the curriculum) (Fig. 2.1). In the first of the three, the teachers interact with the textbook more closely. The mapping arena is not directly related to the classroom, but it is impacted and impacts the daily classroom events. In this model, the teacher is seen as an active participant in the curriculum development process, insofar as his or her decisions determine the enacted curriculum. The teacher’s decisions are instrumental in developing plans and ideas that are to be translated into classroom events. By regarding teaching as a multidimensional activity, this model of teachers’ curriculum development allows us to examine textbook use with respect to the process of enacting the resulting curriculum plans in
Remillard documented how the choices made by teachers regarding task selection were influenced by their ideas about mathematics, students and their learning. The two teachers in this study approached task selection in two different ways, namely appropriating tasks from the textbook and using the text as a source of mathematical ideas to invent new tasks. The teachers beliefs about the nature of mathematics and about teaching and learning influenced how they read the textbook. Within the construction arena, where the curriculum is constructed by adapting tasks according to the students’ performance and reactions to the planned tasks, the teachers examined and analyzed the tasks guided by their ideas about learning and about what students need to know.

In a later study, Remillard and Bryans (2003) described how the ideas about mathematics and the teaching of mathematics, and the view of a particular curriculum determine the teacher’s orientation toward using a curriculum. Engage-
ment with the curriculum materials is affected by this orientation, and in turn it influences the teacher’s views and ideas of and about mathematics. The resulting enacted curriculum and the opportunities for learning that it provides influence again the teacher’s orientation toward using the curriculum, beginning a new iteration of the process (Fig. 2.2).

Figure 2.2: Model of teacher’s orientation toward curriculum materials and its relationship to the enacted curriculum (Remillard & Bryans, 2003)

Other researchers have looked at teachers in the process of adopting new curriculum materials. Lambdin and Preston (1995) observed 34 teachers using sixth grade Connected Mathematics Project materials. They summarized their findings by
means of caricatures, or composite descriptions emphasizing the salient characteristics of a group of teachers, regarding their teaching practices, as they interacted with the CMP materials. The frustrated methodologist, who wants to have tight control over discussions, ignores most statements that are incorrect or might lead to confusion, and has more concern with procedural facility than with conceptual understanding. This teacher is concerned by the fact that there is not enough practice in CMP. The teacher on the grow has a limited mathematics content knowledge, but is strongly committed to being a learner. This teacher might be so involved in the creative aspects of her students work that she might overlook mathematical errors. The standards bearer likes to pose a problem, have students work on it in groups, share their ideas with the whole class, explore related problems, and then return to the problem. The predominant mode of learning in this teacher’s class is student inquiry, she builds classroom discourse around students’ ideas. From the caricatures of the frustrated methodologist and the teacher on the grow, Lambdin and Preston found that it was more difficult for teachers to adapt to new teaching methods, as the former must do, than it was to recover from lack of mathematics background, as the latter had to do.

Some studies have focused specifically on the issue of the textbooks as tools to promote change. For example, Ball (1996b) looked at the role that textbooks have in helping teachers to learn mathematics. She noted that the ways in which teachers engage with textbooks will determine what teachers learn from them.

Lloyd and Behm (2002) conducted a study in which prospective elementary teachers were placed in two different sections of a Mathematics for Elementary Teachers course. One of these sections (section A) used a commonly used college textbook, while the other section (section B) used NSF-funded middle school mathematics textbooks (Mathematics in Context and Connected Mathematics Project). Lloyd
and Behm observed the change in these prospective teachers’ stated beliefs regarding textbooks. Sixty-six percent of the teachers in section A stated at the beginning of the course that “mathematics textbooks should contain example problems (solved),” while 62% of the teachers in section B thought so. In contrast, at the end of the course, 81% of the teachers in section A stated that mathematics textbooks should contain example problems, while only 45% of the teachers in section B stated a similar opinion. None of the teachers in section A thought at the beginning or at the end that “mathematics textbooks should allow students to think about concepts and problems first before providing examples and should help students develop solution methods for themselves.” Three percent of the teachers in section B stated this belief at the beginning of the course, but the number rose to 14% by the end of the course. These results suggest that textbooks have the potential to change beliefs about teaching and learning mathematics. Thus pre-service teachers using these NSF-funded textbooks might change their orientation towards certain textbooks and their expectations regarding these textbooks’ role in the classroom.

Manouchehri and Goodman (2000) observed two seventh grade teachers over a period of two years. These teachers were in the process of implementing an NSF-funded curriculum, Connected Mathematics Project. According to Manouchehri and Goodman, the teachers’ mathematical knowledge was the greatest influence on how they evaluated and implemented the textbook.

Remillard and Bryans (2003) looked at a group of eight elementary school teachers that were using Investigations in Numbers, Data, and Space (TERC, 1998). They observed that even teachers whose stated views regarding the curriculum were very similar, enacted different curricula in their classrooms, thus creating different learning opportunities for their students and for themselves. They developed the
construct of orientation toward curriculum materials to examine the ways in which these teachers related to Investigations during the first year and a half of use. According to the use of the curriculum materials, they defined three main categories of use: intermittent, adopting and adapting, and thorough piloting. Their findings indicate that standards-based textbooks, while not a panacea, can play important roles in fostering reform-based practices. For example, they observed significant changes in the patterns of use of textbook in two of the teachers in the study as a result of their use of the curriculum materials, but these did not occur until after a year of implementation. These teachers reported understanding better how mathematical ideas connect to one another after working with Investigations.

Drake and Sherin (2002) developed a framework of models of curriculum use to describe teachers’ practices when using standards-based textbooks. They used this framework to describe the changes in three teachers’ practices in their first two years of using a reform-oriented curriculum in an elementary school. Their model comprises three processes: reading curriculum materials, evaluating curriculum materials, and adapting curriculum materials. The order and timing of these processes is part of the model, too. Interestingly, they observed that from Year 1 to Year 2 the three teachers moved from viewing the curriculum as something that needed to be changed to viewing it as something that could be used. The teachers “developed a ‘vision’ of reform instruction through the use of the curriculum materials” (p. 13), and consequently the teachers began to trust the curriculum.

The 2000 National Survey of Science and Mathematics Education (Weiss, Bani- lower, McMahon, & Smith, 2000) included questions regarding the extent of use of textbooks and the perceived quality of the textbooks that teachers were using. In middle school mathematics classes, 90% of the teachers reported using one or more commercially published textbooks to help guide instruction (Whittington, 2000).
Of these teachers almost 41% considered their textbook as very good or excellent and 64% of them reported that they covered at least 75% of the textbook in a class that was randomly selected for the study.

In a more recent report of a large national observation study on K-12 mathematics and science education (Weiss, Pasley, Smith, Banilower, & Heck, 2003), Horizon Research concluded that the textbook designated for a class is the second most important factor that influences the selection of content. In their study, 364 mathematics and science lessons in grades K-12 were observed. In 49% of them the textbook was cited among the major factors that influenced selection of content, while the state and district curriculum standards/frameworks was cited in 74% of the lessons observed as being among the major factors that influenced selection of content. The textbook was also the second most frequently cited major factor that influenced selection of instructional strategies, in 71% of the lessons, while “teacher knowledge, beliefs, and experience” was the most cited major factor that influenced selection of instructional practices.

Their recent report also concluded that there does not seem to be a single right way to engage students with mathematics/science content. The report described high quality lessons that were “traditional” in nature, including lectures and worksheets, and high quality lessons that were “reform-oriented” in nature, involving students in more open inquiries. Importantly, the report also noted that there are a much larger number of low quality lessons, both traditional and reform-oriented.

Teachers’ Beliefs and Conceptions

When teachers select tasks they have to make decisions based on desired outcomes. At the same time they are limited by constraints—particular to their individual circumstances—and influenced by their beliefs about mathematics and
about mathematics teaching (Sullivan & Mousley, 2001). Early curriculum development efforts focused on textbooks that would diminish the teacher intervention in this task selection. As Thompson (1992) described it, “There was a time when educators naïvely thought that producing a ‘teacher-proof’ curriculum would go a long way in solving the problems of mathematics instruction” (p. 128).

Without a clear societal consensus on the goals and priorities of mathematics education, teachers have to resolve the conflict. As they teach mathematics, they convey their vision of mathematics and their views on teaching mathematics. The construct of teacher beliefs, or teacher conceptions, reflects these ideas and aims, which are usually not articulated by the teacher in an explicit manner.

Thompson (1992) examined the research on teacher’s beliefs and found that “no simple model of teaching and learning can be used to account for teachers’ and students’ actions in the classroom” (p. 142). Further, Thompson states:

[T]eachers’ conceptions of teaching and learning mathematics are not related in a simple cause-and-effect way to their instructional practices. Instead, they suggest a complex relationship, with many sources of influence at work; one such influence is the social context in which mathematics teaching takes place. (p. 138)

There is, however, evidence that what teachers believe about mathematics influences how they teach. As Remillard (1996, 1997, 1999) and others have shown, it influences how they use their textbooks. Hiebert (1986), Skemp (1978) and others have related these conflicting views of mathematics and mathematics teaching with respect to the particular kind of mathematical knowledge that is regarded more highly. These beliefs might not be explicitly acknowledged by the teachers. Cooney (1983) documented the case of Fred, whose stated beliefs about problem solving being an essential feature of his teaching were contradicted by his actual teaching practices.
Cooney and Shealy (1997) make the case that teachers’ beliefs impact what and how they teach. It is worth noticing that it is not a matter of being mistaken or being right. As Cooney and Shealy put it “The process of teacher change is risky and can be uncomfortable. Retreating to a dogmatic world where right is right and wrong is wrong is a tempting fate” (p. 106). A crucial point is how these beliefs are just a reflection of their, possibly unstated, philosophy of mathematics.

Thompson (1992) observed that teachers’ conceptions are viewed as “a more general mental structure, encompassing beliefs, meanings, concepts, propositions, rules, mental images, preferences” (p. 130), and therefore they are very difficult to evaluate:

From a traditional epistemological perspective, a characteristic of knowledge is general agreement about procedures for evaluating and judging its validity; knowledge must meet criteria involving canons of evidence. Beliefs, on the other hand, are often held or justified for reasons that do not meet those criteria, and, thus, are characterized by a lack of agreement over how they are to be evaluated or judged. (p. 130)

Cooney (2001) noted how the language used by teachers reflects the different views on what is important for students to learn, in particular, teachers do not believe that they are teaching for “rote learning”:

Teachers talk of enabling their students to solve problems and develop reasoning skills. Nevertheless, the evidence clearly shows that lecture is the dominant means of teaching in most school settings...This discrepancy results...from a difference as to what constitutes meaningful learning. Teachers live in a practical and parochial world as they are necessarily commissioned to deal with specific students in specific classrooms in a specific cultural setting. (p. 11)

Kuhs and Ball (1986) found four dominant and distinctive views of how mathematics should be taught:
1. **Learner focused**: mathematics teaching that focuses on the learner’s personal construction of mathematical knowledge;

2. **Content focused with an emphasis on conceptual understanding**: mathematics teaching that is driven by the content itself but emphasizes conceptual understanding;

3. **Content-focused with an emphasis on performance**: mathematics teaching that emphasizes student performance and mastery of mathematical rules and procedures; and

4. **Classroom focused**: mathematics teaching based on knowledge about effective classrooms.

When discussing teacher change, Goldsmith and Schifter (1997) recognized the complexity of the issues that influence the decisions made by the teachers:

[Mathematics teaching] involves a coordination of internal, psychological constructions of mathematics, epistemology and pedagogy that guide a multitude of on-the-spot practical decisions and external actions made in the context of the specific classroom conditions that prevail on a given day and time (p. 38).

It is important to be aware of the subtleties of the observable practices and behaviors of teachers, as opposed to their relation to their actual beliefs about teaching. As Goldsmith and Schifter (1997) point out, “without concomitant changes in fundamental beliefs about the nature of classroom activities, it is possible for teachers to assimilate new materials or strategies into traditional instruction” (p. 26). They further elaborate that “The issue is not simply one of having available a range of instructional strategies, but of knowing how and when such strategies can be most effectively employed” (p. 27). This know-how will be related, ultimately, to pedagogical content knowledge and mathematics content knowledge.
Smith (1998) documented changes in middle grades teachers’ conceptions of mathematics as a result of using an NSF-funded textbook. Smith studied changes in a teacher’s conceptions of mathematics, while she was piloting fifth-grade *Mathematics in Context* materials. She observed that the teacher reconstructed her understanding in and across different domains. In particular, she learned, for example, powers of two, fractions, decimals, percents, and algebraic expressions, reconstructing her understanding about concepts that she did not understand as they were taught to her in school. Smith says that

[Sandy] did this by building up connected conceptions that led from informal understandings in specific contexts to general and formal understandings of mathematical content. The nature of these connected conceptions was materially different from the formal generalizations she had been taught in school, which she indicated she did not then understand, lacked confidence in, and had difficulty remembering and using. (p. 182).

Yackel and Cobb (1996) proposed a framework that delineates two complementary norms of activity in mathematics classrooms, the social and the mathematical norms. These norms may be deliberately instituted in the classroom or are the result of implicit assumptions by the teacher. Lampert (1990), for example, sought to bring the discipline of mathematics into the classroom, looking for a way to teach her students what it means to know mathematics by “creating a social situation that worked according to rules different from those that ordinarily pertain in classrooms...Like teaching someone to dance, it required some telling, some showing, and some doing it with them along with regular rehearsals” (p. 58).

Teachers’ Mathematical Content Knowledge

Ma (1999) presents evidence that American elementary school teachers, for the most part, are not well prepared to teach mathematics with understanding, sug-
gesting that teachers simply don’t know mathematics with the depth and flexibility needed to teach it. Ma points out that “a good vehicle, however, does not guarantee the right destination. The direction that students go with manipulatives depends largely on the steering of their teacher” (p. 5). In the end, knowing how and why is more important: “even though the classroom of a Chinese teacher with PUFM [profound understanding of fundamental mathematics] may look very ‘traditional’ in its form, it transcends the form in many aspects” (p. 152). She sums up her argument by saying that “The real mathematical thinking going on in a classroom, in fact, depends heavily on the teacher’s understanding of mathematics” (p. 153). In this context, how teachers react to students’ claims is very important. In an illuminating example, Mr. Mao, quoted by Ma, tells how he learned from a student a novel solution to a problem, and explains under what circumstances this could happen:

But to catch students’ new ideas such as this one in the classroom you have to have a good understanding of mathematics. You have to catch it in a moment with the whole class waiting for your guidance. (p. 139)

Brown and Borko (1992) review factors that differentiate expert from novice teachers and how these factors are correlated to the depth of the teachers’ content knowledge. Among these factors are preparation time, connections within the discipline, different representations that promote pedagogical content knowledge, and ability to improvise.

Shulman (1986) defined a very useful construct, pedagogical content knowledge which goes beyond subject matter knowledge, to “the dimension of subject matter knowledge for teaching…[it] includes the ways of representing and formulating the subject that make it comprehensible to others” (p. 9).
The Aims of Mathematics Education

The selection of topics and the determination of the concepts and skills that students need relate closely with the bigger issue of what are the purposes of mathematics education. Content determination is closely tied with the intended curriculum, and this is determined by district or state policies that reflect the larger context in which the school is embedded.

Standards and curriculum frameworks embody societal values about what should be learned in mathematics courses. In this sense, they reflect what a particular community values in mathematics. Nevertheless, these values rarely reflect a consensus within such a community. The current controversies around mathematics education are rooted more in differences in goals than in differences in teaching methods or textbooks. Ultimately, these controversies must be resolved in one way or another by the teacher in the classroom. His or her own views on the goals of education in general, and the goals of mathematics education, in particular, will shape his or her decisions.

The NCTM Standards (1989) envisioned a reform that would create a workforce that is productive, creative, flexible, and open to all. In this sense, the standards had an immediate and explicit social motive for reform (Amit & Fried, 2002). The Principles and Standards for School Mathematics (NCTM, 2000) recognizes that “The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase” (p. 3), and enumerates four aspects of mathematics that determine the goals for mathematics education in the United States, namely, mathematics for life, mathematics as a part of a cultural heritage, mathematics for the workplace, and mathematics for the scientific and technical community. According to Amit and Fried (2002), these goals are
“much in the spirit of past reforms governed by a motive of social utility” (p. 359).

In a critique of a “technique curriculum,” Bishop (1988) says that it is based on the expectation of the student becoming a user of mathematical techniques:

So the idea of the average person as a peripatetic problem solver armed with a tool-bag of mathematical techniques and looking for problems to solve is a myth. But it is such a powerful myth. It dominates mathematics education at present, has done so for as long time, and probably will continue to do so for a long time to come, despite such attempts as this [book] to discredit it.

Bishop sees mathematics education as not only teaching children mathematics, but also educating them about mathematics, through mathematics, and with mathematics. “Teaching children to do mathematics emphasizes knowledge as ‘a way of doing’. A mathematical education seems to me, in contrast, to be essentially concerned with ‘a way of knowing’” (p. 3).

It is, likely these differences in the ultimate aims of mathematics education that feed the controversy around curriculum, standards, and textbooks. Curriculum frameworks, the organization of mathematics education, and even the ways in which mathematics is taught are “strongly dependent on the justification and the goals of mathematics education, whether implicit or explicit” Niss (1996, p. 20).

Passmore (1980) made a distinction between open and closed capacities, where the distinction lies in the fact that a closed capacity can be completely mastered. These are indeed necessary capacities, but once they are mastered, they cannot be done any better. They can be exercised faster, perhaps, but not better. The capacity to perform the multiplication algorithm is, in this sense, a closed capacity. On the other hand, however good someone is at exercising an open capacity, somebody else could do it better. Passmore suggests that the ability to play chess or knowing a foreign language are examples of open capacities. In the same way, thinking
or solving problems are open capacities. Further, in mathematics education, these differences have been stated as differences in the kind of knowledge that these capacities entail, instrumental versus relational (Skemp, 1978); procedural versus conceptual (Hiebert, 1986). Goals in mathematics education, as stated in curriculum frameworks and similar documents, usually present a mix of open and closed capacities. Throughout different reforms, the pendulum has oscillated between these kinds of capacities.

**Conceptual Framework**

The conceptual framework for this study was based on Remillard’s model of the teacher’s role in curriculum development (1999). The model includes three arenas (see Fig. 2.1), each one of these “defines a particular realm of the curriculum development process about which teachers explicitly or implicitly make different types of decisions” (Remillard, 1999, p. 322). By looking at the three stages in which teachers interact with their textbooks, clearer descriptions of the factors that might determine how teachers use their textbooks can be explored.

**Design Arena**

This arena is characterized by the decisions teachers make regarding task selection, namely selecting and adapting tasks from the textbook. For example, the way a particular teacher goes about selecting tasks will be influenced by how he or she reads the textbook. The teacher’s beliefs about mathematics and mathematics teaching will then influence how the teacher reads the textbook.

Task selection is also influenced by the teaching context. The classroom and school context will influence both the reading of the textbook as well as the task selection itself. Professional development opportunities, for example, will shape
this context, and will be intimately related to the choices the teacher makes.

Finally, the textbook will be a crucial influence in the task selection process. The availability of tasks, the way these are presented, the ancillary materials that might enrich the teacher’s repertoire of resources, the particular philosophy of the developers and its possible match with the teacher’s own epistemological stance will constitute an important influence, as well.

*Construction Arena*

The construction arena is characterized by task enactment, the actual development of the task by the teacher and the students in the classroom, where task adaptation is a major component. In this arena the teacher has to read the students’ performances and improvise in response to them. In order to enact the tasks, the teacher has to examine and analyze them as the lesson progresses. The interpretation of how the lesson is flowing and how tasks should be adapted is influenced by the teacher’s ideas about learning and about what students need to know. In this arena, the textbook might play a minor role, providing sources for new tasks or for adapting the ones that were planned. In this sense, Steffe (1990) says that “A mathematical learning environment is a variable experiential field whose contents are specified by a community of participants” (p. 392).

Again, in this arena, teachers’ beliefs and conceptions play a major role, as teachers have to react to students’ enactment of the designed activities. Students might respond as the teacher expected, but the teacher will have to make decisions on the spot as to how to pursue a particular task or when and how to deviate from the original plan. What the teacher thinks about how mathematics should be taught will influence the focus of classroom activities and the way the teacher reacts to critical events.
In this arena, the needs of students, as perceived by the teacher, will shape the adaptation and enactment of tasks. In classrooms where teachers are implementing a standards-based curriculum, teachers not fully convinced by the approach may adapt the tasks to fit into their “comfort zone” (Clarke et al., 1996; Remillard & Bryans, 2003), compromising the spirit of innovation. In other cases, teachers might interpret the teaching practices in ways that were not intended. Sfard (2003) addressed this possibility of interpretations of the Standards:

Zealous to bring a real change, [teachers] often start believing that the old and the new are mutually exclusive. This is how the profound constructivist idea of a learner as builder of her own knowledge may be trivialized into a total banishment of “teaching by telling”—and this is how the call to foster mathematical communication may turn into an imperative to make cooperative learning mandatory for all. It is also how the exhortation to teach mathematics through problem solving can bring a complete delegitimatization of instruction that is not problem based—and it is how the request to make mathematics relevant to the student can result in the rejection of mathematics that does not fit in a real-life wrapper. Despite the high quality of the ingredients, the meal we cook in this unbalanced way must, sooner or later, prove harmful rather than healthy.

Curriculum Mapping Arena

The curriculum mapping arena is characterized by topic determination and content determination. The former refers to the selection of topics to be included in the course, such as geometry, number and operations, data analysis, while the latter refers to the determination of the concepts and skills considered to be relevant for the topics selected, including the sequence and pace in which the students will experience the topics. Since the textbook already offers a map for the curriculum, the teachers can use this map as they see fit. They might skip a lesson, or change the sequence, but usually the topic determination is likely to follow closely
the contents of the textbook.

Summary

It has been assumed for a long time that teachers follow their textbooks very closely. Earlier studies substantiate these claims to some extent and more recent studies and international comparison studies add credence to the claim. However, the actual use of the textbook in the classroom by the teacher has received only limited attention. One of the reasons is that teachers rarely are observed in schools where no intervention is being made. In most cases, the data come from surveys, and not from classroom observations. Further, the middle school grades have not received the attention that has been given to elementary grades regarding textbook use.

The interplay of the different factors that affect the use of a textbook in the classroom is a matter that deserves more attention, more so given the documented relevance that the textbook has in American schools, as well as in other countries.

We still can repeat what Cronbach (1955) said so long ago, “The sheer absence of trustworthy fact regarding the text-in-use is amazing.” We also need to address the interaction between the teacher and his or her textbook and its implications for reform and for curriculum development. This need has been recognized more recently, too:

The implicit curriculum of how mathematics is learned or what constitutes mathematical exploration is seldom addressed in syllabi of intended curricula; yet it constitutes an important part of the implemented curriculum. What is important to recognize, then, is that any study of curriculum reform or the context in which learning occurs must contend with the interaction between the curriculum as designed and the way in which teachers interpret and teach that curriculum. (Cooney, 1993, p. 16)
This study addresses two main issues. On the one hand, it addresses directly the question, how do middle school mathematics teachers use their textbooks? Collecting and analyzing data from a group of teachers in different states using different kinds of curriculum, a description of the trends and dominant practices will be discussed. On the other hand, this study will explore more in-depth the factors that affect teachers’ decisions regarding their use of textbooks. Three case studies will illustrate these findings.
METHODOLOGY

The design of the study, the cases selected, data collection methods, and data analysis approaches are described in this chapter. Teachers from 11 middle schools participated in this study. The selection of participants and the relevant information about them is discussed in detail. The data sources included surveys, observations, and textbook diaries developed for the Middle School Mathematics Study. These instruments are presented in this chapter. A discussion of how the data were analyzed concludes the chapter.

The Middle School Mathematics Study

The Middle School Mathematics Study, or (MS)$^2$, a project of the University of Missouri, is a two-year longitudinal study that addresses questions regarding the impact of different middle school mathematics curricula on student learning. This research assesses student mathematics achievement in grades 6-8 and monitors these students’ progress during a two-year period. In addition to evaluating student mathematics achievement, the study examines links between the fidelity of the implementation of the programs and students’ mathematics achievement.

Eleven school districts are participating in the (MS)$^2$ study, six of them are using NSF-funded curricula —*Connected Mathematics, Mathematics in Context*, and *MATH Thematics*— (involving 27 teachers), while the other five (comprising 26 teachers) are using a variety of different commercially generated textbooks.
In six of these districts, teachers use NSF-funded curricula (see Table 3.1): Connected Mathematics Project, Pearson Education (districts 1 and 2); MATH Thematics, McDougal Littell (districts 3 and 4); and Mathematics in Context, Encyclopædia Britannica (districts 5 and 6). The rest of the schools, identified as companion schools, use a variety of textbooks: Math Advantage, Harcourt School Publishers (district 7); Mathematics: Applications and Connections, Glencoe McGraw-Hill (districts 7 and 10); Addison-Wesley Mathematics, Addison-Wesley (district 8); Mathematics, Houghton Mifflin (district 8); Mathematics Today, Harcourt School Publishers (district 8); Math Matters, An Integrated Approach, South Western Educational Publishing (district 8); The Mathematics Experience, Houghton Mifflin (district 9); Saxon Math 76, Saxon Publishers (districts 9 and 11); and Saxon Math 87, Saxon Publishers (district 11).

Schools were selected based on the following criteria:

— Schools using NSF-funded curricula had to be nominated by the respective curriculum developer.

— Schools using NSF-funded curricula had to have at least two years of implementation.

— Grade 6, 7 and 8 students had to be housed in same building/campus. As noted above, exceptions had to be made in two of the companion districts.

— Schools and teachers had to be willing to participate.

— Baseline achievement data (at grade 4 or 5) had to be available.

— Companion schools were suggested by the schools using NSF-funded curricula as schools that would have similar characteristics.
Table 3.1 summarizes the information about the schools that participated in the study, the kind of city where their district was located, and the percent of students eligible for free and reduced lunch. For the purpose of this study, the districts were determined to be urban if they had strong urban characteristics and a population over 100,000. Suburban districts were those with population between 5,000 and 100,000, near or part of a larger populated area. Small city districts were those where the city’s population was between 5,000 and 100,000 but were not near or part of a larger populated area. Rural districts were those in locations with strongly rural characteristics and population under 5,000.

In all cases, except one in which one teacher declined to participate, all sixth and seventh grades teachers at the school participated in the study.
Table 3.1

Description of Participating Schools

<table>
<thead>
<tr>
<th></th>
<th>URBAN</th>
<th>SUBURBAN</th>
<th>SMALL</th>
<th>RURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMP</td>
<td>District 1</td>
<td>10 teachers</td>
<td>55% FRL</td>
<td>District 2</td>
</tr>
<tr>
<td>MT</td>
<td>District 3</td>
<td>4 teachers</td>
<td>26% FRL</td>
<td>District 4</td>
</tr>
<tr>
<td></td>
<td>District 5</td>
<td>5 teachers</td>
<td>53% FRL</td>
<td></td>
</tr>
<tr>
<td>MiC</td>
<td>District 6</td>
<td>4 teachers</td>
<td>24% FRL</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>District 7</td>
<td>8 teachers</td>
<td>13% FRL</td>
<td>District 8</td>
</tr>
<tr>
<td></td>
<td>District 9</td>
<td>3 teachers**</td>
<td>13% FRL</td>
<td>District 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>District 11</td>
</tr>
</tbody>
</table>

* from three elementary schools and one junior high school
** from one elementary school and one junior high school
Several instruments were developed to collect data for (MS)². An initial teacher survey was designed to document teachers’ background, beliefs, practices, professional development opportunities, and use of the textbook. During three 10-day periods (fall and spring) teachers were asked to keep a diary indicating the extent of use of the district-adopted textbook. Observations were conducted in each classroom three times per year. A standard observation instrument was used to collect information about the use of the textbook during the observations. Teachers were interviewed focusing on their beliefs on the use of textbook materials and instructional decisions related to implementation of the mathematics curriculum.

Overview of Study

The study reported here was part of the longitudinal (MS)² study. One of the primary goals of the (MS)² study was to describe how teachers use district-adopted mathematics curriculum materials and other curricular resources. Due to its broader perspective, the Middle School Mathematics Study was not designed to provide insight on finer issues regarding how teachers use their textbooks. The purpose of the study reported here was to gain more in-depth understanding of the reasons behind the decisions made by the teachers regarding mapping, planning, and enacting the district-adopted curriculum.

A descriptive study of the whole group of participants in (MS)² was conducted. Analysis of survey data, textbook diaries, and classroom observations was used to describe the use of mathematics textbooks by teachers in 11 middle schools. Three teachers from this group were identified for individual case studies. A case study approach was selected to provide a finer grained view of the nature of textbook use. These teachers were interviewed on several occasions and were observed for longer periods.
The data were collected to address the following research questions:

1. How do teachers utilize district-adopted school mathematics textbooks? To what extent do they use them? For what purpose?

2. Why do teachers make the instructional decisions they do regarding the use of the district-adopted textbook?

3. Are there differences in how the district-adopted mathematics textbook is used between middle school teachers that use standards-based textbooks and teachers that use traditional textbooks?

Research Design

This study had two components. First, a descriptive analysis of 53 teachers from 11 schools participating in (MS)$^2$ was conducted. Second, an instrumental collective case study (Creswell, 1998; Stake, 1995) was conducted with three of the (MS)$^2$ teachers. Two of these teachers, David and Pamela, were selected from school 6, Hamilton Middle School, the third teacher, Kate, taught at school 9, Charles Elementary$^1$. These case studies focused on the issue of textbook use and the decisions made by teachers regarding textbook use.

Even in a collective case study as this one, it is very difficult to choose representative or typical cases (Stake, 1995). The criterion used to select the cases was to maximize the differences, following a maximum variation sampling strategy for purposeful sampling (Patton, 1990), from the schools for which the researcher was the data collector for the (MS)$^2$ study.

A case study can be the best method to use when the purpose of the study is to examine the interaction of different significant factors associated with a phe-

$^1$The districts’, schools’, and teachers’ names are pseudonyms.
nomenon (Sowder, Philipp, Armstrong, & Schappelle, 1998), the use of textbooks in this case. Although “Case study is not a methodological choice, but a choice of object to be studied” (Stake, 1994, p. 236) it does define the approach taken towards the inquiry, which in this case was of an interpretive nature. Accordingly, this study looked for patterns more than for correlation (Stake, 1995). This was accomplished by studying particular cases. Following the instrumental approach, the first priority was to understand the cases. A first level of understanding was descriptive, trying to look at what teachers were doing and how they were doing it, and the second level was that of explaining and sense-making (Huberman & Miles, 1994). Both of these levels were taken into account for the within-case analysis and the cross-case analysis.

Case Studies

Hamilton Middle School

Hamilton is one of the five middle schools in Palmerston School District. Palmerston is a city with a population of 130,000 (180,000 for the whole metropolitan area). The student population of Hamilton is 90% White, 3.3% American Indian, 2.4% Black, 1.8% Asian, and 2.2% Hispanic, while 24% of the students are eligible for Free or Reduced Meals plans. The school does not have an English as a Second Language program, for two other middle schools in the district are designated ESL Center Based Sites. According to the assistant principal, the recent growth in Palmerston has created the distinct situation of Hamilton receiving students from both very wealthy families and very poor, and very little in between. The professional staff to student ratio in Hamilton is around 1 to 15.

Palmerston School District adopted Mathematics in Context in its five middle schools three years ago, after a committee that included several teachers piloted
different standards-based curricula. David and Pamela were selected for the case study among the four middle school mathematics teachers at Hamilton because data from their initial survey suggested that differences between the two of them would be substantial, with regard to their background, beliefs, and practices.

**Harlan Elementary**

Harlan Elementary is the only elementary school in Charles School District, in a rural community of 1200 people. The district has a junior high-school (grades 7–9) and a high-school (grades 10–12). In the 2002–2003 school year, the student population in Charles School District was 98% White, with 32% of students eligible for free or reduced lunch. There were 53 students in sixth grade.

Harlan Elementary had tried several mathematics curriculum materials, but the teachers were not happy with the results. For the 2002–2003 school year a committee formed by teachers in the district recommended the adoption of *Saxon Math* (Hake & Saxon, 1997) for grades K–6. Both sixth grade teachers were very much in favor of this adoption. As part of the selection process, they had a sales representative teach a lesson to students in Harlan, so that the students opinion could be taken into consideration. Data from the initial survey did not reveal differences between the two teachers. Kate was invited to participate.

**Data Collection**

**Descriptive Study**

This study utilized instruments developed by the Middle School Mathematics Study research team including this researcher. The following instruments were developed for the (MS)² project, and therefore were the data sources for the de-
scriptive study of the sample of 53 teachers. These data were collected by the (MS)² research team.

— Initial Teacher Survey

The survey was designed to document the teachers’ background, beliefs, practices, professional development opportunities, and use of textbook. An adapted version of the 2000 Math and Science Education Survey: Mathematics Questionnaire was used (see Appendix A). The data were collected during the first six weeks of the 2002–2003 school year.

— Textbook-use diary

During the fall 2002 and winter 2003, teachers were asked to maintain a daily textbook-use log for 10 class periods. The log provided a basic record of the topic, the pages of the textbook used in planning or during the lesson, whether students used the textbook and, if so, how it was used, and what other materials were used to plan and implement the mathematics lessons (see Appendix B). Teachers kept these diaries for two 10-day periods, during fall, 2002 and winter, 2003.

— Classroom observations

Two classroom observations for each sixth and seventh grades teacher were conducted by the (MS)² research team, including this researcher in Hamilton and Harlan. These observations were done during the fall 2002 and winter 2003. The observers used the class script notes taken during the classroom observation to complete the observational instrument. The observation instrument included a short pre-observation interview with the teacher, a description of the main activities that took place during the class period, and
the amount of time devoted to each activity. This observation instrument was developed at the University of Wisconsin for the Longitudinal Study of Mathematics, and revised at the University of Missouri for the Middle School Mathematics Study (see Appendix C). The instrument also includes a post-observation interview with the teacher regarding the materials used both to plan the lesson and to make decisions during the enactment of the lesson. Utilizing information gathered during the observation, the data collectors answered some analytical questions regarding the use of textbook and the nature of the tasks enacted in the classroom during the lesson.

Case Study

For the case study, the data collected for the (MS)$^2$ was used, but additional sources were needed for the three cases. These additional sources were classroom observations, including short pre- and post-observation interviews, and three in-depth interviews with each one of the three teachers selected for the case study.

— Additional observations were done by this researcher for the case studies. David was observed nine times and Pamela was observed during 14 lessons over two one week periods in November, 2002 and February, 2003. Kate was observed nine times, one week in November, 2002 and one week in January, 2003. These observations were audio-recorded.

— Teacher Interviews

David, Pamela, and Kate were interviewed for (MS)$^2$. This interview served the purpose of providing data about how each teacher used his or her textbook for planning the course/lesson as well as his or her perception of the district-adopted textbook (see Appendix D). Shorter additional interviews
were done in conjunction with the observations, in order to clarify what had been recorded during the observation and why certain decisions had been made. The purpose of these interviews was to ensure that the observer’s notes accurately reflected what had been observed.

Three additional in-depth semi-structured interviews were done with each case study teacher (see Appendix E). One of these interviews focused on the teacher’s experience as a mathematics teacher and to explore the teacher’s view of mathematics and of mathematics teaching. The second interview focused on the teacher’s perception of strengths and weaknesses of their mathematics textbook and the role of the textbook in his or her teaching. The interviews were supplemented with additional questions following up the observations and the post-observation interviews, with the purpose of gaining an understanding of the reasons behind certain decisions made by the teachers related to the use of textbooks or other instructional materials. A third interview was done during the second round of data collection, focusing mostly on the use of the particular textbook that each teacher was using and on their views on mathematics teaching, among other issues.

All interviews were audio-recorded and the three in-depth interviews were transcribed. Informal conversations helped clarify the context and enrich the researcher’s perspective on the data.

All these instruments were piloted with two seventh grade mathematics teachers not participating in the study. This pilot study provided information on the usability of the surveys and diaries, and the kind of problems that teachers could encounter when using them. The interview questions were also tried and refined as result of the pilot study. Feedback from the two teachers was received on all
instruments used.

In August 2002, the (MS)$^2$ local data collectors participated in a two-day training session, during which videotaped lessons were observed and the observers’ notes compared in order to ensure interrater reliability of the instruments.

Data Analysis

Descriptive Study

Initial Teacher Survey Data

The survey data were organized and summarized. A database was created in order to be able to sort and group the teachers according to different categories, such as grade, district, age, experience, type of curriculum used, among others. From these database summaries were prepared, and frequencies of different variables were calculated. These frequencies were the data used for the comparisons with the data from the 2000 National Survey of Science and Mathematics Education (Weiss et al., 2000; Whittington, 2000). In particular, the survey data were further organized into categories, according to the kind of curriculum used by the teachers, and according to grade, and the results of the survey were compared across curricula and grade. When appropriate, $\chi^2$ tests were done in order to determine whether association between variables could be established.

The data from the teachers in this study was compared with the middle school teachers’ data from the Report of the 2000 National Survey of Science and Mathematics Education (Weiss et al., 2000; Whittington, 2000). This established the representativeness of the sample of 53 teachers in (MS)$^2$ as compared with the national sample.
Textbook-use Diary Data

The textbook diaries provided data on the extent to which teachers drew on their district-adopted textbook to plan and enact daily instruction. In particular, three variables from this instrument were used (Textbook pages used by teacher, Textbook pages used by students during the lesson, Homework from textbook assigned). Numerical codes were assigned to the teachers’ responses, according to the source of activities or tasks for the lesson.

For each column, the researcher coded the teacher entries, indicating whether the teacher used the “district adopted textbook” (coded as 1), “other materials” (coded as 2), “nothing” (coded as 4) for each day of the 10-day period, with other codes used for cases in which a test or quiz was taken, or to indicate a blank entry when the teacher did not explicitly stated that no materials were used. A sample coded diary is in Appendix F.

These diaries provided some measure of the extent of use of the textbook by teachers and students on 20 instructional days from October–January. Frequency of use was determined by the percentage of the 20 lessons during which the textbook was used by the teacher, by the students, or to assign homework. These percentages were compared with those on textbook use from the initial survey, in particular with question 32 of the survey (see Appendix A), which deals with the frequency of use of the textbook.

Classroom Observations Data

The classroom observations provided information on how the curriculum materials were used by the teacher and students. The observations for the 53 teachers in two rounds of observations were summarized and entered into a database for
further analysis. The entries for use of textbook by the teachers were examined and sorted according to emerging patterns. The observers used free text descriptions of how the textbook was used in the classroom. These descriptions were categorized.

These are sample descriptions done by the observers:

1. Teacher read from text, selected demonstration problems and form of lesson from text, assigned homework from text.

2. The teacher followed material in text exactly, reproduced some on transparencies.

3. Showing diagrams (decimal place chart) and assigning homework.

The initial categories were:

1. Select problems for assignment and review

2. Read from text

3. Assign homework

4. Resource for data

5. Transparencies from textbook materials

6. Referred to text

7. Used notes from textbook

8. Selected activity from textbook

9. Used problems/exercises to guide lesson

10. Used questions from the textbook for discussion
11. Followed the lesson as laid out in the textbook

12. Showed diagrams

13. Selected examples to demonstrate

These first categories were too descriptive and were not helpful to classify the data in a meaningful way. Different categories were then collapsed into more general categories. Categories of use were thus generated and revised.

The second round of revisions yielded the following categories:

1. Demonstrated problems or examples

2. Assigned problems

3. Definitions or introductions from text

4. Transparencies from text

5. Followed lesson structure from text

6. Source of data/figures

7. Planning only

In this scheme, the three entries given as examples were coded: 1 and 2 the first one; 5 the second one; and 6 the third one. These first classifications did not use the other entries of the observation tool (see Appendix C). Other data in the instrument was considered to have a better picture of textbook use during the lesson. For example, other data used were the description on how the students used the textbook, the perceived influence that the textbook had in the content or presentation of the lesson, and the use of other materials. A new category emerged,
from those cases in which the teacher was reported using the textbook or activities but some evidence existed on the task not reflecting the way it was posed in the textbook. This evidence could come from the perceived influence of the textbook in the presentation (“not at all,” or “very little”), as reported by the observer, or from an explicit statement by the teacher about adapting a task from the textbook, as opposed to using it as laid out in the textbook.

Through an iterative process of revising the coding, the codes eventually used focused on the primary use of the textbook during the lesson in terms of time or emphasis in a way consistent with the conceptual framework and current literature (Remillard, 1999; Remillard & Bryans, 2003). In their study, Remillard and Bryans (2003) suggested similar categories for what they called primary curriculum sources. The researcher found these categories to be consistent with a revised description of the categories, and these were organized accordingly. Descriptions for each of these categories were drawn from data from the observation tool, as described above. The revised categories, and their descriptions are as follow:

**Teacher used the textbook to selected tasks.** Teachers selected different kinds of tasks. Some teachers assign their students a list of exercises from a section in the book to work individually, others assigned more elaborated activities for students to work in groups. While teachers used tasks that required different levels of student engagement and difficulty and organized their classes differently, teachers were included in this category if their primary use of the textbook was for their students to work on tasks from the textbook posed with little modification.

**Teacher used the textbook to adapt tasks from it.** In this case teachers made explicit modifications to the textbook’s tasks that were either apparent to the
observer or stated by the teacher in the pre- or post-observation interviews.

**Teacher used the textbook to draw examples.** This category includes teachers who were observed using examples, problems, or exercises from the textbook and demonstrated them to the students as the main activity during the lesson.

**Teacher used the textbook to guide the lesson.** Teachers followed the lesson as it was laid out in the textbook. In some cases the teachers followed more thoroughly than others the recommendations in the teacher’s guides, however, teachers in this category generally followed the lesson structure, content, and organization as outlined in the textbook.

**Teacher used other materials.** This category includes teachers who used other curriculum materials, except those designed by the teachers themselves, as the main source of content of the lesson.

**Teachers used no textbook.** Teachers created worksheets, or had examples and exercises in notes or transparencies. Teachers in this category used no mathematics textbook of any kind during the observation.

These modes of use of textbook were used to describe the primary role of textbook during the lesson. A sample of a database entry corresponding to the first teacher in the examples above is in Appendix G.

**Case study**

*Classroom Observation Data*

For the three case studies, the classroom observations were used as a basis for lesson summaries. After each lesson, a short summary was written. Some incidents were identified to be followed up in the post-observation interviews and to
produce an initial narrative of the case. Part of this narrative was the result of the same analysis done for the teachers in the descriptive study. During subsequent phases of analysis, the tape recordings of the lessons were heard several times, to complement and revise the summaries. Emerging themes in the mathematics lesson routine were identified for each teacher. During this process, the content of the textbooks used by the teachers, *Mathematics in Context* (David and Pamela), and *Saxon Math 76* (Kate), were additional sources of data that were compared with the lesson notes in order to examine how teachers made sense of each text’s features and content.

*Interviews Data*

The three in-depth interviews were transcribed. During the process of checking the transcriptions, a first identification of the main issues was completed. Analytic notes were made from these data in relation to the conceptual framework. Relevant excerpts from the interviews were identified and organized to be part of the narrative of each case.

Cases narratives were developed, looking for holistic pictures of the teachers, but at the same time organizing these narratives according to the conceptual framework described in the previous chapter. A cross-case analysis was done by looking for commonalities and contrasts in the descriptions and then returning to the cases to check the validity of the claims.

Interview data were triangulated for each case with the initial survey, the textbook diaries, and the observation summaries. For example, teachers were asked to describe their typical lessons, and the initial survey had questions regarding teaching practices and the frequency with which the teacher would use them. At the same time, observation data would corroborate what was stated during the
interview, and also provided new questions to include in subsequent interviews.

To ensure that the narrative of each case and the claims made therein were accurate and trustworthy descriptions of each case, lesson tapes selected randomly were reviewed again and compared with the narrative. The researcher reviewed all interviews for the same purpose.

Summary

Surveys and classroom observation data from 53 middle school mathematics teachers in 11 different schools were used to document the extent of use of mathematics textbooks. For a more in-depth view of the factors associated with the nature of use of mathematics textbooks, three case studies were conducted with additional observations and more extensive interviews. Based on these different sources of data, inferences were made regarding the interaction between teachers and curriculum materials. The results are presented in the next chapter.
RESULTS

The results are presented in this chapter and are organized in two main sections: the (MS)$^2$ teachers and the case studies. For the first section, the results are organized by data source. Each source —initial teacher survey, textbook diaries, and classroom observations— provided data that help describe both the group of (MS)$^2$ teachers and their background, and the extent and nature of textbook use by these teachers. The cases are described in the second section. For each case, general descriptions of the lesson routine and the content of the lessons observed are given. The interactions of each teacher with the district-adopted textbook are described, using the three arenas of Remillard’s model as organizers.

The Teachers in the Middle School Mathematics Study

A descriptive analysis of the whole group of participants in (MS)$^2$ was conducted. Analysis of survey data, textbook diaries, and classroom observations was used to describe the use of mathematics textbooks by teachers in 11 middle schools. These results are presented here.

Initial Teacher Survey

The teacher survey (Appendix A) used in this study was adapted from the 2000 National Survey of Science and Mathematics Education (Weiss et al., 2000). The national survey provides a benchmark and was used to determine the representa-
tiveness the sample of teachers in this study were similar to the national profile. The survey, completed by \((MS)^2\) participants prior to the 2002–2003 school year, requests information on teachers’ professional background, teaching practices, and on views about mathematics learning and teaching. Responses were compared with those in the national sample.

**Teachers’ Background**

Approximately 64% percent of the 53 participants in this study were female, while in the national sample, 72% of the middle school teachers were female. The mean age was 43 years old (median 42). Figure 4.1 illustrates the comparison of the participants with the national sample and confirms that the distribution across age groups is similar.

![Figure 4.1: Age Groups of Participants Compared with a National Sample](image)

The mean overall teaching experience (summarized in Figure 4.2) of the teachers in this study was 14.8 years.
The distribution of ages of the participants in this study was similar to that of the national sample. Nevertheless, in the group of participants in this study 65% of teachers had 11 or more years of experience, compared with 54% in the national sample, while 12% of the participating teachers had two years or less of experience, compared with 20% in the national sample.

Forty four percent of the teachers in the national sample had a master’s degree. Among the teachers in this study, 53% of them had a master’s degree. Figure 4.3 illustrates a comparison of the two surveys with respect to the undergraduate degree of the participants. In this study, many more of the participants had a degree in mathematics education.

The teachers that participated in this study have a wide range of certifications, with many of them holding multiple certifications. Table 4.4 summarizes their responses, grouped by the kind of textbook they use. Twenty six of the teachers have neither a middle school mathematics certification nor a high school mathematics
certification. These teachers had a general certificate to teach in middle school or an elementary school certification.
When separated by grade, 23 sixth grade teachers have neither a middle school mathematics certification nor a high school mathematics certification. Only four of the seventh grade teachers have neither of those certifications. Figure 4.5 shows the number of teachers that are certified to teach for each grade level. Some teachers are certified to teach at different grades.

Figure 4.5: Teachers’ Certification*, by Grade

Most of the teachers, both in this study and in the national sample, reported feeling “adequately qualified” or “very well qualified” to teach a number of topics. There were, however, some differences. For example, while 90% of the teachers in the national sample said they felt qualified, including both “adequately qualified” or “very well qualified,” to teach algebra, only 72% of the (MS)² participants responded in the same way. Sixty-five percent of the teachers in the national sample felt qualified to teach functions and pre-calculus concepts compared with 40% of the teachers in this study. Sixty-eight percent of the teachers in the national sample
indicated feeling qualified to teach the use of technology in support of mathematics, while 57% of the teachers in this study felt qualified to do so.

There were apparent differences in the time spent in professional development in mathematics during the past three years between the participants in this study and the national sample. The difference is concentrated in the category of those who have not spent any time and those who have spent less than 6 hours in professional development in the past three years. Nearly one fourth of the teachers in this study had no professional development opportunities in the past three years, as is illustrated in figure 4.6.

Figure 4.6: Time Spent on Professional Development in Mathematics in the Last 3 Years

When separated by the kind of textbook they use, the teachers using NSF funded textbooks seemed to have had, as a group, more opportunities for professional development, as is illustrated in Figure 4.7. When grouped by grade level, almost a third of the sixth grade teachers reported not having spent any time in profes-
sional development activities, while more than half of the seventh grade teachers reported having spent more than 35 hours in professional development activities over the last three years (see Figure 4.8).

Figure 4.7: Time Spent on Professional Development in Mathematics in the Last 3 Years, by Textbook

The participants in this study seem to parallel the national sample in many respects. There are however more teachers with graduate degrees in this study, and, as a whole, these teachers have more teaching experience than those in the national sample. In spite of this, more teachers in this study expressed feeling not adequately prepared to teach certain topics than in the national sample, and they indicated having less professional development opportunities.

Textbook Use

Regarding the use of their textbook, the teachers in the national sample and the teachers in this study expressed comparable expectations about the percent of their
textbook that would be covered in the school year. For example, figure 4.9 shows about half of each group expected to cover between 75 and 90% of the content in their textbooks.

When asked how they would rate the quality of their district-adopted textbook, the responses from the (MS)² teachers were similar to those from the national sample (see Figure 4.10). Over 90% of the teachers both in this study and in the national sample rated their textbook as being of “fair quality,” “good,” or “very good.”

The initial survey included questions related to the extent and nature of use of their mathematics textbook. Teachers were asked to describe how they used their textbook by indicating how often they used the textbook for a number of purposes. Table 4.1 summarizes their responses, grouped by kind of curriculum.

While in general the responses from teachers using NSF funded curricula were similar to those using other textbooks, some differences are worth noting. For
example, NSF curricula users were more likely than non-NSF curricula users to indicate using the textbook to plan lessons. NSF curricula users were also more likely to read the teachers guide and use the textbook to guide the structure of the
course (see Table 4.1).

The data suggest that mathematics textbooks are used frequently by middle school teachers. Moreover teachers using NSF curricula report using textbooks to a greater extent for planning than users of other curricula. This could be evidence of a different role played by the textbook. On the other hand, among teachers using non-NSF curricula, teachers using *Saxon Math* displayed a remarkably faithful implementation of their curriculum, using the textbook to plan almost all the time. Table 4.2 summarizes responses to question regarding use of textbook for planning, grouped by textbook.

In the survey, teachers responded to a question regarding their perceived degree of control over matters of textbook selection, curriculum mapping, planning, and assessment. Table 4.3 summarizes their responses, with the answers from teachers not using NSF-funded curricula in parentheses.

There was no discernible pattern between these responses and the curriculum that the teachers are using. There was however, a slight indication that teachers using NSF-funded curricula are least likely to see themselves in control over determining course goals and objectives, selecting textbooks, and selecting the sequence in which topics are covered.
Table 4.1
*Frequency of Responses to Survey Question on Textbook Use. (N = 53)*

by type of textbook

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I follow the textbook page by page</td>
<td>(3)</td>
<td>3 (5)</td>
<td>10 (8)</td>
<td>12 (6)</td>
<td>3 (3)</td>
</tr>
<tr>
<td>b. I pick what is important from the textbook and skip the rest</td>
<td>(3)</td>
<td>7 (3)</td>
<td>12 (9)</td>
<td>6 (10)</td>
<td>3</td>
</tr>
<tr>
<td>c. I follow my district’s recommendations, not the textbook’s</td>
<td>1</td>
<td>2 (2)</td>
<td>8 (7)</td>
<td>8 (12)</td>
<td>5 (5)</td>
</tr>
<tr>
<td>d. The textbook guides the structure of my course</td>
<td>0</td>
<td>2 (3)</td>
<td>1 (7)</td>
<td>20 (13)</td>
<td>4 (3)</td>
</tr>
<tr>
<td>e. I incorporate activities from other sources that follow the textbook’s philosophy</td>
<td>(1)</td>
<td>4 (2)</td>
<td>7 (11)</td>
<td>13 (12)</td>
<td>1</td>
</tr>
<tr>
<td>f. I incorporate activities from other sources that provide what the textbook is lacking</td>
<td>0</td>
<td>1 (3)</td>
<td>10 (9)</td>
<td>15 (14)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>g. I follow the suggestions in the teacher’s guide when I design my lessons</td>
<td>0</td>
<td>1 (4)</td>
<td>8 (12)</td>
<td>17 (9)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>h. I use the textbook to plan my lessons</td>
<td>0</td>
<td>(1)</td>
<td>4 (14)</td>
<td>18 (5)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>i. I read the teacher’s guide</td>
<td>0 (1)</td>
<td>2 (3)</td>
<td>2 (9)</td>
<td>19 (8)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>j. I assign homework from the textbook</td>
<td>0</td>
<td>1 (1)</td>
<td>5 (10)</td>
<td>14 (9)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>k. My students use their textbook during the math lesson</td>
<td>0</td>
<td>0 (4)</td>
<td>5 (8)</td>
<td>15 (12)</td>
<td>6 (2)</td>
</tr>
<tr>
<td>l. My students use their textbook after the math lesson for homework assignments</td>
<td>0</td>
<td>1 (2)</td>
<td>6 (9)</td>
<td>13 (10)</td>
<td>5 (7)</td>
</tr>
</tbody>
</table>
Table 4.2: Number of Teachers That Reported Using their Textbook to Plan Lessons, Grouped by Textbook (N = 53)

<table>
<thead>
<tr>
<th>Textbook</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMP</td>
<td>1</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH Thematics</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MiC</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saxon Math</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other non-NSF combined</td>
<td>1</td>
<td>14</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>


Table 4.3
Frequency of Responses Regarding Perceived Level of Control over Different Aspects of the Mathematics Classes (N = 53). By type of textbook.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>No control</th>
<th>Very little control</th>
<th>Some control</th>
<th>A fair bit of control</th>
<th>Strong control</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Determining course goals and objectives</td>
<td>4 (1)</td>
<td>9 (4)</td>
<td>7 (5)</td>
<td>3 (9)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>b. Selecting textbooks/instructional programs</td>
<td>8 (3)</td>
<td>8 (5)</td>
<td>7 (7)</td>
<td>3 (6)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>c. Selecting other instructional materials</td>
<td>3 (3)</td>
<td>7 (5)</td>
<td>9 (11)</td>
<td>7 (6)</td>
<td></td>
</tr>
<tr>
<td>d. Selecting content, topics, and skills to be taught</td>
<td>6 (2)</td>
<td>5 (6)</td>
<td>8 (5)</td>
<td>4 (7)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>e. Selecting the sequence in which topics are covered</td>
<td>4 (3)</td>
<td>4 (1)</td>
<td>9 (5)</td>
<td>6 (8)</td>
<td>4 (8)</td>
</tr>
<tr>
<td>f. Setting the pace for covering topics</td>
<td>2 (1)</td>
<td>3 (1)</td>
<td>7 (5)</td>
<td>8 (9)</td>
<td>6 (9)</td>
</tr>
<tr>
<td>g. Selecting teaching techniques</td>
<td>1 (0)</td>
<td>2 (1)</td>
<td>2 (5)</td>
<td>12 (6)</td>
<td>10 (13)</td>
</tr>
<tr>
<td>h. Determining the amount of homework to be assigned</td>
<td>0 (1)</td>
<td>1 (1)</td>
<td>7 (6)</td>
<td>19 (17)</td>
<td></td>
</tr>
<tr>
<td>i. Choosing criteria for grading students</td>
<td>0 (1)</td>
<td>0 (2)</td>
<td>2 (1)</td>
<td>8 (10)</td>
<td>17 (11)</td>
</tr>
<tr>
<td>j. Choosing tests for classroom textbook</td>
<td>2 (0)</td>
<td>1 (3)</td>
<td>2 (4)</td>
<td>9 (9)</td>
<td>13 (9)</td>
</tr>
</tbody>
</table>
Textbook Diaries

The teachers in the (MS)² study kept “textbook use” diaries (see Appendix B), reporting how they used their mathematics textbook during 10 consecutive lessons in one class, once in the fall and once in the winter. In these diaries, the teachers recorded what materials they used for each lesson, including specific pages of the district-adopted textbook or other materials. The diary also requested information on the materials used by students (during the lesson and for homework).

These diaries were coded to enable the researcher to make counts of days in which the textbook was used in some way during these two 10-day periods. Since teachers were asked to fill in these diaries only during days when they had actual instruction, the resulting data, expressed as percent of days in which the district-adopted textbook was used, does not include days that were used for different purposes (assemblies, tests, etc.).

Frequency of Use of the Textbook

Almost 70% of the teachers in the study reported using their mathematics textbook in 75% or more of their lessons during two 10-day periods. These results are consistent with teacher self-reports in the survey. In some cases teachers reported using the teacher’s edition to prepare for their class, in other cases the textbook was used during the lesson to select problems or examples. The frequency was calculated as a percent of the total “instructional days” during these two 10-day periods. In some cases, teachers had a test or other activity when a lesson was not taught, and therefore those days were not counted as an instructional day. The results were grouped in the same categories as the choices given to answer the survey question “What percentage of the time do you use the district-adopted
textbook in this class?” Figure 4.11 illustrates these distributions.

Figure 4.11: Frequency of Textbook Use by the Teacher, as Reported in the Survey (N = 53)

![Bar graph showing frequency of textbook use by teachers](image)

There was little difference between the frequency of use of textbook reported by teachers using NSF-funded textbooks and those teachers using other kinds of textbooks. Figure 4.12 summarizes the frequency of textbook use as it was reported by the teachers in their textbook diaries, grouped by the kind of curriculum they are using. All but two teachers reported using their textbooks for at least half of the lessons. Two teachers using NSF-funded textbooks reported using their mathematics textbooks for less than half of the lessons. Such an intermittent use made it difficult to classify these teachers as users of those particular curricula.

When separated by grade, the frequency of textbook use by teachers was very similar. Figure 4.13 illustrates these frequencies. Since there were more sixth grade teachers than seventh grade teachers, the frequencies are expressed as percents of the total of teachers in the corresponding grade.

Frequency of textbook use by students, as reported by the teachers is summa-
Figure 4.12: Frequency of Textbook Use by the Teacher, as Reported in the Diaries (N = 53)

Figure 4.13: Frequency of Textbook Use by the Teacher, as Reported in the Diaries (N = 53)
rized in Figure 4.14. “Use” of the textbook by students includes reading from the textbook or solving problems from the book. The textbook diaries were not meant to describe the precise nature of use of textbook by students. In fact, teachers reported only what pages of the textbook were used by the students. According to the diaries, two-thirds of the teachers using NSF funded textbooks reported that their students used in one way or another their textbook in 75% or more of their lessons, whereas over half of the teachers not using the NSF-funded curricula reported that their students used their textbooks as often. Over 80% of all teachers’ students used their textbooks in 50% or more of their mathematics classes.

Figure 4.14: Frequency of Textbook Use by Students, as Reported in the Diaries (N = 53)

In all cases, it can be said that regardless of the kind of textbook used, the overwhelming majority of teachers in this study used their mathematics textbook very frequently, a claim reported repeatedly in the literature (Grouws & Smith, 2000; Tyson-Bernstein & Woodward, 1991).
Classroom Observations

All 53 teachers in the (MS)² study were observed, once in the fall and once in the winter. Using the Observation Tool (see Appendix C), the observers recorded if the textbook was used by the teacher and by the students, if homework was assigned from the textbook, and if the textbook influenced the content and presentation of the lesson. The observers also recorded how the textbook was used by the teacher and by the students.

During the classroom observations most teachers used their textbooks at least during part of their lessons. Table 4.4 summarizes the number of classes where the textbook was used by the teacher, by the students, and to assign homework, respectively, during both observations.

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>Used by teacher</th>
<th>Used by Student</th>
<th>Used for homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Obs. (N=26)</td>
<td>24</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>2nd Obs. (N=25)</td>
<td>22</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>non-NSF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Obs. (N=24)</td>
<td>20</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>2nd Obs. (N=25)</td>
<td>20</td>
<td>16</td>
<td>11</td>
</tr>
</tbody>
</table>

During the classroom observations, the data collectors reported not only if the textbook was used by teachers and students, but how it was used. Further, the
observers made a judgement, based on the observation protocol, to what degree
the textbook influenced the content of the lesson and the presentation.

The influence of the textbook on the content of the lesson was rated as \textit{A good deal} (GD, in the table), \textit{Somewhat} (S), \textit{Very little} (VL), \textit{Not at all} (NA), or \textit{Can’t tell} (CT). The observers characterized this influence as “A good deal” when the majority of the time the lesson addressed a topic set by the textbook pages being used by students and teacher. “Somewhat” and “Very little” would describe either a class in which the textbook was used less, or where the teacher addressed different topics, not all of them related to the textbook pages being used. Table 4.5 summarizes the number of classes that were categorized by one of these descriptors for the first and second observations.

\begin{table}[h]
\centering
\caption{Influence of Textbook on Content, from Classroom Observations}
\begin{tabular}{llllll}
\hline
Curriculum & GD & S & VL & NA & CT \\
\hline
NSF Funded Curricula & & & & & \\
1st Obs. ($N = 26$) & 19 & 3 & 2 & 0 & 0 \\
2nd Obs. ($N = 25$) & 14 & 7 & 2 & 2 & 0 \\
non-NSF Funded Curricula & & & & & \\
1st Obs. ($N = 24$) & 15 & 6 & 2 & 1 & 0 \\
2nd Obs. ($N = 25$) & 16 & 8 & 1 & 0 & 0 \\
\hline
\end{tabular}
\end{table}

Similarly, the influence of the textbook on the presentation of the lesson was rated as \textit{A good deal} (GD), \textit{Somewhat} (S), \textit{Very little} (VL), \textit{Not at all} (NA), or \textit{Can’t tell} (CT). Table 4.6 summarizes these descriptors for the first and second observations.
The data indicate, while the textbook appears to have a strong influence of both content and presentation, its greatest influence is on content.

Table 4.6

*Influence of Textbook on Presentation, from Classroom Observations*

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>GD</th>
<th>S</th>
<th>VL</th>
<th>NA</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF Funded Curricula</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Obs. (<em>N</em> = 26)</td>
<td>12</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2nd Obs. (<em>N</em> = 25)</td>
<td>11</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>non-NSF Funded Curricula</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Obs. (<em>N</em> = 24)</td>
<td>10</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2nd Obs. (<em>N</em> = 25)</td>
<td>8</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Primary Role of Textbook

The frequency of textbook use by teachers or students does not tell how the textbook is actually being used. Teachers and their students may use their mathematics textbook in many different ways. The textbook can be a source of problems and examples, or it can be a guide that determines the structure of a lesson or an entire course. It can be heavily supplemented or be the sole resource used by a teacher. Thus, describing the nature of use of the textbook is both an important component of any attempt to understand the role of textbooks and also a challenging aim due to its intrinsic complexity.

Using the observation tool the observers recorded descriptions of how the textbook was used by the teacher and by students. These descriptions were coded by the researcher by looking for patterns across teachers. In order to reflect broader categories of textbook use the coding was revised. As a result of this iterative process, the following categories of use were developed to describe the teachers’ primary use of the textbook. During a given lesson, a teacher could exhibit more than one of these modes of use. However, the classification was made according to the primary use of the textbook in terms of time or emphasis, as explained in the previous chapter.

Teacher used the textbook to selected tasks. Teachers selected different kinds of tasks. Some teachers assign their students a list of exercises from a section in the book to work individually, others assigned more elaborated activities for students to work in groups. While teachers used tasks that required different levels of student engagement and difficulty and organized their classes differently, teachers were included in this category if their primary use of the textbook was for their students to work on tasks from the textbook posed
with little modification.

**Teacher used the textbook to adapt tasks from it.** In this case teachers made explicit modifications to the textbook’s tasks that were either apparent to the observer or stated by the teacher in the pre- or post-observation interviews.

**Teacher used the textbook to draw examples.** This category includes teachers who were observed using examples, problems, or exercises from the textbook and demonstrated them to the students as the main activity during the lesson.

**Teacher used the textbook to guide the lesson.** Teachers followed the lesson as it was laid out in the textbook. In some cases the teachers followed more thoroughly than others the recommendations in the teacher’s guides, however, teachers in this category generally followed the lesson structure, content, and organization as outlined in the textbook.

**Teacher used other materials.** This category includes teachers who used other curriculum materials, except those designed by the teachers themselves, as the main source of content of the lesson.

**Teacher used no textbook.** Teachers created worksheets, or had examples and exercises in notes or transparencies. Teachers in this category used no mathematics textbook of any kind during the observation.

Figure 4.15 summarizes teachers’ use of the district-adopted textbook according to the categories described above for the 100 total observations. Two sixth grade teachers and one seventh grade teacher were observed only during the first period of observations. Three sixth grade teachers were observed only during the second period of observations. One teacher taught both grades, and he was ob-
served as a seventh grade teacher in the fall and as a sixth grade teacher in the winter.

Figure 4.15: Percent of Lessons Observed Corresponding to Each Category of Teachers’ Primary Use of Textbook, Grouped by Grade

Most teachers used tasks from the textbook or taught lessons guided by the textbook, in both grades. Teachers using NSF curricula were more likely to let the textbook guide the lesson, as Figure 4.16 suggests. A few teachers (four using NSF curricula, five using other curricula) exhibited little use of their mathematics textbook, or supplemented it with other resources. Differences are more pronounced in seventh grade than they are in sixth or in the total sample (see Figure 4.17). More teachers using NSF curricula were observed using the textbook to guide the lesson, while teachers using other mathematics textbooks were more likely to use tasks from the textbook. Considering all the 100 observations together, 37 of them were coded as “lesson guided by textbook,” 22 of those were from classrooms where NSF curricula were used, eight where teachers used Saxon Math, and seven of them
from all of the other textbooks combined.

Figure 4.16: Percent of Lessons Observed Corresponding to Each Category of Teachers’ Primary Use of Textbook, Grouped by Curriculum
Figure 4.17: Number of Lessons Observed During Both Rounds of Observations for Each Category of Teachers’ Use of Textbook, 7th Grade Teachers ($N = 41$)
Summary

As a whole, these data support previous studies that have established that teachers in the U.S. rely heavily on their mathematics textbook, and that the mathematical content of the classroom is heavily influenced by the textbook (Grouws & Smith, 2000; Robitaille & Travers, 1992; Tyson-Bernstein & Woodward, 1991). Whether the teachers selected tasks from the textbook or let the textbook guide their lessons, the two dominant ways in which textbooks were used, it is clear that textbooks determined to a great extent what was taught in these classrooms and how it was taught. These data also support the idea that teachers using NSF curriculum materials are likely to engage with the textbook in different ways than those teachers using other curricula, and therefore their students might have different experiences. The teachers in this study are not part of a professional development project, and their districts are not related in any way. In spite of that, these data show a remarkable consistency in terms of how and how often teachers are using their mathematics textbook.

It is apparent that this analysis is merely scratching the surface of a more complex phenomenon. Finer grained data are needed to explore more in-depth the role of mathematics textbooks in the middle school classroom. The following sections address three cases of teachers that were part of this larger sample. These individual cases will be examined against the backdrop of the larger group.
Case Studies

Three teachers were selected for case studies. David and Pamela taught sixth and seventh grades mathematics, respectively, at Hamilton Middle School and used *Mathematics in Context*. Kate taught sixth grade at Harlan Elementary in a self-contained classroom and used *Saxon Math* to teach mathematics. In this section the philosophy of their textbooks is presented. Their districts and their process of textbook adoption is described.

Mathematics in Context

*Mathematics in Context* was developed by the Wisconsin Center for Education Research at the University of Wisconsin–Madison and the Freudenthal Institute at the University of Utrecht in The Netherlands following the recommendations for school mathematics set forth in the *Curriculum and evaluation standards for school mathematics* (NCTM, 1989). Romberg and Shafer (2003) state that the developers “attempted to create an existence proof that a program could be created with NCTM’s vision in mind” (p. 233). The developers selected the Dutch Realistic Mathematics Education (RME) approach, based on the work of Freudenthal (1983). They believed that it was epistemologically similar to the approach envisioned by the NCTM. The basic tenet of this approach is that “students make sense of a situation by seeing and extracting the mathematics embedded within it.” A process of “progressive formalization” is implied (Romberg & Shafer, 2003, p. 233):

This implies that instruction, as is too commonly done in mathematics classes, should not start with presenting students with the formal terms, signs, symbols, and rules and later expecting them to use these formal ideas to solve problems. Instead, the activities should lead students to the need for formal concepts and procedures of mathematics. The implication for students is that they should gradually develop
more formal ways of representing complex problems.

The 40 units in this 4-year curriculum are grouped under the following mathematical strands: number, algebra, geometry, and statistics and probability. In a given grade level, there are one to three units for each of four mathematics strands.

The philosophy of Mathematics in Context, as presented in the Teacher resource and implementation guide (2003, p. 4), includes:

— Real-world contexts support and motivate learning. Mathematics is a tool to help students make sense of their world. Since mathematics originated from real life, so should mathematics learning. Therefore, Mathematics in Context uses real-life situations as a starting point for learning and contexts illustrate the variety of ways in which students can use mathematics.

— Student reinvent significant mathematics. Rather than memorize algorithms and rules, students discover mathematics for themselves. They use their own significant knowledge and experience as a foundation for understanding mathematics. Through interaction with other students and the teacher, students expand this understanding. The teacher’s role is not to disseminate knowledge, but to help students make connections and synthesize what they have learned.

— Interaction is essential for learning mathematics. Interaction between teacher and student, student and student, and teacher and teacher is an integral part of creating mathematical knowledge. The problems posed in Mathematics in Context provide a natural way for students to interact before, during, and after finding a solution.

— Valuing multiple strategies is important. Most problems can be solved with more than one strategy. Mathematics in Context recognizes that students come to each unit with prior knowledge and encourages students to solve problems in their own way—by using their own strategies at their own level of sophistication. It is the teacher’s responsibility to orchestrate class discussions to reveal the variety of strategies students are using. Students enrich their understanding of mathematics and increase their ability to select appropriate problem-solving strategies by comparing and analyzing their own and other students’ strategies.
— Teacher and students assume different roles. The teacher is both facilitator and guide in the teaching and learning process. Students create mathematics for themselves; they do not copy examples without understanding the underlying mathematics.

— Mastery develops over the course of the curriculum. Because mastery develops over time, teachers should not expect students to master mathematical concepts after a single section or even after a single unit. Each unit is connected to the other units in the curriculum. Important mathematical ideas are revisited throughout the curriculum so that students can master the ideas over time.

— The mathematics is often new and different. Many of the mathematical concepts and models in *Mathematics in Context* may be unfamiliar to both students and teachers. To understand these concepts and how they are presented, teachers must work through each unit as if they were students, preferably with other teachers. Teacher will need to embrace the mathematics, collaborate with others, and reflect on their understanding—much the same way students will learn these concepts. Through this active involvement, teachers will see the kinds of difficulties students might have, and they will more fully understand and appreciate the purpose of the unit. Planning and preparing in this way helps teachers determine what is essential and what is optional; it will also suggest additional materials and activities that will enhance student learning.

Palmerston School District adopted *Mathematics in Context* in its five middle schools (including Hamilton Middle School) three years ago. As a group, teachers select the units from MiC to be used in each grade. At the end of every school year they review and adjust, according to their experiences during the school year. During the school year, teachers at the same grade level (two per grade in Hamilton Middle School) have a weekly planning session built into their regular day where they discuss their progress, share challenges, and make decisions on assessment.

*The Case of David*

David is 54 years old and he has been teaching for 32 years. This is his last year of teaching. He has a bachelors degree in Elementary Education and a masters de-
gree in Educational Administration. He majored in Physical Education and he was advised to have a minor, so that he could teach and coach, and he chose mathematics. Up to 1990, he was a 6th grade teacher in a self-contained class. For the last 11 years he has been a 6th grade mathematics teacher. When his district changed to a middle-school model, sixth grade teachers had to be certified in some subject area. Although certified to teach mathematics, reading, and language, he choose to teach mathematics “just ’cause I enjoyed math” (11/4/02). He noted that he could have as easily been a reading teacher. As a student he enjoyed mathematics.

The most recent mathematics course he has taken was in 1969. However, during the last three years he has spent over 35 hours in various professional development activities focused on mathematics. The activities included workshops on mathematics teaching, workshops to learn how to use the district adopted textbook, and meetings with a local group of teachers to discuss mathematics teaching issues. Learning how to use inquiry/investigation-oriented strategies and understanding student thinking in mathematics have been addressed to some extent during these workshops, David reported that the primary emphasis of professional development has been learning how to use the textbook adopted by the district.

David was observed five times during the week of November 4 through November 8, 2002, and four more times during the week of February 3 through February 6, 2003. During each of these observations he was teaching a regular 6th grade class and class periods are 40 minutes long. In this class, there are 23 students, 10 of which are boys. There are 20 White students, two Black, and one Hispanic.
Lesson Routine

The observed lessons were generally consistent with David’s characterization of his teaching as described during the second interview (11/8/02):

Well normally it would be some kind of a warm up activity at the beginning, which again could be one of any 12, 15 different types of things. I would take the first 5-10 minutes and then if there was an assignment we would correct the assignment together — very seldom would they trade papers and correct— most of the time its self correction. And discuss the assignment from the previous day.

Observations revealed that on six of the nine days, David used a warm-up activity. These activities ranged from a few minutes to 16 minutes in length. On one of these occasions he assigned computational problems as the warm-up. In other cases, students solved riddles or word problems. In all, the warm-up activities accounted for 19% of the total instructional time during the observed lessons.

In five of the nine observed lessons from six to 17 minutes were used to check, discuss, and score homework. This ranged from simply checking the answers for correctness to a more thorough discussion of the solutions. In total, the time spent with homework accounted for 15% of the total instructional time during the observations.

Major activities of the observed lessons (warm-up, homework review, lesson) are summarized in Table 4.7. On one day, David extended the lesson beyond the end of the period. He could afford doing so, because the students stay with him after his lesson, for a 10-minute reading time. On occasion, he uses part of that time for the mathematics lesson. In six of the nine observed lessons, considerable time was spent in other matters. Among these were preparation of their “packet” or preparation for the parent-teacher conferences, during which students present to their parents their progress. The “packet” is a collection of the graded work
for every section. It includes the homework assignments, tests, and daily work. The tests are mostly the *Try this!* sections of the textbook, and they are done after every section to assess the students’ understanding of the content of the section.

Preparing this packet meant that students physically gathered the different elements of assessment and recorded their grades. These packets are used during the parent-teacher conference. These activities took 22% of the total time during these observations, ranging from nine minutes to 20 minutes per day.

The “lesson” that came directly from the textbook accounted for from seven to 36 minutes, for an average of almost 17 minutes, or 43% of the total time during these observations. David described his use of the textbook during this segment of the class period as “pretty much question by question.” Students read together the problems, and then David assigned a few problems for them to work. Most of the times students were supposed to work individually, a few times with a partner, before having a class discussion. Usually, at the end of the lesson David asked

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Table 4.7

*Time (in minutes) spent in different activities — David’s 6th grade class*

for every section. It includes the homework assignments, tests, and daily work. The tests are mostly the *Try this!* sections of the textbook, and they are done after every section to assess the students’ understanding of the content of the section. Preparing this packet meant that students physically gathered the different elements of assessment and recorded their grades. These packets are used during the parent-teacher conference. These activities took 22% of the total time during these observations, ranging from nine minutes to 20 minutes per day.

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his students to finish the assigned problems as homework. During the lessons observed, there was no teacher-led summary for any of the lessons.

David’s Lessons

During the first five observations, David was working on the Reallotment unit of MiC (Gravemeijer, Pligge, & Clarke, 1998). According to the Teacher Guide, ”The purpose of this unit is to broaden students’ understanding of area by involving them in a wide range of real-life situations. This is in sharp contrast to the conventional introduction to area—using a formula such as length times width or counting squares” (p. xii). The mathematical content for the unit includes “estimating and computing the areas of figures and irregularly shaped figures.”

The first day of observation (11/4/02), David took some time to check the students’ homework (Try this!), which was part of section A, The size of shapes. That same day, and the following four days, David’s students worked on Section B, Areas. In this section, students are to “compare the areas of a variety of shapes” and “estimate and measure the areas of geometric figures by reallotting sections to make new shapes” (p. xiii).

During this week, David had a warm-up activity on four of the five days. These warm-ups were neither related to the main lesson nor related to one another. The warm-up activity for the first day (11/4/92) was taken from a book on estimation. Students had to identify, out of five choices, which shape was nearest in size to a given shape (Seymour, 1981). In a second task in this warm-up students were asked to order eight shapes from smallest area to largest area. Students worked on this for a few minutes. When they were done, David read the correct answers and the students scored their work. No discussion of the answers took place. The second day, students spent some time preparing material for the parent-teacher
conference\textsuperscript{1}, so there was not much time available and no warm-up activity was done. The third day, a problem was given to students in which they had to arrange on a checkerboard eight checkers so that no two checkers are in the same column or row and not two squares with checkers touch each other. After a few minutes, David asked a couple of students to give their solutions. After a couple of solutions were presented, no further discussion was done. The fourth day, students solved a set of computation exercises (operations with fractions and decimals). When they were done, David read the correct answers, and students scored their work. The last day of this first round of observations, David read students a story, ”How did a single firefly win a fight against one hundred apes?” (Shannon & Síí, 1985), and students had to solve the mystery.

During the second round of observations, David began the unit *Fraction Times*. The unit, according to the *Teacher Guide*, “uses the context of a newspaper to formalize the fraction operations of addition, subtraction, and multiplication while also connecting fractions to ratios, decimals, and percents” (Keijzer et al., 1998, p. xii). The mathematical content includes “using fraction bars and pie charts” and “comparing fractions.”

During the four lessons observed in this second round of data collection, David and his students worked through Section A of this unit. In this section, students were to “use fractions to describe a part-whole relationship; use several strategies to add, subtract, and compare fractions; use equivalent representations of (benchmark) fractions, percents, and decimals to solve problems” (Keijzer et al., 1998, p. 4).

Two of the four lessons included a warm-up activity. The first day, David read

\textsuperscript{1}In Hamilton, these conferences are led by the student, who presents to their parents both his or her progress during the quarter and his or her plans for the following quarter. It is relevant to state this, since that explains why so much student time is spent preparing for the conference.
a list of items (a bike, a car, a can of soda,...), and the students were asked to estimate the price of each. Then students read their responses, and the whole class, by means of thumbs up or down, would judge the reasonability of the estimates. A second part was the reverse situation, David read an amount and students had to name an item that could cost about that much. No further discussion of the answers took place. The fourth day of observation David presented two word problems. After giving the students some time to solve them, David had a whole class discussion on the solutions. While the discussion was led by David, he took time to discuss in detail the solution to one of the two problems. In that solution he made a point of introducing an equation as a better strategy, but he gave opportunities for students to explain what they had done as well.

*A typical lesson*

While the nine lessons observed were not identical, there was a routine with elements common to most of them, so with minor variation any one of these lessons may be taken as typical. The lesson taught on 2/6/03 is such a lesson, because it had the three main components of most classes in David’s classroom: a warm-up activity, checking homework, and the lesson from the textbook.

As a warm-up, David posed two problems. The first one was to be done by the boys and the second by the girls.

1. James is learning Spanish using a special system. Each day he learned seven more words than he had learned the day before. In five days he learned a total of 100 new words. How many words did he learned the first day?

2. Ines finished reading a 75-page mystery book in $1\frac{3}{4}$ hours. It was so exciting that she read faster at the end than at the beginning. If Ines read the last 30
pages in half the time it took her to read the first 45 pages, how long did Ines spend on the last 30 pages?

David immediately suggested that the girls make a table. After a couple minutes he asked the boys if anyone had a solution. The boys did not seem very interested, but one of them said “4.” David checked on the board if 4 would work. It did not, and he did not ask the students to use this case as a stepping stone for a better solution. Another student said “65,” to which David simply noted that it was way off. A student said “6,” David checked it. It worked and no discussion took place. The student was not asked to explain, no one noted how the result was related to the first guess.

For the second problem, none of the girls had an answer, so David said that they would do it together. First David suggested to change the hours into minutes.

T: If we wrote it as we might in an algebraic sentence, let’s make this an unknown, whatever this is, plus half of this, is going to be 105…

So, whatever that number is, plus half of it is going to be 105. So what might that number be? What number plus half of itself would be equal to 105? Or if you were in a prealgebra class you’d write it something like this: unknown, or $n$ [writes $n$ on the chalkboard], plus half of $n$ [writes $\frac{1}{2}n$] equals 105 [writes $= 105$].

[On board: $n + \frac{1}{2}n = 105$]

Derek: What $n$ stands for?

Teacher: That’s a good question, Derek, what does $n$ stand for? That’s the answer…Meghan?

Meghan: $n$ stands for 52.
T: $n$ stands for 52?

M: No.

T: OK, you say yes, you say no, which one is it?

M: Yes, yes, yes.

T: 52?

M: Yes.

T: OK, so Meghan says 52 is $n$, so $n$ is 52 [writes 52 on the chalkboard]... and Meghan, what's half of 52?

M: ...26.

T: 26. What's 52 + 26?

M: 78.

T: What is it supposed to be?

M: 105.

T: 105. So, what's wrong with the 52, Meghan?

M: Too low.

T: So we've a starting point. Now we know that 52 is too low... Laura?

Laura: [Unintelligible]

T: $n$ is 70? OK, Laura says $n$ is 70, so let's try that: 70 plus... laura, what's the half of 70?
L: 35.

T: 35. Add them together, what do we get?

L: 105.

T: 105.

Class: Whoo!

Then David went back to the original problem, reading it and trying to see if the solution “fit with the problem.” He checked that it did and went on to comment that they could go into other things, for example “reading rate,” how many pages per minute she was reading at the beginning, how many pages per minute at the end.

Next David checked student’s assignments, walking around the classroom. Some students had incorrect answers and others had not completed the assignment.

The Curriculum Mapping Arena

The choices that determine content and organization characterize the mapping arena (Remillard, 1999). These decisions define and organize the content, sequence, and timing of the topics. Remillard suggests that two categories of decisions are involved: (a) topic determination, and (b) content determination. In the case of David, topic determination was determined at the district level and included participation of teachers from the five middle schools:

I’d say that’s a district decision. We have the same text throughout the district and as far as the different books that are from that text everybody in the city pretty much does the same thing. And then we
usually meet at the end of the school year and review the year and look at the different books and [decide] should they stay the same, should we adjust them. This year for example in the advanced class we moved three or four books from the 7th grade down to the 6th grade advanced cause we felt that they were more appropriate there. We eliminated some books that we had done before because we thought again maybe they’re too easy or they don’t fit (interview, 11/8/02).

We have approximately 8 books that we use from this series throughout the year and they are basically laid out about two per quarter, or one a month. The order of them and the time frame for them is set up before school ever starts, and normally what we’ve done is we’ve met at the end of the school year and kind of done some adjusting for the next year, if we want to change the order, if we want to take some books out and put some books in. Last year, in the summertime, I didn’t go, but others went to a workshop where someone from Wisconsin was here and helped them work through that (interview, 2/3/03).

The way he sees it, there is no time to stray from the text.

We are basically going through the textbook page after page after page, whereas we probably had a little more flexibility with some of the other programs we’ve had we can throw in something. It seems like we’re always under the gun to cover the book, to cover the content, that just the idea of okay I’m just going to take a day today and play a game we don’t really do that. Really don’t do that. […] It just makes you one more day late getting to the end of the section or getting to the end of the book or accomplishing what you hope to accomplish in that half quarter or whatever the case may be (interview, 11/8/02).

If adjustments are to be made, it is decided in consultation with the other sixth grade teacher in the building: “Yeah we are [literally on the same page]. Every Thursday we plan together and write our plans out for the week “(interview, 11/8/02).

David perceives that his input into instructional decisions is limited to the content of the daily warm-up activity. While the warm-up activities are meant, to some extent, to make up for the perceived lack of attention to computation in *Mathematics in Context*, these activities only occasionally focus on computation.
The attempt there of course is to set their mind thinking towards math. Try to get them settled into class. Normally we call it warm-up activity, some kind of a warm up type thing before we get into the text book. And I’ve got… basically what I have is a list of about 15 different things that we just kind of rotate through and it usually takes five or ten minutes to do those kinds of things. That’s also where we get computation worked. And again you don’t see a lot of computation [in the textbook] so we try to work that in at the beginning of—about every fourth day we’ll do computation problems. They may only be three, four, or five problems but it’s a review. It’s a kind of continual review of computation that you don’t see in the regular text book (interview, 11/8/02).

During the first round of observations, the main topic of the unit (Reallotment) was area and calculating area of irregular shapes. During this same period, the warm-up topics were: comparison of areas by estimation, a problem in combinatorics, operations with fractions and decimals, and a logic problem. As mentioned above, the underlying principle that guides David in determining the focus of warm-up activities is unclear. However, his action is neither inconsistent nor haphazard. David’s selection of a range of warm-up activities is consistent with his view of the purpose of mathematics teaching at this grade level. For David, his relation with students and his ability to make math enjoyable are of primary importance, more so than the content or the particular curriculum that was used.

Over the years you always hear from meetings and conventions that the kids… you always hear they don’t remember if you taught them anything. They just remember if you were a nice teacher or not. […] They remember if you’re nice or not, they don’t remember if you taught them how to do a story problem or if you taught them how to do a process. [The most important thing] for the student to learn or to remember about math? Well it gets back to whether or not you make math enjoyable. I think if you make it enjoyable for the student again they’re going to remember that they enjoyed the class and they enjoyed you more than if they enjoyed the curriculum or if they learned anything from the curriculum (interview, 11/4/02).
The diverse selection of problems, riddles and stories is meant, then, to convey a message about mathematics being fun. David does not like the textbook, so these warm-ups are not only something to get them started, but a way both to address the shortcomings of the textbook, as perceived by David, and to add more “mathematics” to it.

My first impression of this textbook was that it really wasn’t a math textbook. ’Cause math to me is numbers. Whether you’re doing paper and pencil calculation or whether you’re doing problem solving, to me it’s not a math book it’s a concepts book […] it’s still a concepts book it’s not technically a math book (interview, 11/8/02).

When asked whether he liked the textbook:

Oh, absolutely not. We have to supplement with math concepts, computation, we have to complement it with computation. We have to sometimes revise some of the assessments (interview, 11/8/02).

The need to add something through the warm-ups seems to be a response to outside pressures, such as test scores.

There are several different things we use for warm-up problems, like the estimation book that I used today. There are several different sources that we use. We really haven’t supplemented the book itself, with outside sources. The warm-up things that we do is kind of an attempt from the district to put some computation in the program, for there’s very little, if any, computation in this book. […] The textbook is the main thing, [but other things that influence what I teach are] the warm-up skills, for example, that we do, are influenced by test scores, how well they’ve done on different parts of the test. We tried to line them up with things that we think our students are missing (interview, 2/3/03).

The content determination in the mapping arena is influenced in David’s case by the fact that, for him, the textbook is not “mathematical enough.” In this regard, David did not elaborate on his major goals for his students —what mathematics he
expects them to know by the end of the year, although he recognizes that fractions is an important topic in middle school.

Well, fractions are always important. Right now I know we’ve got a committee studying a K-12 study how to teach fractions at all the different grade levels and primarily its not felt that this series does justice [to fractions]. We used to spend in our old traditional math program we spent three months on fractions (interview, 11/4/02).

When asked about the goals for mathematics in sixth grade, he did not seem to have an articulated goal.

Well, and I think that’s changed a little bit with the text, too. You know, I think with the old text when they went to high school we wanted them to do the computation so they would do computation. With the series we have now its more being able to apply math. It’s more an application type of thing. Whether or not it’s successful or whether or not its going to make a difference when they get to high school, we’re kind of removed a little bit from that, so there’s nothing black and white that let’s us know if its that way or not but... (interview, 2/5/03).

David was not able to characterize his long term goals.

See, that’s hard. I’m not sure how I would answer that one really because I don’t know. I don’t think about it. You get to the end of the year and you go back and you wonder what they’re going to remember. I’m not sure how I’d answer that, to be honest with you (interview, 2/5/03).

For David “math is numbers.” Consequently he believes the content should focus on arithmetic skills, and finding an efficient way to solve problems. During the observed lessons in David’s classroom, procedures were valued more than concepts or relationships. While the topic determination was heavily dependent on the textbook, the content determination was more consistent with David’s own conceptions about mathematics and mathematics teaching. While everyday decisions did depend to some extent on the students reactions to tasks, the decisions
about topic determination and content determination within the design arena seemed to be independent of occurrences in the classroom. For the most part, content is not determined explicitly by David. After the many years that David has taught, it seems to be more a result of values and routines established long ago. In fact, David’s lessons are consistent with the pattern described by Stigler and Hiebert (1999), who characterized the typical lesson in the U.S. as “learning terms and practicing procedures.”

The Design Arena

The design arena is characterized by the process of “selecting, altering, and constructing mathematical tasks to present to students” (Remillard, 1999, p. 323). From David’s perspective, there is not much to pick or skip in Mathematics in Context:

[A]s far as the planning part of it, it’s just a matter of going through the book, it’s pretty much just through the book page by page. Some books in the past, where we’ve had computation and story problems and practice and such you can kind of pick and choose from amongst those things, depending how much of each part you want. This textbook we just pretty much [go] question by question (interview, 2/3/03).

Although David reported following the textbook, there is an active process of selection on his part, guided mostly by the assessments. He stated that the problems or activities from the text that he skipped are those that the Teacher Guide identifies as “optional.” Indeed, some problems are listed as optional in the “Planning instruction” section of the Teacher Guide, but often times he skipped problems that are not identified as optional.

During the first week of observations, David was using section B of the Real- lotment unit. For this section, the Teacher Guide indicates that there are no optional
problems. In spite of that, out of the 15 problems or questions included in the section, David skipped four. It is possible that students found this unusual (since the four problems were consecutive). “We’re skipping a lot!” said a student when David instructed them to go from problem 5 to problem 10. He answered that those problems were optional. During the post-observation interview (11/5/02), he explained that for the sake of time he decided to not address those problems.

During the second week of observations, David began the *Fraction Times* unit. This unit has six tasks. The *Teacher Guide* indicates that there are no optional problems in this section, and David did not skip any.

It appears that David selected tasks in a purposeful way and that he favored those tasks that would offer an opportunity for practicing the procedures needed for a successful completion of the end-of-section assessment. In the example given above (*Reallotment*, section B), problems 6–9 fit the textbook’s stated goals, for these problems are exactly the way the authors introduce the idea of reallocation. Problems 10–12 are much closer to the problems in the *Try this!* questions that are used at the end of the section as an assessment activity (Gravemeijer et al., 1998, p. 49). These problems, all selected by David, can be solved in a way that can be told to the students, and this method does not necessarily spring from discussion of the strategies used by the students. In this case, an emphasis on the formula for the area of a rectangle and a focus on an efficient and general procedure sufficed to enable the students to solve the problems in the assessment. For example, problem 10 asks students to find the area of shapes that can be seen as a rectangle minus a region formed by triangles (see Fig. 4.18).

In his lesson on 11/5/02, David gave a short explanation before the problems in 10 by pointing out that the area of the shaded region in 10 b. can be solved by dividing by two the area ($\text{length} \times \text{width}$) of the rectangle (see Fig. 4.18), and that
Figure 4.18: Problem 10 j. from Reallotment, p. 13.

9. Do you think the farmers will be willing to trade their land for the factory site? Why or why not?

Use Student Activity Sheet 7 to answer problem 10.

10. Determine the area of each of the shaded pieces on the right. Give your answers in square units. Be prepared to explain your reasoning.

This example could be used in all exercises.

They will use it later [the idea of dividing a figure in rectangles and seeing how parts of those rectangles were shaded]. Whether they remember or whether they on their own will use it... but definitely they will use it on Friday when we do the assessment for this section (interview, 11/6/02).

David wanted to make sure that the formula for the area of a rectangle was established during these lessons, in spite of not being directly addressed in the textbook.

Well, I think they’ve been working with those shapes but they may or may not... the text book never really comes out and says “you’re finding area.” It never comes out and says, “okay to find the area or the
number of squares in this shape take the length times the width.” The book never says that. So that’s first of all why I wanted to incorporate that in there.

To make sure that idea comes across, right, then the fact also that they’ve taken the grid mark, they’ve taken the next step so their grid mark’s gone now, so they can’t count squares. ‘Cause a lot of them…you can see the different levels of thinking those people who just counted the squares and those people who moved them around and then those people who actually did take the entire space and then eliminate what wasn’t there. So there’s different levels of thinking but for those who have a hard time. Those who were just counting squares they need to take it to the next step so if they’re going to take the length times width (interview, 11/6/02).

Well the major thing was to get them to discover concept of area although it never really comes out actually. In the next section it comes out and literally says area equals length times width. But the authors, again, the authors of the book, it’s kind of a discovery unit even though you get to the point where especially the low achieving students you want to tell them area equals length times width (interview 11/8/02).

David’s task selection followed this pattern, choosing tasks directly related to the end-of-section assessment.

During the second round of observations David was using the unit *Fraction Times*. There are six tasks in section A of *Fraction Times*, and they build directly into the problem in the *Try this!* used as an assessment activity. In this case David selected all of them. He indicated liking this activity, which he characterized as “an excellent presentation” and very practical. However, in spite of strong recommendations in the *Teacher Guide* to “be sure to discuss students’ solutions and strategies” (p. 13), his questions to students focused more on the arithmetic steps than in the graphical representations of the sets involved in the problems.

The last task in the unit is about comparing two classes, one with 20 students and the other with 30 students, and their favorite subjects. The *Teacher Guide* recommends discussing students’ solutions and strategies and stressing the differ-
ences between absolute and relative comparisons. David’s focus however was on the computations involved in the tasks, “They have to take the 20 class times 3 and the 30 class times 2, they have to have a commonality there, and they’ll build on as they go through that book, that’s the main part” (interview (2/5/02).

Another important factor that determined David’s selection of tasks was the time available. Each one of these sections had to be finished in a week, and periods are only 40 minutes long. The tasks selected were those that could be completed in this time frame. However, only about a fourth of the time per lesson was spent on tasks drawn from the textbook (see Table 4.7). In planning the lessons, David distributed the time between the warm-up activities and the tasks from the textbook. Since he teaches the same lessons to different sections during the school day, the first time he teaches it sets the tone for the rest of the day.

Well some of the activities from the text book supplier are optional and there again most of the time the things that are optional we skip because of the time constraints. And it may be again, it may be for example I have four regular classes, you saw the first one, that one kind of sets the tone for the day as far as how far we get or if we have an assignment. We try to keep them just for the sake of bookkeeping we try to keep them all the same. But a lot of times even though we have a skeleton sketch of where we’d like to be a lot of times that first class determines…we got this far, like today, we got this far so we can go ahead and make this assignment. If I hadn’t gotten that far, if I’d gotten farther yet, then that would dictate the rest of the day.

[... A] lot of times you don’t know if you’re going to cover, you know, and I had my administrators come here a few weeks ago and they, they suggested in the advanced class that when the kids walk through the door the first thing you do is write down their assignment for the next day. And it’s like… I can’t do that. [...] I don’t know where we’re going to get. And the principal was in that day and I said you know you saw the class today we were comparing cereal boxes. I said I could’ve spent 10 minutes on it or I could’ve spent 30 minutes on it I said when those kids walk in the door you don’t know how far you’re going to get. You don’t know what the assignment is going to be for the next day. I mean its nice to have that goal and we always have that. I want to get
to here to I can assign this but obviously that doesn’t always happen (interview, 11/4/02).

At the same time, his experience during the first two years using *Mathematics in Context* helps him make decisions regarding task selection.

Well you know we probably, we may include or exclude some of those optional things you know based on how they’ve done it in the past or you just... again, having done it before, you know, having gone through the text now for the third time we maybe just know, okay, this section is not something that we want to do or something is going to work. So we just kind of eliminate it (interview, 11/8/02).

The way David “translates” the tasks from *Mathematics in Context* derives from his reading of the book. His lessons are not meant to be implemented as it is recommended in *Mathematics in Context*. The goals embodied in the textbook are not his. His planning is a compromise between satisfying the district’s requirements and doing what he deems important. From this perspective, the book provides the “concepts,” while at the same time he has to make sure that his students are prepared for the assessments, and so he focuses on procedures as he sees them implied by the concepts or applications suggested by the textbook. In this way, the textbook plays a role of organizer of topics and tasks, but is not enough by itself, for the teaching of mathematics must tie the concepts with certain procedures that go with them. When asked what would he like to see in his textbook, he underscored the importance of computation.

I’d like to see computation problems blended into these lessons. Where you can present the concept and still have some paper pencil computation kinds of things that go along with it that the kids could still do and still have it tied to the concept that you’re working on (interview, 2/5/03).
David’s conception of mathematics is therefore what shapes his opinion about the textbooks, and hence the interaction that is established between his planning and the textbook suggestions.

Again, I’m still the old time. Number, there’s not a lot of numbers in [Mathematics in Context]. To me math is numbers, working with numbers, whether you’re…it doesn’t matter what you’re doing with numbers. It’s more a concepts book than it is a numbers book, so in that way I rank it down because of that. If I had a decision to make on that I would not probably use it. But that’s what our district has chosen to go with, that’s what we have to work with.

[The authors] value the concept idea, just like the name Mathematics in Context, in situations. That’s good, in situations, but again, the computation, actually working a problem is not in this book.

I’m not sure that [the book achieves its purpose] because…we’ll go through the section, especially if we’re using the Try this! as an assessment, a lot of times the kids will not pass the Try this!, they’ll fail the Try this! So I’m not sure whether it’s a text problem or more a student problem (interview (2/3/03).

David’s vision of a good mathematics teacher is someone who is able to show how mathematics is done, “Well, ideally he would present the material in such a manner that they would be able to learn, grasp the concepts, and he would also reinforce it so they’d retain those concepts” (interview 11/8/02). Among the four dominant views of how mathematics should be taught, as characterized by Kuhs and Ball (1986), David’s view corresponds to content-focused with an emphasis on performance, that is “mathematics teaching that emphasizes student performance and mastery of mathematical rules and procedures.” His interaction with the textbook is interpreted through this lens.
The Construction Arena

This arena is “comprised of all interactions in the classroom, planned or un-planned, that influence, shape, or contribute to the enacted curriculum” (Remillard, 1999, p. 328), where task adaptation is a central activity. David displays confidence and his lessons appear to flow as he expected. Most of the lessons observed went “as planned,” as David said during the post-observation interviews. In a few cases, students were not able to finish all the tasks, and the remaining tasks were assigned as homework on those occasions.

During the lessons most of David’s interactions with his students are exchanges of short questions and answers, sometimes working together through a problem or exercise. Sometimes he asks his students how they got an answer. In most cases, an explanation of the procedure is all that is expected.

Working in groups is often a recommendation in the Teacher Guide, however, David rarely asks his students to form groups. Because of this lack of small group discussion, and given that the classroom practices are dominated by David taking a central role, there is little room for unexpected ideas that would require some degree of improvisation or adaptation of a task as planned. In spite of this, students do not seem to feel discouraged to participate or volunteer explanations. This occurred rarely during the observations, but the fact that students seem comfortable explaining their thinking might be evidence that there is some expectation of them communicating their thinking. However, in at least a couple of lessons a student’s explanation was deliberately ignored. For example, on 11/6/02, a student was trying to explain a solution. His explanation was not clear, and perhaps incorrect. Instead of questioning him to better understand what he was trying to say, David asked another student to “help him out.” She simply gave her own
response, which was clearly explained. During the post-observation interview, David explained that this was “an easy way to help, not with what he was trying to explain, but with the answer.” Even when the answer was correct, lengthy explanations were avoided, so that other students would not be confused.

Sometimes you don’t want them to, you know, I didn’t want her to explain because it was okay for her and she got it right but to try to explain it to other kids...I thought it would just make it more confusing for them, for the rest of them. So that’s why I asked her not to proceed and sometimes that happens (interview, 11/8/02).

Almost without exception, David intervened when a student was struggling with a problem either by asking another student to give the correct answer, by explaining how to solve the problem, or by guiding the student through the problem. The resulting adaptation of the tasks meant a shift in the focus of the task, in most cases towards computation and away from inquiry.

Some kids can’t find that on their own. There’s some kids that need just to be told, if you tell them in black and white, if you tell them this is the way you do it. “Take that rectangle, take this number times this number, divide it by two,” then they’re okay but they don’t have either the intelligence or they don’t have the mathematical experience. They really just can’t discover it on their own.

The better students will do fine. Just like the assessment today. The better students, the ones that are brighter, more mathematically inclined, they’ll do fine but it’s the lower achieving student that can’t do that exploration or can’t do that discovery on their own. They just need to be told this is the way to do it. There’s some that are that way. And with the discovery type of approach they aren’t going to achieve (interview, 11/8/02).

He does not see any need or purpose in letting students struggle, since for him it is very likely that these students’ limitations are something that might be rooted in their natural ability and attitude.
[To be] Good at math? Well basically, you know, some of it is natural. Some of it is just intellect and tied into that is of course the work habits and whether or not they’re willing to. We have a lot of regular math kids that could be much better if they chose to be. Whereas the advanced kids, most of the advanced kids that we have not only do they have the ability but they have the work ethic to go with it. So they want to achieve. I think it’s a combination of having the ability and, you know, obviously what you do with it.

A lot of them come from very professional families where you know that mom or dad was probably very bright or very smart and genetically it just came down to the kids. And of course those kids have good family lives, too, which, you know, makes it… (interview, 11/4/02).

Summary

David’s decisions and choices in the three arenas—the curriculum mapping arena, the design arena, and the construction arena—were heavily influenced by his view of mathematics and mathematics teaching. Mathematics was viewed as a set of procedures and mathematics teaching as being concerned with students mastering those procedures. David’s interaction with the textbook is then shaped by this view. For David, the textbook did not represent a philosophy of teaching, but only a curriculum map and a source of activities. The fact that he did not like the textbook, and that he does not consider it a “real math book” also explains why he dismisses most of its recommendations on method, while not on pace or topics. His teaching practices have been shaped by a long career of teaching. He has a lot of experience, and had no problems with classroom management. His students like him very much. All these factors, together with the fact that he was soon to be retiring, also explain why he was willing to accommodate the external pressures—the district’s policies—and his own stance towards the curriculum.
The Case of Pamela

Pamela is 32 years old. She has been teaching middle school for seven years. She always wanted to be a teacher. Pamela majored in elementary education with a middle school endorsement, although she was more interested in elementary grades. She was a substitute teacher for two years after college, and most of the time she substituted in middle school grades, and she “fell in love with that age group” (interview, 11/4/02). In college she took extra classes in mathematics, so that she could be certified to teach mathematics. Having always felt that mathematics was her strong area, she decided to teach mathematics at the middle school level. She has a master’s degree in Educational Leadership.

During the past 12 months, Pamela has had more than 35 hours of professional development. According to her initial survey, these professional development activities emphasized understanding students’ thinking in mathematics, learning how to use inquiry oriented strategies, and learning how to use the textbook adopted by the district. She attributes changes in her teaching and assessment practices to these professional development activities. She considers herself very well qualified to teach most topics in mathematics.

Pamela was observed one week in the fall and one week in the winter. During the first round of observations, two classes were visited every day, a seventh grade advanced class and a regular seventh grade class. Both classes use Mathematics in Context, but they use different units and work at a different pace. During the second round of observations, only her advanced class was visited. In total 14 lessons were observed.

Four out of 22 students in the seventh grade advanced class are boys, and four of the girls are sixth graders. To be admitted in an advanced class, students at
Hamilton have to meet certain criteria, such as SAT9 total math score of 76.5–77.6 NCE (Normal Curve Equivalent range), current class performance in mathematics of an A, and a “teacher observation of 36 or greater out of 45 possible points.” It is a class where there are no behavior problems. Students work well without constant supervision, and they are focused on their work most of the time.

In her seventh grade regular class 12 out of 23 students are female. All students in this class are seventh graders. It seems to be a more heterogeneous class than the advanced class and it tends to be a class where Pamela has to struggle a little more to keep students on task.

*Lesson Routine*

A typical lesson in Pamela’s classroom is guided, in one way or another, by the textbook:

[U]sually throughout the day though there is some large group instruction, small group time, and then perhaps independent practice time too. But we do typically...I feel we are guided by our text and then supplement somewhat our text (interview 11/4/02).

While not every lesson looks like this, the patterns in her classes are very consistent in both the routine and the way the content is addressed. There were only two disruptions of the regular routine, both of them during the first week of observation. Pamela’s regular class had a “Junior Achievement” lesson. During this lesson, a volunteer from the community comes once a month to teach a mathematics lesson and show its relation with the “real world.” This was a hands-on lesson not related directly to the topic Pamela had been working on with her students. Her role during this session was limited to supervising the work of students and helping them to get going. During this same week, the advanced class had a Conti-
mental Math League test for a mathematics competition, which took 30 minutes out of the 40 minutes of the period.

Pamela’s lessons consisted of reviewing the homework problems, which involved detailed discussion of the solutions, and solving new problems. She did not use a warm-up activity. At the end of a section, which comprised four to five lessons, her students did a “peer evaluation,” which means that they prepare each other’s grades, recording scores for different items using a “packet rubric” very much like in David’s class. This usually took up to 25 minutes.

Table 4.8

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* This includes activities not directly related to the lesson, such as preparing their packets or the “Junior Achievement” lesson.

There were, however, noticeable differences in the way Pamela organized the lesson time in her regular and in her advanced classes (see summary in Tables 4.8 and 4.9). She did not assign any homework to her students in the regular class. There was no review of homework, because all problems were solved in class. Considering that the homework problems come from the textbook, Pamela spent
more time working with the textbook in her advanced class (66.4% of the time) than in her regular class (59.7%). The total time is not exactly 40 minutes, because the time was measured from the actual beginning of the lesson until the class was dismissed. For one reason or another, there were up to 3-minute differences.

Table 4.9

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Pamela did not use any other curriculum materials than the district adopted textbook to teach her lessons. However, she assigned a weekly computation worksheet for each of her classes to be done as homework. Sometimes this worksheet is from the MiC materials. The time spent with other activities was spent mostly with managerial activities (e.g. assigning seats or grading students’ work) or in sessions that had an entirely different purpose, such as the Junior Achievement session in the regular class or the mathematics competition test in the advanced class.

Pamela conducted mostly whole class discussions with her regular class, while she allowed for more time working in cooperative groups in her advanced class. When her students worked in groups she walked around asking and answering
questions, although the nature of these interactions was slightly different in each class. She tended to ask more leading questions to students in her regular class, and she provided students more scaffolding in her advanced class. In both cases her interventions had the intention of making sure students were able to be successful on the textbook problems.

_Pamela’s Lessons_

During the first week of observation, Pamela’s seventh grade regular class began working with the _Cereal Numbers_ unit (Abels, Gravemeijer, Cole, Pligge, & Meyer, 1998). The focus of section A is to “investigate volume and surface area by constructing cubes (rectangular prisms)” and “solve problems involving volume” (Abels et al., 1998, Teacher Guide, p. 4). The context of this section is that of a company that sells popcorn and needs to construct boxes of varying sizes to distribute the popcorn. This set the stage to address problems of estimation, volume, and surface area. It is suggested in the _Teacher Guide_ to take two days for section A, but Pamela needed three days, even skipping a couple of questions. Problems 4.a. (see Fig. 4.19) and 7.a. (see Fig. 4.20) took most of the time during the week and were the main focus of the section.

During the same week, Pamela’s seventh grade advanced class began working on the _Building Formulas_ unit (Wijers et al., 1998). According to the _Teacher Guide_, section A should take five sessions. The focus of this section is to “identify, extend, and represent visual patterns using tables, NEXT-CURRENT formulas, and direct formulas; informally evaluate and use direct formulas; and compare formulas that look different but are mathematically equivalent” (Wijers et al., 1998, Teacher Guide, p. 4). This is a very long section, rich in problems in which students have to generalize patterns and find expressions to describe them. Design-
ing a movie set provides the context in which designers create tile garden paths. These designs are explored in detail. At first these patterns are described with NEXT-CURRENT formulas (recursive formulas), and later in the section direct (or explicit) formulas are to be found by the students. At the end of the same section problems involve patterns of rods to construct beams. Again, students are asked to find explicit formulas and determine the correctness of some formulas that are given, and relate their meaning to the context. Throughout the section, Pamela followed the textbook problem by problem, giving students as much time as they needed to complete the problems before moving on. The problems in this section lead students to explore equivalent expressions, which correspond to different ways to look at the patterns. Pamela’s routine in this class involved more
work in cooperative groups, and homework as an important component of the lesson.

In both classes, Pamela frequently asked her students to explain how they solved each problem. These explanations were part of the culture of the classroom. The students in the regular class gave explanations that focused more on the procedures used to find an answer, while the students in the advanced class gave more elaborated responses and looked for different ways to approach each problem.
The Curriculum Mapping Arena

As is the case of David, the topic determination, one of the two categories of decisions in this arena, is made mainly at the district level. A group of teachers from the different middle schools in Palmerston meet for a week during the summer to plan for the upcoming school year. They use this summer week to plan together and share ideas, which they continue to do during the school year, meeting once a quarter. Although this seems to be a collaborative effort, Pamela found it restrictive.

I don’t think I have a lot of freedom because I am mandated by our district what units I need to teach and in which order and given a certain timeline to follow as well (interview, 2/4/03).

We have, you know, the middle school coordinator and we have a committee of math teachers that gets together to set the pace and choose the order of the units in which they’re taught. So we are given a guideline of two units a quarter, about. And then we have some freedom with what things to supplement and ideas like that but for the most part I feel somewhat tied to our curriculum too (interview, 11/4/02).

If we as teachers in our district have the freedom to, “hey here’s the concepts you need to teach, here’s what seventh graders need to know when they leave your room,” that’d be exciting to continue to plan with, you know, my colleagues as well, but just to have a little more freedom. I do feel like we do need to work through these units and for the most part follow them and do everything that’s in those units. So I feel like some of my freedom’s taken away in that manner and I don’t disagree with what we’re doing, and if the mandates weren’t there, there are teachers who wouldn’t, you know, maybe…I don’t know, but… (interview, 11/8/02).

In her mathematics classes Pamela values student ability to solve problems and to explain, to be able to share one’s thinking. Thus, this shapes the content determination of her course. Although she finds some weaknesses in MiC, she trusts the curriculum, mainly because it aligns with her own philosophy. In this sense,
the content of her lessons, not only the topics, is heavily determined by the district-adopted textbook and the view of mathematics that it embodies.

It encourages them to think and to build the concepts and to solve problems in a way that makes sense to them. It teaches the students that there’s more than one way to solve a problem and so they can learn from their peers as well as their teacher. And overall I think it’s a good program for kids (interview, 11/8/02).

Nevertheless, Pamela is not very enthusiastic about *Mathematics in Context*. She repeatedly said that she found an important weakness in MiC in its lack of computational practice. In spite of this, her lessons follow the textbook and its recommendations very closely. The textbook is her main guide, it is the most important factor in both the topics and the content she selects.

*The Design Arena*

Selection of tasks is very straightforward in Pamela’s planning process. Once the units and sections to be used are determined by the district, Pamela follows the recommendations in the *Teacher Guide*.

For the most part I follow the guidelines set up by the company and just work through the units. I don’t think I have that much freedom [of choosing to use some parts and not others], I use the examples and how the [textbook presents the lessons] (interview 2/4/03).

During this process the interaction with the other seventh grade teacher at Hamilton is very important for Pamela. Together they plan weekly, and through this interaction they make decisions on what examples and problems will be used, and also how are they going to supplement a particular topic.

[Our district allows weekly planning time with our subject level grade partners so that we can brainstorm together ideas that are best for our students.]...
I also do a lot of planning with my other seventh grade math teacher. I do find a lot of times, when planning with [him], things that I want to add. I mainly use the textbook and it drives my main lesson, but here and there I would supplement some things or throw in some extra practice (interview 2/4/03).

Pamela reads the *Teacher Guide* looking for problems that are identified as critical, for those may later become the core problems of a lesson. She looks at the sample solutions, anticipating where her students might face difficulties.

As described above, Pamela planned differently for each of her classes. When planning for her regular class, Pamela prepares ahead of time certain things that will save her students some time. For example, for her lesson on 11/4/02, she inverted the order of the problems, in order both to gain some time, and also to provide a concrete aid that would help her students better visualize the volume of 1 dm$^3$. Prior to her class she made a net for her students to construct a cube, instead of letting them draw the net by themselves. This advanced preparation enabled her students to have more time to solve other problems. It is important to note that this adaptation was done during the design process, it was not a decision made during the lesson. Pamela carefully read the *Teacher Guide* looking for terms or concepts from the lesson’s problems that might be troublesome, and she planned to ensure that these terms and concepts were part of the classroom discussion. In other cases, the sample solutions offered by the *Teacher Guide* were used by Pamela. For example, a sample solution to problem 7.b. (Abels et al., 1998, Section A, Teacher Guide, p. 13) depicts a table where the area of each side of the box is calculated and recorded. Pamela chose to present the table to her students on the whiteboard. This was perhaps the most significant adaptation during the observation period. For the 11/7/02 lesson with her regular class she decided to skip problems 5 and 6 (Abels et al., 1998, p. 3, 4), and she posed problem 7 to her
students. The *Teacher Guide* suggests that “if students are having difficulty, suggest that they look at different configurations of 24 cubes with side 1 dm.” Pamela decided prior to the lesson to go ahead and suggest this as the preferred method to her students. The change is significant because it does change the stated intentions of the authors of having students to draw upon their number sense and “smart counting techniques,” which eventually lead to a formula to find volume. With the described adaptation, Pamela ensured two things: that the problem would be successfully solved by the majority of the students within the lesson’s time, and that the table would provide a shared tool to look at the changing surface area of a shape with fixed volume.

In contrast, planning for her advanced class involved no changes in the way the tasks were presented in the textbook. During the nine lessons observed with this class, Pamela did not skip any problem or question. She neither changed the order of the questions nor made changes to the tasks. One of the few occasions when she departed from the textbook was when she chose the weekly computation worksheet. By reading ahead in the textbook, she decided that the order of operations would be an issue in the forthcoming lessons, so she selected a worksheet on order of operations, and made a short digression to teach the rules of order of operations.

Pamela valued cooperative learning groups experiences. It is a style of teaching for which she considers herself very well prepared. From her experience as a graduate student, she finds this style of teaching “inspiring:”

[I]t was never a lecture style where we sat there and they talked and we took notes. It was so untraditional and they, you know, we would brainstorm ideas. You know, what are current trends in education or what would you like to learn more about and we’d break down our list and then groups may be assigned different topics to present anyway they want. And books, we read two or three books each month and then even a sharing of the books was done in just a variety of ways. But
it just was fascinating. You know, I kind of feared going in for my Master’s that, oh, you know, you’re going to sit there and listen. And in fact my husband who is a teacher as well and earned his Master’s a couple years before I did had a traditional style. You know he’d come home and be drained and worn out from sitting all day and I’d come home from my classes and I almost felt guilty because I left him home with the kids and I would be excited. I just was energized about education. And so it was such a neat experience and so that kind of atmosphere to me, too, really does inspire learning (interview, 2/5/03).

Her decisions about when to use groups and when to engage in whole class discussion were based both on her reading of the textbook and her own view of her students’ readiness to work by themselves. If the Teacher Guide states that a particular problem is “critical,” Pamela preferred to have a whole class discussion to address that problem. On the other hand, she often anticipated problems her students would likely experience and planned for them.

I think if I have a feeling the kids are going to have a lot of frustration within their groups, that’s when I guide them more as a large class and if I really feel they can handle it, they can problem solve on their own, I’ll let them explore. I just try to use my professional judgment, if there are things that I really don’t feel the kids area ready to master on their own, that they really can’t handle [it], that’s when I choose to do a little more of the guiding. Otherwise I do try to let the kids in their cooperative learning groups often times to explore and process on their own (post-observation interview, 2/6/03).

Unlike David, all of Pamela’s decisions in the design arena are made with the textbook in mind. Whether she decides to adapt a particular task, or make the students work in groups, and even when choosing a supplemental activity, she takes into account the content of the textbook and the recommendations of the Teacher Guide. When she began Section E (Tessellating with triangles) of Patterns and Figures she added a couple of short activities that were not in MiC. As she planned for the lesson she selected activities because they matched the content
of the lesson and she anticipated they would help students better understand the
topic at hand. For one of these activities, students had to make polygons with
a long piece of string, without talking. In the other, they did a “choral reading”
of the properties of tessellations. The purpose of these activities was to make the
students recall the names and properties of polygons, and to identify polygons
that tessellate. Both of these ideas came from the first question of the section. The
tessellations were not the object of the section, but only the context in which some
algebraic problems were posed. However, Pamela found this was a good point in
which to address topics that she considers relevant. It was apparent that she tried
not to disrupt the flow of the lesson from the textbook. So, when she looked for
activities or tasks to supplement the textbook it is generally for an identified need
or anticipated problem. Her planning decisions were directed towards enriching
the textbook, more than deviating from it.

The Construction Arena

Given Pamela’s careful planning, there is not much room for the unexpected.
On one hand, she prepares for the kind of questions her students might ask, or the
responses they might give her; on the other she ensures that the pace of the lesson
is within the time constraints she faces. During the two periods of observation, in
both of her classes, her improvisations did not appear to detract or depart from her
planned lessons. The changes she made during a given lesson were mostly adjust-
ments to her plans. If time was running short, she would leave some problems for
the next day, in her regular class, or assign them as homework, in her advanced
class. Other adjustments observed had to do with classroom organization, chang-
ing from working in groups to whole class discussion when the groups were not
progressing with the tasks assigned.
The interactions with her regular class students were characterized by frequent questioning and coaching as students worked on problems. When students worked in groups she walked around, always busy giving some hints to the different groups. She asked questions that would lead them to the right approach to the problem, that is, the approach shown in the sample responses in the Teacher Guide, or the approach that would relate this particular solution to problems ahead in the unit. In this sense, the textbook provided Pamela with a map of sorts, and gave directions about where her students should be going.

Curiously, during the observed lessons, her students in the regular class rarely used the textbook. They had the textbook on their desks, but it was Pamela who read aloud the text, and she translated it for them, explaining what needed to be done. Pamela’s students focused their attention on her, not on the textbook.

In the lesson on 11/7/02 discussed above (see Fig 4.20), problem 7.a. was difficult for some students. While the Teacher Guide suggested that students think about the dimensions, Pamela decided to have them look at physical models. Students were not able to find all six possible shapes, so Pamela gave a hint to some of them to examine the possible dimensions:

**Pamela:** Will that one work? Because you remember how the dimensions are related to the volume?

**Student:** Oh, yeah, OK!

**P:** So, think about $3 \times 3 \times 4$.

**S:** Oh, yeah.

**P:** So, will that one work? $3 \times 3 \times 4$ work?

**S:** It is ... it is 36.
P: Yes.

However, this approach was not pursued further and the help of the physical cubes was again emphasized. Later, the issue of the relation between the dimensions and the volume emerged again.

P: Remember how the dimensions are related to the volume, Sam?

Sam: When you times them all they equal 24.

P: When you times them all they equal 24. $6 \times 2 \times 2 = 24$, $8 \times 3 \times 1 = 24$, so see if you can think, too, gentlemen, three numbers that we have not used yet that multiplied give us 24.

The class was not very cooperative at this point, but Pamela’s suggestion did produce the missing prism: $12 \times 2 \times 1$. Pamela seemed more concerned about getting to the answer, by using the formula of volume, rather than getting to the formula of volume by looking at the different combinations of the answer.

The interaction between Pamela and her students in her advanced class was different. These students worked more independently and Pamela had them work in groups more often. However, most of the time these students seemed to be more comfortable working individually, and that was the most prevalent way they worked. When Pamela asked her students to think about a problem, she would wait silently for them to work the problem. Thus, the class was often completely silent while students worked on problems or questions from the textbook.

Pamela read aloud the introduction and questions from the book, just as she did with her regular class. She said that she reads instead of asking her students to read because she did not want to embarrass students that might not be good readers. While reading the book, Pamela led and guided her students’ work, asking
questions that would move her students toward a solution. More than “coaching” them, she initiated the work with them, setting the stage for them to work. By reading from the book, she also translated it, rephrasing some questions at times, to make sure that students have something to start with.

However, once students were working in groups on a problem, there was minimal interaction with Pamela. She walked around, looking at students’ work, but without intervening. After letting them work on the problems, they discussed among the whole class their solutions. During these discussions, Pamela asked students frequently to explain their answers. By reading ahead in the Teacher Guide, she had an idea of what she wanted to hear. Nevertheless, she listened very attentively to any student who had a response. Even when the responses were not clear, she made an effort to first understand what the student was saying, and second, to let the class look at other approaches to the problems. It was also a way to see the progress her students had made. For example, at one point a student found a very complicated and inefficient way of solving a problem. Pamela was extremely patient and let the student explain her solution in detail. During the post-observation interview, Pamela explained that she wanted to hear this student’s solution because

I think it’s important to let students understand their thinking. And it wasn’t the easiest way to solve that problem, but what she did was right, and she did achieve her answer, and really, she’s taken what she’s learned throughout this unit and how to apply a formula to get that answer (interview, 2/4/03).

Pamela valued these opportunities for students to share their thinking, and so learn from one another.

Pamela rarely changed the activities with the advanced class, she did not adapt them. When she intervened, it was usually to draw students’ attention to the im-
portant features of the problem or the context that would enable them to find a solution, scaffolding their thinking. However, she gave more guidance whenever she thought it was appropriate. During her lesson on 2/6/03, students had to find the 29th and 31st triangular numbers, given the 30th. A student was having trouble attacking the problem.

**Pamela:** Number 2. You’ve got to find the 30th triangular number. Here’s the first one, here’s the second one, the third, and the fourth. And actually I read that wrong: they’re giving you the 30th, you have to use that to find the 31st and the 29th. So I want you to think about this: did you compare how these are growing, what they increase by?

**Student:** No.

**P:** OK, here’s the first one and to get the second one it went up by what?

**S:** Three... or two!

**P:** OK, here’s your second one and so what’s the third one increased by?

**S:** Three.

**P:** This one goes up by...

**S:** Four!

**P:** So, there’s a relationship between how these are increasing. So if you know what the third one is, you can add four to find the next one. So, I want you to think, if you know the 30th one, how much would it increase by to find the 31st one? You’ve got to look that pattern.
Pamela struggled with maintaining the right balance between providing guidance and letting her students work through a difficult situation. On one hand is the need for students to do things on their own, “My biggest concern is if I tell the kids too much, rather than let them to figure it out” (interview 11/6/02). On the other hand, is the need to move kids onto new material, “Another thing I’ve questioned myself is if I follow too much, if we have to do each little problem, write each little answer, rather than letting the lesson just develop…” (interview 11/6/02).

Regarding the former, she recognizes that the use of MiC has changed her teaching in this respect.

Definitely. Because I think in the past I still used to tell students, “okay now this is exactly how you are going to do this problem, just follow these steps and you’ll be fine,” because we never want to see kids struggle, we want to help them out. Whereas now I think I do let them experience the struggling process a little bit more and I try to let them answer without me telling so much. And I think I’ve improved on that and I still maybe have ways to go. But just to be more of a facilitator role in the learning and I’ve tried to improve on my questioning techniques—rather than just say things always—to get the kids to come up with the ideas.

There were cases, however, where she was more directive with her students, telling them how something should be done. For example, when she introduced the order of operations, she stated the rules, provided a mnemonic phrase to remember the order, and assigned a worksheet. She saw no conflict with the MiC lesson. On the contrary, she viewed this as providing her students a tool that would help them deal with problems throughout the week.

In the advanced class, students interacted with the textbook constantly, unlike the students in the regular class. Since Pamela assigned problems to be solved in groups, the students read the book as they went. While in both classes she played an intermediary role, with her role being to ensure that the students follow
the textbook correctly and efficiently, in the regular class she replaces the book, whereas her students in the advanced class read the book with her. In the latter class the textbook served as a common referent and organizer for both teacher and students.

The pattern in the advanced class can be described as a cycle that began with Pamela reading aloud from the book, she then asked the initial questions or assigned some problems for her students to solve, students worked in groups or individually while Pamela had little or no interaction with them, students explained their answers in a discussion with the whole class, and then the cycle began again. As can be seen in Table 4.9, not all lessons flowed this way. However, when there were no distractions (peer evaluation, mathematics competition test), this was the way the lessons generally evolved.

As important as explanations are in Pamela’s classroom, the flow of the mathematical conversation was from her students to her, and from her to them, rarely among the students, and then only when working in groups. She sees the validation of explanations or arguments as part of her role. The explanations are therefore directed to her, not to the rest of the class. However, she believed the students’ explanations should be shared so that students can learn from each other and see other strategies, and understand each other’s thinking. Whenever she was convinced of the correctness of a student’s solution, she readily shared it with the class. When a student’s response was not immediately clear, she waited to hear the whole explanation, and then asked some questions to make sure that she could determine if it was a correct answer or not, before making it available to the class. She viewed her role as accepting or correcting solutions. During the lesson on 2/5/03 some responses were not what she expected:

These two kids these last two days have thrown me with something
that I need to think to make sure I agree before I pose that to my students. So, I do sometimes say “do you agree?” or “can you tell me about what this person’s thinking?” But I think with the last two days lessons I tried to model to the kids that “hey, I don’t get your thinking when you say it right away, tell me more and help me figure it out.” And so I think that is a good thing to model to the students, too. So, I didn’t ask their classmates for help because I was trying to follow her thinking first. And I wasn’t certain that it was true [right] (interview, 2/5/03).

**Summary**

For Pamela, solving problems and being able to explain with clarity one’s solutions were of paramount importance. Although this is not the defining characteristic of *Mathematics in Context*, it is a view compatible with the tenets of the curriculum. In this sense, *MiC* represented a reasonable match with Pamela’s teaching philosophy. She saw her role as an intermediary between the textbook and the students, a role in which she facilitated and structured the interactions between her students and the tasks posed in the book. The textbook provided her a map of what was ahead on the horizon and provided a glimpse of where her students were headed. Pamela’s decisions in the three arenas were influenced by this match between her own intentions, her district’s goals, and the possibilities that the textbook offers. While she admittedly would welcome more freedom, she managed to introduce and attend to the content that she considered relevant without breaking the continuity established by systematically following the textbook.

**Saxon Mathematics**

Harlan Elementary adopted *Saxon Math* in grades K-6 for the 2002–2003 school year. The *Saxon* mathematics program is based on three basic principles: incremental development, continual practice and review, and frequent cumulative as-
sessment. Its developers describe it as “a content-based curriculum that explicitly teaches skills and concepts through direct instruction” (Saxon Publishers, 2003). The focus is on presenting a small number of new concepts or procedures every day, solving very few examples of them, and solving a larger number of examples based on previous material. As the primary author put it, “Why not review continuously? Why should we present 25 problems of the new kind? Why not present only three or four problems of the new kind, along with 25 review problems?” (Saxon, 1982).

The curriculum guide recommends that lessons be presented to the students in the same exact order as they appear in the book. The developers (Saxon Publishers, n. d.) explain the routine as follows:

Saxon Math 7/6 mathematics program consists of 120 daily lessons and 12 activity-based Investigations. Students are tested after every fifth lesson, and all tests are cumulative. Concepts are introduced incrementally and are continually practiced throughout the problem sets. Each daily lesson consists of the following:

1. Warm-Up (8-10 minutes)
   Students take a quick Facts Practice Test to increase their proficiency with basic operations; solve several mental math problems; and complete a problem-solving exercise by using such strategies as making lists, drawing pictures, working backward, and guessing and checking.

2. New Concept(s) (10-15 minutes)
   The teacher presents the new increment(s) and works several examples with the class.

3. Lesson Practice (5-10 minutes)
   Students solve problems that cover the new concept(s).

4. Mixed Practice (20-30 minutes)
   Students solve problems that provide practice on previously introduced concepts as well as the new concept(s).

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The description corresponds to the fourth edition. Kate, the teacher in this study, was using the third edition. Nevertheless, there are no substantial differences as far as it pertains to this study.
The idea of distributed practice is neither new nor exclusive of the Saxon curriculum materials (see Suydam, 1984). However, Saxon made it the main tenet of his program.

Saxon should get credit for putting in published form something that had been proposed since the 30s, distributed practice. Before Saxon, some teacher guides would suggest distributing practice by taking a few exercises from different sections and distributing them along a certain period of time, but Saxon was the first to write a book with that idea in mind (Joe Crosswhite, personal communication, April 8, 2003)

*The Case of Kate*

Kate was 37 years old when this study was done, and had been an elementary school teacher for 13 years, ten of which she taught in a self-contained sixth grade classroom. She has a bachelor’s degree in Elementary Education, and she is certified to teach elementary school and middle school (general). In her initial survey (see Appendix A), she stated having had less than 6 hours of professional development activities in the past three years.

In Kate’s self contained sixth grade class, there were 27 students, 14 boys and 13 girls. There are no minority students in this class, but ten of her students (37%) are eligible for free and reduced lunch.

*Lesson Routine*

Kate was observed nine times during two one-week periods. The length of each mathematics lesson varied (an average of 53 minutes), due to different schedules and activities at the school. On at least one occasion, the lesson was shortened to accommodate for the observation. The routine of each lesson was consistent throughout the observation periods. Table 4.10 shows how Kate distributed her
lesson time.

The timed tests took one minute, after which Kate read the correct answers, her students scored their tests and then made a record in their record sheet. These timed tests are part of the materials that come with the textbook. they are part of every lesson, and students take the same test several times during the year. For example, the test taken on 11/19 was taken again on 11/21, the test taken on 1/21 was taken again on 1/24. These tests (“90 division facts,” “30 fractions to reduce,” “64 multiplications facts”) have simple exercises that can be done mentally, and students just record their answers. This was always the first activity every lesson. Kate’s students seemed enthusiastic about these tests. The teacher recorded the number of correct answers each day in her grade book. Students were able to monitor their progress when they took the same test again.

The “Mental math & problem solving” is the second part of every lesson. The mental math section began with a counting aloud activity, that was done by the whole class together, for example counting by 12’s from 12 to 132, counting up and down by $\frac{1}{8}$’s between $\frac{1}{8}$ and 3, or counting up and down by 5’s from −25 to 25. It also included seven or eight arithmetic problems ($6 \times 250$, $8.75 + 5.00$, $4 \times 1.99$). The last part of this section includes a problem. These problems could be word problems that were not related to the topic of the lesson, or problems that could require a wider range of strategies (e.g. smart counting, using some geometric property, missing digits problems). In Kate’s class, the mental math exercises and the problem are displayed from a transparency on the board, and the class solves these exercises together, which takes an average of 6 minutes every lesson.

The next part of the lesson was presented by Kate. One or two new terms or definitions were presented, and a couple of examples were shown demonstrating a new procedure. Next, few practice exercises focused on the new procedure were
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solved by Kate with the whole class observing or answering to her questions, usually about simple calculations.

After this presentation from the textbook, students worked on the exercises assigned. Each problem set had 30 exercises. During the observed lessons, students solved at least 12 or 14 of these problems, with some students finishing the whole set before the end of the class period. Those students that didn’t finish, completed them at some other time during the day. Kate did not assign homework problems, because she did not want the parents doing the homework for their children. She also had concerns about her students getting confused by different terminology or different ways of doing things, so she insisted that students finish their problem sets before going home.

The publishers created some support materials for students that might have difficulties solving the problems in the problem sets. These materials included worksheets in which each problem of the problem set has a hint, or the procedure to solve it is laid out in steps for the student to fill in the blanks. Some students in Kate’s class use these worksheets, instead of the problems in the textbook. These students are students that struggle with the original problem sets. Kate determines who needs to use these worksheets, based on her knowledge of each student’s previous work. All other students worked with the textbook on their desks.

While students worked on the problem set, Kate walked around, checking students’ work, answering questions, and offering hints or solving problems with some students.

*Kate’s Lessons*

The Saxon program consists of 120 lessons, with each lesson focusing on a specific topic. Each topic is presented as a small increment every day. There are no
chapter divisions, and a problem set has exercises from many different topics covered in previous lessons. In fact, each exercise has a number next to it, indicating in what lesson it was introduced. Because of this, it is difficult to establish the main topic of a given lesson. Although each lesson in the textbook has a topic, and it is presented after the mental math activities, in terms of time, students spent a longer time doing exercises of previous lessons, exactly the way the developers intended this program to be implemented. In any case, the main topics introduced during the observed lessons were,

— Areas of rectangles. Comparing differences.
— Rounding decimal numbers.
— Mentally dividing decimal numbers by 10 and by 100.
— Decimal chart. Simplifying fractions.
— More on reducing. Dividing fractions.
— Writing fractions as percents.
— Ratio.
— Changing percents to decimals.

Each of these topics was presented with minimal discussion, focusing on any needed definitions and a standard procedure associated with the topic. For example, on Lesson 50, “Rounding decimal numbers,“ the following explanation is given with the first example:

We will mark the places that will be included in the answer

$0.55|12$

137
Next we decide the possible answers. We see that $0.5512$ is a little more than $0.55$ but less than $0.56$. We will decide whether $0.5512$ is closer to $0.55$ or $0.56$ by looking at the next digit. If the next digit is $5$ or more, we round up to $0.56$. If the next digit is less than $5$, we round down to $0.55$. Since the next digit is $1$, we round $0.5512$ down (Hake & Saxon, 1997, p. 247).

Some topics had longer explanations, but it was in the spirit of the program to keep these explanations to the basic definitions and procedures, with examples of their immediate applications.

_The Curriculum Mapping Arena_

Charles School District had a guide for sixth grade mathematics that was a list of objectives—skills that students should have at the end of the year, rather than a list of topics to be covered. Kate and the other sixth grade teacher compared *Saxon Math 76* with their district expectations for sixth grade, and considered that the textbook exceeded these expectations. A representative of the publishers visited the school several times to demonstrate the use of the textbook and to answer questions from the two teachers. After these visits, the plan for the school year was to use the textbook every day as recommended by the publishers. Both scope and sequence were then determined by the textbook, as well as pacing (one lesson per day). As recommended by the publisher, Kate and the other sixth grade teacher decided to test their students every five lessons, using the tests that come with the textbook.

Kate and the other sixth grade teacher were not happy with the results they were getting with previous textbooks. They felt they had to do a lot of remediation, and that is one of the reasons they decided to adopt a new textbook:

>[It was unacceptable] For a majority for 20 out of 27 kids to not be able to multiply basic facts. And each year got worse. Each year it was a
few more kids that couldn’t do it and each year it was a few more kids that were farther and farther behind and didn’t know place value and didn’t know basic things that they needed in order to pick up the book where you’re at, so the entire system needed to be reworked in one way or another (interview 1/24/03).

In the past they felt students would do well on a test after a certain chapter, but retention of the concepts and skills was not good. The possibility of higher retention of knowledge if they used Saxon Math was extremely appealing for teachers. Once convinced that Saxon Math could be what they needed, they decided to adopt it and follow its recommendations to the letter. This is why the planning of the school year was completely determined by the adopted textbook. They advocated for adopting Saxon Math at other grades and all the elementary grades adopted it.

Math was a large failure in the elementary for several years and so we’ve tried all kinds of things and this is the next thing we’re trying. So that’s basically how…All the other programs work the same. When we got to adopting a textbook and we said “no, we’ve got to find a way to get them to be able to understand how to do math and carry over and remember it from the beginning of the year to the end.” And that’s why we chose this program (interview, 11/18/02).

This was the fist year they were using Saxon Math, so they decided to be as faithful to the textbook as possible.

This is basically the first year, so I am strictly going on “this is the recommendation.” I’ve got those gut reactions where I don’t feel like we’re quite there or I don’t feel like we’re quite ready to take the next step. And then I make those judgement calls and we deal with it. But the expert that came to talk to us said that your best results will come from true use of the series and so I try to stick to that as much as possible. I feel like I’ve got the freedom to add, you know, or say “today it was too much, we’ve got to take another [day] for it” but…(interview 11/21/02).

Data suggests this textbook responds well to Kate’s view of mathematics and mathematics teaching. It addresses the problems she has experienced in the past,
and it helps her to teach mathematics the way she believes is necessary. Kate viewed mathematics as a competency, as a tool for everyday life:

[Y]ou need math in every day life. You’ve got to balance a check book and... [Y]ou know, we’ve brainstormed all kinds of real world uses for decimals and fractions and percents... I do [balance my checkbook] to the penny, yes, and calculating gas mileage and, you know, estimating the bills for the month and how much do you pay for the dance classes this month or should we pay more towards the piano lessons for this month or... (interview, 11/21/02)

Kate believed that mathematics would be difficult for many students. For her, mathematics was not an enjoyable experience.

[I did not like math as a student] it was just really hard for me. I was more the English/Language Arts and math was really, really, really hard for me. But I think because it was really hard for me I work harder at teaching math...

I just didn’t like the subject. I think it was a self confidence issue. I had gotten straight A’s through school and hit a math class that was not at all structured it was a move at your own pace kind of... and I wasn’t highly motivated to push myself and I got a C for the first time ever. And then I just assumed that I was dumb and stupid and couldn’t do math. So every math class from that point on I was like, “Oh I’m not going to be able to do this.” So it was just the confidence (interview, 11/18/02).

Ensuring greater confidence in her students was one important goal for Kate.

I want them to be successful. And I think because math is an issue in our school district right now and the district is supporting what’s going on in the K-6 and wanting to extend it to K-8 and it’s a focus. I’m wanting my kids to be completely prepared when they go to junior high to advance to the next level in their skills. I want to really give them a really good foundation (interview, 1/24/03).

Kate seemed to have a view of mathematics as a collection of closed capacities, in the sense of Passmore (1980), capacities that can be completely mastered. In this
sense, Saxon Math represented a promising teaching tool for Kate. It only made sense to adhere to its philosophy, trust it, let it be the curriculum, and hope for the best.

_The Design Arena_

Kate did not select or adapt tasks. The problems in the textbook were for the most part one-step exercises that were always presented to the students as they were laid out in the textbook. The process of planning or designing tasks does not involve the use of any other resource, not even teacher-generated materials, such as worksheets. The curriculum materials necessary to teach according to the recommendations from the publisher were part of the textbook. Although the presentation of new concepts or procedures could admit some input from Kate, she deliberately chose not to change anything. When she presents something, she reads it directly from the textbook:

Right now I still read a lot of the textbook because I want to make sure I use the same wording that they’re going to see later on. Now, maybe I’ll find that I could have worded something different and it’s not going to affect what they read later. But when they hear me use a particular wording for a solution to a problem and then they never see that again and they see it worded some place else they can’t make that transition very well. So right now I am heavily reading out of the book (interview 1/24/03).

Kate got together with the other sixth grade teacher to plan together, which basically meant exchanging ideas and making sure they followed the same pace. When they found some difficulty with the text they discussed it, and sometimes they got advice from the publishers:

[I] Talk to my partner and we brainstorm some things, because our text book and the 5th grade text book are laid out very similarly, then we’ve
talked “okay, how are you handling this issue?” and then we’ve got the email and the phone number of the gentleman [from Saxon Publishers] and we’ve called him and emailed him before (interview, 11/21/02).

Kate’s preparation included making sure her teaching followed the new way of teaching that this new textbook embodied and carefully prescribed.

Saxon has a different style of teaching, it’s not teacher-centered it’s student-centered, so instead of what I would call a traditional math classroom where a teacher stands up and lectures and gives examples and examples and examples for a majority of the time and then gives the kids their assignment, the majority of this classroom time is spent with the kids working and me being one-on-one with them and helping them, which is different than in other times. I am teaching a different style because of this textbook 11/20/02).

The publishers state clearly that Saxon Math is a teacher-centered curriculum, probably in response to standards-based curricula that might claim to be student-centered. However, in Kate’s view, it is a student-centered textbook because she has time to focus her attention on her students, as opposed to her students having to focus their attention on her.

In Kate’s classroom the most important rules and terms are posted on the walls of the room, and students consult those freely when they are working on the problem sets. Rules for operations with fractions, rules for operations with negative and positive numbers, units of measurement, and other rules deemed important by Kate have a space on the classroom wall. This is consistent with Kate’s view of mathematics, as rules and methods that must be mastered.

*The Construction Arena*

All mathematical tasks posed to the students in Kate’s class were exercises and questions that required very few steps. They usually reflected immediate applications of procedures that did not require changes in representations or any other
kind of flexibility in the approach. While some of the questions and exercises could be solved in different ways, e.g. the estimation tasks, they were usually solved using a standard approach following the method or procedure presented in the classroom. In this sense, there was little variability, if any at all, between the way the tasks were designed and the way the tasks were enacted in the classroom.

During a typical lesson there seemed to be two high priorities, related to each other, in Kate’s role in the classroom. The first priority was to maintain constant encouragement of the students. Kate has frequent words of praise for them, and has a positive attitude towards the lesson and the mathematics. Even when the exercises were straight-forward (e.g. $10 - $0.10), she acted as if all exercises were very exciting. According to her and her students, she usually would add some humorous attitude during the lesson, including some singing and dancing that did not take place during observations. While this might have been her style all along, she deliberately used it as an instructional strategy based on the class demonstration by the people from Saxon Publishers.

Probably the biggest influence was the day I was able to sit and watch him demonstrate, ‘cause I’m real visual and so I can hear that “this is how you do it” but when I saw him in action he “said you can cheerlead them.” And I was like “oh, yeah that’s a good idea” but not until I saw him actually just wandering by and going “yeah! That’s alright! Awesome answer!” I was like “okay” (interview, 11/21/02).

The second priority is not to make any student feel bad about not being capable to do math at the level of the rest of the class. As a result, she only asked questions of students who were raising their hand, or helped students when they were working individually on their problem sets, making sure that they progressed. This is why she valued the opportunity to work with students one-on-one, because that way she can provide every student the help that he or she need, without having
to have the rest of the class involved. To make sure that every student felt successful, Kate would say, for example, “all who have finished at least 15 problems can leave,” but only after checking that every one had 14 or more. She did not want their students to associate feelings of discomfort with mathematics. It seemed that she has succeeded, for her students were enthusiastic most of the time during every observed lesson. According to Kate, mathematics is now their favorite subject.

While her lessons were always organized in the same way, there was at least one instance in which she departed a little bit from the usual format when she found that many students were all getting a particular question wrong. She interrupted their work to explain how to answer that question.

Kate: Can you stop for a second and look up here? I don’t know how many of you have gotten to this point, and some of you may have gotten to it and gone on. Would you double check for me? Yesterday we had a fraction and we changed them into... what did we do yesterday? Percents? OK. The question today is take $\frac{7}{8}$ and change it into a decimal. Does anybody remember how did we do that? Tyler?

Tyler: 7 divided by 8.

K: Good, 7 divided by 8 [writes it on the board], where does my decimal point go here?

T: After the 7.

K: After the 7, and what do I need to add?

T: A zero.

K: Good, add my zero, where does my decimal point go?
Kate’s interactions with her students were not very different from this example. Exchanges of questions with short answers, going through a procedure to get the answer. Only rarely did students give explanations for their solutions, and in those cases the explanation was limited to a description of the sequence of steps. When students were working individually the interaction with Kate was limited to asking her to determine the correctness of an answer or a procedure, or to request her help on a particular problem. Collaboration among students was not structured into the lesson, but sometimes it occurred spontaneously, and it was not discouraged. When this happened, students usually checked answers with each other, more than solved problems in collaboration.

In every sense, the textbook was the center of the lesson. Terms, definitions, procedures, and examples were all taken directly from the textbook. It guided the whole course, and every lesson. It was used by the teacher, and by the students. Because the way the textbook is conceived, unexpected situations seldom arise. Improvising in response to students’ actions was therefore not an issue. The way the lesson was presented in the textbook was always the way the lesson was enacted in the classroom.

Kate’s Attitude Towards the Study

In one respect the case of Kate is much different than those of David and Pamela. Kate had feelings of extreme anxiety about taking part in the study. She agreed to participate in (MS)$^2$, the larger study, very reluctantly, and did not want to be part of the cases for this study. She admitted not being a confident teacher, and ever
since her first contact with the study—filling out the initial survey—she experienced feelings of inadequacy.

I’ll be very honest. That survey, I hated that survey…

[A]fter you’ve gone through the whole how much education have you taken in math and blah, blah, blah, okay, you know, I have nothing else to add to this discussion…

[B]y the time I actually got down to, you know, after you got through the whole personal background, okay, well it doesn’t matter what I say because its going to be wrong. There was nothing in there about how much time do you spend preparing. There was nothing in there about how much child psychology have you had. There was…it was all math training and no, I don’t have any math training. I don’t have any science training. I don’t have any reading training. I got general education training and classes that I take all summer and blah, blah, blah…

It’s okay [now] but I just wanted to tell you that I don’t know how valid my survey was because by the time I finally got down to doing it I was like “incompetent, incompetent, incompetent, incompetent” (interview, 11/21/02).

During our informal conversations she said that every time she was going to be observed she felt so bad that she felt like throwing up.

This situation must be considered beyond the anecdote. It illuminates the circumstances in which a teacher like her would embrace faithfully a textbook. Kate had the firm conviction that there is one best way to teach mathematics, that someone “out there” knows this way, and that if she only knew about this way of teaching, she could learn to do it by watching someone teaching. Being observed put her in the position of being singled out as a teacher that does not know how to teach.

My assumption is always that there’s some piece of evidence, research, something, that I just haven’t gotten to yet that’s, you know, late-breaking and says this is how you do it and the person who’s watching me is going “that is so old school and that’s not the way to do it at all.” And I’m up there teaching my heart out and looking like a complete and
total idiot because I’m not doing the new thing or the right thing or the... (interview, 1/24/03)

During the process of the elementary textbook selection she and the other sixth grade teacher were in favor of choosing Saxon Math, and were strong advocates for the adoption. Being part of a study that, from their perspective, could potentially make a claim that this textbook was not a good choice put a burden on them that was difficult to bear. In this context, Kate found herself in a vulnerable position. In a way, having put so much at stake in the textbook selection became strong motivation to use the textbook as close as possible as its developers recommended. At the same time, it made outside scrutiny an unneeded, and certainly uncomfortable, pressure.

Summary

Kate needed curriculum materials that would help her students get better results in mathematics. She was particularly concerned that her students would forget before the end of the year what they had learned. After looking at different textbook series, she and other K-6 teachers at Charles School District became aware of Saxon Math, and found it promising. It matched her view of what is important in mathematics, namely the mastering of concepts and procedures through practice and repetition. The textbook developers’ recommended approach to the teaching of mathematics seemed appealing, and she embraced the philosophy and goals wholeheartedly. The textbook offered structure and guidance she could trust. Kate saw the textbook as an authority both in content and method.
Summary of the Three Cases

In this section, the cases of David, Pamela, and Kate have been described. David and Pamela used the same textbook (in different grades), but the way they used it differed greatly. David’s teaching practices placed an emphasis on instrumental understanding in mathematics (Skemp, 1978), while Pamela posed tasks in ways that would emphasize a relational understanding in mathematics. Both of them faced external pressures that limited their options regarding the use of the curriculum materials, and they responded by adapting their teaching in different ways. Pamela made a constant effort to match her teaching practices to the philosophy of the textbook, while David made sure that he covered the topics in the textbook, adapting the tasks along the way to better match his own style of teaching.

On the other hand, Kate, like Pamela, had a certain sense of ownership in the decision of selecting the textbook, both of them having been part of the group of people that ultimately made the final decision on this matter. Like Pamela, Kate found herself working with a textbook that matched to an important degree her philosophy of teaching. For different reasons and viewing mathematics teaching from almost opposite perspectives, Pamela and Kate became thorough implementers of the curricula they were using. Their teaching practices were very different, but in both cases these practices were determined by a match between their own view of mathematics and a textbook that matched this view.

David and Kate had similar beliefs about mathematics and mathematics teaching, and therefore their interactions with students and their teaching practices were similar. Their interactions with their respective textbooks were nevertheless very different. Of the three of them, David was the only one who frequently used other
resources, for he was the only one that did not like the textbook he was using.

The three of them, for different reasons, were teachers who followed their textbooks very closely. Their mathematics courses were shaped directly by the textbook. Their conceptions about mathematics and mathematics teaching, on one hand, and their view of the role of curriculum materials, on the other, influenced in no simple ways the way they use their textbooks and the ways these textbooks affected their teaching practices.

Summary

In this chapter results from the two parts of this study were presented. From the 53 (MS)² teachers data sources include a survey, textbook diaries, and two classroom observations. These data suggest that teachers use extensively their district-adopted textbook, and that textbooks influence in important ways the content of their mathematics lessons. There is also evidence that NSF curricula are used in different ways than traditional textbooks, mainly with regard to planning a course and planning each lesson.

The three case studies presented in the second section present a finer grained picture of textbook use by three teachers that reported using their textbooks very frequently. Drawing from classroom observations and extensive interviews, these cases examined the contextual factors that explain how teachers interact with their district-adopted textbooks in three different realms, namely the mapping of the curriculum, the designing and adapting mathematical tasks, and the enactment of these tasks.
CONCLUSIONS

Summary of the Problem

The adoption of mathematics textbooks in American schools has been brought to the center stage of a political arena where visions of mathematics and goals of mathematics teaching from opposite camps collide with one another. Discussion and debate have gone from school board meetings and academic journals to the mass media. It is frequently assumed during these debates that a change in the textbook used by a teacher will bring a change in the teacher’s teaching practices. The unstated premise in these arguments is that teachers using the same textbook will teach in more or less the same way.

Mathematics textbooks are an important component in determining the curriculum, but textbooks are not the curriculum. The enacted curriculum results from the interaction of teachers’ with their students. By being mediators between students and textbook, mathematics teachers make decisions that determine the role curriculum materials will have in the classroom. In this sense, by adapting, interpreting, supplementing, or even ignoring the tasks and the pedagogical approach proposed by the textbook, teachers are the ultimate developers of the curriculum that takes place in their classrooms. Thus two teachers using the same textbook could be enacting two completely different curricula. In this context, the need to understand how mathematics teachers use their textbooks is extremely important.

Previous studies have focused on the extent to which teachers “cover” a text-
book, or how closely they adhere to the textbook, in terms of scope and sequence (Freeman & Porter, 1989; Sosniak & Stodolsky, 1993; Stodolsky, 1989). These studies have documented that teachers rely heavily on textbooks to teach mathematics.

Responding to the need to develop mathematics curricula that reflected the NCTM Standards, the National Science Foundation (NSF) funded five curriculum development projects to produce middle school mathematics curricula. These curricula’s content and organization are markedly different from traditional textbooks. Schools and teachers adopting these textbooks face unique challenges due to the fact that these textbooks not only reflect different views about mathematics content, but also about desirable teaching practices. For the past five years these curricula have been the focus of research studies in which teachers have been examined in the process of adopting reform curriculum materials (Lambdin & Preston, 1995; Smith, 1998), and also the factors influencing the process of reform curriculum implementation (Bay, 1999). In these studies, how teachers use their textbooks is not the main object of research, but rather how teachers’ practices adhere to a certain standard embodied by the textbook. In a growing body of work, Remillard (1996, 1999, 2000) has approached the problem by noting that there is a need to characterize what use of curriculum materials really means. As a result, she has proposed a model to examine teachers’ use of textbook. Her model has been used as the conceptual framework for this study.

There is a need to understand how middle school mathematics teachers use their textbooks. The research investigations mentioned throughout this dissertation have examined the process of change during the early stages of curriculum implementation. Moreover, they have not focused on textbook use. The theory building work by Remillard, on the other hand, has focused on elementary school teachers. This study considered middle school mathematics teachers that are past
the initial stages of implementation and utilizes the three arenas model proposed by Remillard as a tool to study textbook use.

In particular, this study addressed the following questions:

— How do teachers utilize district-adopted school mathematics textbooks? To what extent do they use them? For what purpose?

— Why do teachers make the instructional decisions they do regarding the use of the district-adopted textbook?

— Are there differences in how the district-adopted mathematics textbook are used between middle school teachers that use standards-based textbooks and teachers that use traditional textbooks?

Methodology

Using data from the Middle School Mathematics Study, a descriptive study was done to document and categorize the extent and nature of textbook use among 53 teachers in 11 middle schools throughout the United States. Surveys, classroom observations, and textbook diaries were the sources of data used for this purpose. The teachers were observed twice during the 2002–2003 school year. In six of these 11 districts, teachers used NSF-funded curricula (see Table 3.1): *Connected Mathematics Project*, Pearson Education (districts 1 and 2); *MATH Thematics*, McDougal Littell (districts 3 and 4); and *Mathematics in Context*, Encyclopædia Britannica (districts 5 and 6). The rest of the schools, identified as companion schools, were using a variety of textbooks: *Math Advantage*, Harcourt School Publishers (district 7); *Mathematics: Applications and Connections*, Glencoe McGraw-Hill (districts 7 and 10); *Addison-Wesley Mathematics*, Addison-Wesley (district 8); *Mathematics*, Houghton Mifflin (district 8); *Mathematics Today*, Harcourt School Publishers (district 8); *Math
Matters, An Integrated Approach, South Western Educational Publishing (district 8); The Mathematics Experience, Houghton Mifflin (district 9); Saxon Math 76, Saxon Publishers (districts 9 and 11); and Saxon Math 87, Saxon Publishers (district 11). Most schools had used their adopted textbooks for at least two years. Teachers using Saxon Math and teachers piloting Houghton Mifflin Mathematics were in their first year of using these textbooks.

From this group of teachers, three teachers were selected for case studies. In addition to the survey, the textbook diaries, and the two observations, other sources of data were utilized for the case studies. In particular, these teachers were observed for two one week-periods, during the fall and winter. These observations were audio-taped. Four interviews with each teacher were done, besides several shorter post-observations interviews. The interviews were audio-taped and transcribed.

Findings

There were two components for this study, namely a descriptive study of a group of 53 teachers participating in the Middle School Mathematics Study, and case studies with three of the 53 teachers. Both in the methodological approach and in the sources of data these two components had little overlap. Given that the results from each component informed the other, these components were used to answer the research questions. The research questions are presented here with a discussion of the findings from both components of the study.

The first research question is: How do teachers utilize district-adopted school mathematics textbooks? To what extent do they use them? For what purpose?
Extent of Use

According to the textbook diaries that they kept for two 10-day periods, a little over 60% of the 53 teachers in the (MS)\(^2\) study used their textbooks at least 75% of the instructional days. There was little difference when teachers were separated by grade or by the kind of textbook. Forty eight percent of the teachers using NSF-funded curricula reported using their textbooks more than 90% of the time, while 27% of those using other textbooks reported using their textbooks as often. In spite of the fact that the NSF-funded curricula were the official district adopted textbooks for at least two years prior to this study, a couple of these teachers reported using them less than 50% of the instructional days. In short, most teachers in this study, regardless of the kind of curriculum or grade, reported using their textbooks very frequently. With very few exceptions, during classroom observations the textbooks were used as a significant instructional tool by the teacher.

These findings are consistent with the relevant literature (Grouws & Smith, 2000; Robitaille & Travers, 1992; Tyson-Bernstein & Woodward, 1991; Weiss et al., 2003) on the matter. However, this study is unique in the fact that all participants teach mathematics in middle school. Previous studies on textbook use have included other subjects, such as science, and have not addressed exclusively middle school teachers. Moreover, the teachers in this study were not part of any project or collaboration effort aimed at changing their practice or at implementing new curricula.

Nature of Use

During the enactment of the lesson, i.e. in the construction arena, most teachers used the textbook in two primary ways, namely as a source of tasks and as
a “lesson plan” to guide their instruction. In both cases these uses entailed little modification to the lesson as presented in the textbook. While the level of difficulty or the focus of certain tasks likely changed as a result of a teacher’s actions and decisions, tasks seemed to be presented to students as they are posed in the textbook. In this sense, the content of instruction was heavily influenced by the textbook. However, the teaching practices did not necessarily reflect those practices associated with some of the curricula used by the teachers in this study.

The individual case studies confirmed the inferences made for the larger group in regard to the extent and nature of use of the textbook. The three teachers in these cases relied on the textbook to plan the lesson, and actively used the textbook during the lesson. One of them, David, used more tasks from sources other than the district-adopted textbook, but even in his case, the textbook was a primary influence during the curriculum mapping and also during the planning of the lessons. On the other hand, Pamela and Kate had a more faithful stance toward the textbooks they were using. Both of them found their district-adopted textbooks closer to their own views about mathematics teaching and rarely used other resources. All three teachers followed the sequence of topics set by the textbook. More specifically Pamela and Kate deliberately tried to follow the recommendations put forth by their respective textbooks’ developers, whereas David focused his instruction on tasks from the textbook adapting them within the construction arena by shifting the emphases of the lessons toward a more procedural approach. In Kate’s classroom this same procedural approach was inherent to the textbook she used.

For Kate and Pamela the textbook represented a road map that guided the entire course and the everyday planning of the lessons. For David, the textbook provided the topic and offered tasks that were adapted to fit teaching practices established for a long time.
The second research question was: *Why do teachers make the instructional decisions they do regarding the use of the district-adopted textbook?*

Pamela and Kate were active participants in the textbook selection and adoption process in their districts. They helped choose the current textbook in part because of the match between their own goals and beliefs about mathematics and mathematics teaching and those represented by the mathematics textbooks. As a result, their instructional practices and their decisions regarding the use of their textbooks were aligned with the textbooks’ aims and methods. Both of them saw their textbooks as a map for the entire course. The textbook was the primary curriculum source of their lessons. Kate did not consider herself well prepared to teach mathematics, so she needed a textbook that would not demand great knowledge from her, and that at the same time would help her students succeed in mathematics. On the other hand, Pamela had a stronger background in mathematics and that gave her the confidence to use the tasks in *MiC* and be ready for encountering multiple approaches in her students.

In contrast, David had a passive role during district textbook selection and adoption process and he did not like his textbook. His view of mathematics and mathematics teaching conflicted with the textbook. He complied with his district directives, but without letting the textbook guide the course. Because the topic determination and the pace were decided at the district level, David was committed to use *Mathematics in Context* every day. However, the textbook for him was more a source of activities, and he used those activities primarily to prepare his students for the planned assessments. These weekly tests drawn from the textbook guided his choice of tasks and therefore he adapted those tasks to match his view of what is important in mathematics and prepare his students to be successful in the assessments.
Because Pamela and David teach in the same school, they share certain external pressures related basically to time available and curriculum mapping. Both of them felt that they had little control over certain aspects of planning. It is noteworthy that David was the only teacher in the group that stated that he had no control over “selecting teaching techniques” (see Table 4.3). Both teachers stated that they would like to have more freedom to plan, but nevertheless both complied with the district’s directives. Their periods were relatively short (40 minutes), and therefore the activities could not be carried out with flexible timing. They had to get things done, and this accounted for more structured lessons, where there was not much room for improvisation in response to students’ actions, mostly in Pamela’s classroom.

Teachers’ view of the curriculum and the match, or lack of it, between their own views about mathematics and mathematics teaching and the philosophy of the textbook—whether it is explicit or not—were the primary factors that determined how the textbook was used. However, the primary factor that determined what tasks were presented to students was the textbook.

The enacted curriculum in these three teachers’ classrooms was shaped as much by the textbook as by the teachers’ beliefs about mathematics and mathematics teaching. Their broader goals for their students were reflected on their teaching but also on their relation with the textbook as a tool for instruction. Teachers with similar views about mathematics, such as David and Kate, enacted very different curricula due to the influence of textbooks with very different assumptions about the roles of the teacher and students. At the same time, teachers within the same school and using similar textbooks, such as David and Pamela, also enacted very different curricula, as a consequence of decisions based on their views about mathematics and their stance towards the curriculum materials they were using.

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The third research question was: *Are there differences in how the district-adopted mathematics textbook is used between middle school teachers that use standards-based textbooks and teachers that use traditional textbooks?*

Teachers in the larger set of 53 teachers in the (MS)² study using NSF-funded curricula tended to adhere more closely to the textbook. They reported viewing the textbook as a guide for the structure of their courses and as a source of ideas and directions for the teacher. They were also more likely to read and use the teacher guide.

Each of these uses pertain to Remillard’s design arena and this is where differences between the two groups is most noticeable. Teachers in this study using NSF curricula plan differently than teachers using traditional curriculum materials, they are more likely to read and use ideas suggested by the curriculum materials.

In the construction arena, during the enactment of the lesson, there were not discernible differences in the way NSF-funded curricula and other textbooks were used in the classroom by teachers. Nevertheless, the tasks that students were doing were of a different nature. Even if the teacher used the textbook to select tasks to present to the students, and followed the lesson as laid out in the textbook, the resulting lesson would depend on the characteristics of the tasks presented in the textbook. The teaching practices and the interactions between teacher and students would also vary, according to the expectations of the textbook. In other words, the fact that textbooks were used in similar ways, does not imply that the teaching practices were also similar. This is particularly clear in the cases of Pamela and Kate. Both adhered closely to the textbook and followed it to the page. Nevertheless, the kind of activities in which their students were involved, although dictated by the textbook, were substantially different. One of the textbooks offers more
elaborated activities with the assumption that there will be interaction among students while the other focuses on repeated individual practice of procedures. The organization of the classroom work was different (e.g. work in groups versus individual work on sets of exercises). For both teachers, the textbook constituted a map of the course, for both teachers’ students the textbook was a source of tasks and interacted directly with the textbook. However, the nature of the tasks and the sociomathematical norms in the classroom were very different and reflected the philosophy of their mathematics textbooks.

Discussion

Remillard and Bryans (2003) and Lambdin and Preston (1995) identify categories of use or implementation including thorough piloting and standards-bearer, respectively, to describe teachers that “faithfully implemented” their textbooks. In both cases, however, the textbooks used were inspired by the NCTM Standards. In the comparisons made between Pamela and Kate in this study it has been implicitly established that a similar category might fit teachers that adhere very closely to their textbook, even in those cases where the textbook is not aligned with the Standards. It is clear that in these cases, the nature of the mathematical tasks presented to students, their richness and quality, does depend on the textbook used by the teacher. In this sense, the findings of this study support the notion that the choice of textbook matters and impacts in significant ways the opportunities for learning mathematics that students have.

The case of Kate illustrates the fact that teachers dislike commercially generated textbooks for different reasons. For example, teachers change textbooks for lack of better results with their students. They turn to a textbook like Saxon Math, because it looks different and reflects qualities such as procedures accompanied by
distributed practice that teachers view as central to learning mathematics. While some label *Saxon Math* as a traditional textbook, its developers and supporters see it as innovative. Its goals are appealing to many teachers for whom mathematics proficiency means mastery of basic procedures. It addresses a need that is usually absent in reform curricula\(^1\), namely the need for repetition. Sfard (2003) has identified this as an important need, and one that needs little justification for many teachers.

The case of David illustrates what seems to be a common occurrence in many stories of reform curricula implementation. It is possible to “adopt” a textbook and use it frequently without really espousing the epistemological assumptions that are attached to the textbook, and thus not change teachers’ practices in ways that would better match the goals of a particular curriculum. Bay (1999, p. 242) noted that “teachers resort to traditional practices unless professional development and opportunities to collaborate are present.” David had both, and he still resorted to traditional practices, but in subtler ways. He did not ignore the textbook or skip sections. He changed the approach of certain problems, and assumed a role as teacher that would give room for more showing and telling. The professional development and collaboration did not appear to influence his teaching practices, in part because he had a very robust belief about what mathematics is that was not affected by the professional development or his interaction with other teachers.

Previous studies have found that teachers improvise frequently in response to their students progress and struggles and “that the curriculum constructed in the classroom is largely improvisational” (Remillard, 1997). However, this study presents three cases in which teachers infrequently improvised. Improvisation did

\(^1\)I am using *reform curricula* to include those NSF-funded curricula and those who, although not funded by NSF, claim to be based on the NCTM *Standards.*
not appear to be central to the enacted curriculum in their classrooms. Unlike the teachers in Remillard’s study (1996; 1997; 1999), the teachers in the case studies interacted more closely with the textbook during the construction arena. This was as much a consequence of the nature of the textbooks used as the particular circumstances these teachers faced in their schools. In the three cases, instructional time for mathematics and the commitment to comply with the established pacing guide were significant influences that shaped the design and mapping of the curriculum. In all three cases teachers frequently reported that their lessons went as planned, a testimony of how they resolved conflicting demands within the curriculum mapping and the design arenas.

These cases illustrate that variability in use of mathematics textbooks can be a relevant object of study in itself, as one of the several factors that determine students’ opportunities to learn mathematics. As these case studies illustrate, teachers pay attention to different aspects of mathematical tasks presented in textbooks, according to their view of mathematics and mathematics teaching. Only one of the three teachers saw the textbook as an opportunity for her own learning of mathematics. This awareness of the potential use of textbooks as tools for teachers’ learning should be more closely examined.

This study has documented how teachers enacted essentially different curricula in spite of using similar textbooks. This of course illustrates the fact that textbook adoption, by itself, does not necessarily change teachers’ practices. However, to the extent that textbooks influence topic determination, the impact of textbook choice on students’ opportunities for learning mathematics is certainly relevant.
Implications

Implications for Future Research

One of the goals of this study was to utilize Remillard’s model to examine textbook use at the middle school level. This study demonstrated that this is a robust and useful model. Further work is needed to establish whether it should be revised or refined to better fit the needs of those investigating curriculum. More complete characterizations of use of textbook need to be develop, so that categories of use of textbook can be established. Evaluating the impact of textbooks in students’ learning can be better informed by a more structured way of looking at how teachers use their textbooks.

This study examined in a holistic way how teachers interacted with their textbooks. Finer grained descriptions are needed, looking into how teachers interpret the mathematical content of a lesson. We need to know what features of a textbook foster, or hinder, a clearer interpretation of the mathematical goals of a lesson. The development of new curricula and the revisions of existing curricula will benefit from a deeper understanding of how mathematics teachers use their textbooks.

The (MS)$^2$ has collected student achievement data for all the students in the participating teachers classes. Analysis of these data together with the extent and mode of use of the textbook can further contribute to the understanding of the impact of textbooks in student achievement. Curriculum evaluation should encompass all these variables in determining the results produced by the adoption of a textbook.
Implications for Teacher Education

There are currently ongoing efforts for using NSF-funded middle school textbooks in mathematics content classes for preservice teachers, which is of paramount importance if we want preservice teachers to experience these curricula as learners. Nevertheless, a comparable attention to the teacher’s guides is not evident in the literature. Preservice teachers need to familiarize themselves with these tools, to explore their potential, to learn how to interpret them. The extent to which teachers are willing to rely on a textbook for planning and teaching will depend on how rich are their experiences regarding using textbook as a tool, and not only as a source of problems, during their preservice education.

Implications for Professional Development

As Kate’s and David’s cases, matching a textbook with the teacher’s own philosophy has important consequences. What kind of professional development does a teacher need to change his or her views on teaching mathematics? Professional development supporting textbook adoption has focused on fidelity of implementation. If teachers can reconcile their own views with those advocated by the developers, frequent adaptations by the teacher will change the content being taught. A more flexible understanding of what is textbook use could enrich the possibilities of professional development activities. By acknowledging that teachers might not change radically their own views, middle ground solutions can be a better strategy for promoting teacher change. Conceptualizing what do we mean by textbook use can go a long way towards helping mathematics educators to better serve the needs of inservice teachers. Professional development can focus more on understanding the particular needs of a community of teachers, rather than
trying to impose an implementation.

Limitations of the Study

The schools using NSF-funded curricula in this study had been doing so for at least two years, and they were nominated by the curriculum developers. It is possible that their curriculum implementation is not typical. On the other hand, the individual case studies focused on cases of teachers that reported using their textbooks very frequently. More data is needed to document how teachers supplement their textbook.

The number of observations was limited, and the teachers knew well in advance when they would be observed. Nevertheless, as far as the different sources of data can support the conclusions of this study, it is unlikely that teachers did things substantially differently due to the scheduled observations.

In terms of experience and professional background, the three teachers in the individual case studies may not reflect the diversity of contexts in which teachers actually work. In both schools the teacher population in sixth and seventh grade was very stable and all of the teachers were experienced. Profiles of beginning teachers’ use of their mathematics textbook would be useful.

The survey data regarding teacher’s practices from the three case studies’ teachers did not always match what was observed in their classrooms. While differences were not extreme, it raises a question about the survey data from the rest of the teachers. It is this researcher’s belief that the statements based on these data are well justified, but there might be a few cases in which further observation would be needed to make broader generalizations.
Summary

This study examined textbook use by middle school mathematics teachers. Its findings are consistent and complement other studies done at the elementary school level and studies done with teachers in the process of adopting new curricula.

The majority of teachers in this study used their textbooks frequently. They used the district adopted mathematics textbook to select tasks and to plan their lessons. Three case studies further inform us about how a teacher’s views of mathematics and mathematics teaching shape his or her use of textbook, as well as their stance toward the textbook they are using.

Two of the teachers in the case studies had had an active role in the textbook selection and adoption process, had a positive view of the textbook and as a consequence were more committed to faithfully implement their textbooks. Their views of mathematics and mathematics teaching matched those represented by their respective textbooks. The textbooks they used were as different as their views of mathematics. Their different levels of mathematics content knowledge and their experiences as learners of mathematics shaped their views of the textbooks they were using. One of them found herself identified with a textbook focused in procedural knowledge and a strong reliance on repetition, while the other had views more closely related to a textbook based on realistic contexts in which students are supposed to reinvent significant mathematics.

The third teacher had no active part in choosing his district’s textbook, and the one chosen, and NSF-funded curriculum, did not satisfy him. His views of mathematics and mathematics teaching conflicted with those embodied by his district adopted textbook, and therefore his teaching practices modified the tasks
in the textbook, shifting towards a more procedural approach than the one found in his textbook.

For different reasons, the three teachers in the case studies had little control to set course goals and select topics for their courses. Nevertheless, their sense of ownership of the course and their perceived role varied greatly. The teachers using an NSF-funded curriculum had to follow the pace and selection of topics done at the district level. The other teacher deliberately took the decision of following the textbook as recommended by the developers, with no pressure from the district. Ultimately, their sense of ownership did not depend on this process of mapping the curriculum, but on the teachers’ stance toward the particular textbook each one of them was using.

The critical role of the teacher as ultimate decision maker is examined here through the lens of the tools he or she uses to provide opportunities for learning for his or her students. Textbooks have been at the center of heated debate in mathematics education in the U.S. It is time to go beyond superficial discussions of efficacy and move towards building much needed theory and enriching our knowledge about these matters, so that we are better prepared to assess the impact of textbooks in student learning, which should always be our ultimate goal.
REFERENCES


Kuhs, T. M., & Ball, D. L. (1986). *Approaches to teaching mathematics: Mapping the domains of knowledge, skills, and dispositions*. East Lansing, MI: Michigan State University, Center on Teacher Education.


APPENDIX A

Initial Teacher Survey
Middle School Mathematics Study (MS)²
Teacher Survey

Your school has been selected and has agreed to participate in a study examining student learning and use of curriculum materials in middle school mathematics classrooms.

Please complete this survey by responding to the questions that follow in the spaces indicated. All responses will be kept confidential. Your individual responses will NOT be shared with district personnel.

Class Selection

Part of the questionnaire (sections C and D) asks you to provide information about instruction in a particular class. If you teach mathematics to more than one group of students, answer the questions with regard to your 2nd math class of the day. Indicate in Section C information about this class.

If You Have Questions

If you have questions about the study or any items in the survey, ask the study representative who is administering this questionnaire or contact the staff (see contact information at the bottom of this page).

Each teacher and school participating in the study will receive a stipend. More information about the stipend and a summary of the study will be provided to you as part of the study orientation meeting. A written summary of the study will be shared with each school. Individual copies can be obtained by contacting the study staff.

Thank you very much. Your participation is greatly appreciated and will help us understand the context within which you work and how your students learn mathematics. Please return the completed questionnaire to the (MS)² staff member who gave it to you or return it to the University of Missouri-Columbia in the postage-paid envelope provided.

Middle School Mathematic Study (MS)²
Attn: Barbara Reys
University of Missouri
121 Townsend Hall
Columbia, MO 65211

ReysB@missouri.edu
(573) 882-8744

NOTE: Significant portions of this instrument were adapted from an instrument developed by Horizon Research, Inc. for the 2000 National Survey of Science and Mathematics Education sponsored by the National Science Foundation.
Section A: Teacher Opinions

1. Please provide your opinion about each of the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>No Opinion</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Students learn mathematics best in classes with students of similar abilities.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>b. The testing program in my state/district dictates what mathematics content I teach.</td>
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<tr>
<td>c. I enjoy teaching mathematics.</td>
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<tr>
<td>d. I consider myself a &quot;master&quot; mathematics teacher.</td>
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<tr>
<td>e. I have time during the regular school week to work with my colleagues on mathematics curriculum and teaching.</td>
<td></td>
<td></td>
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<tr>
<td>f. My colleagues and I regularly share ideas and materials related to mathematics teaching.</td>
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<tr>
<td>g. Mathematics teachers in my school regularly observe each other teaching classes as a part of sharing and improving instructional strategies.</td>
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<tr>
<td>h. Most mathematics teachers in my school contribute actively to making decisions about the mathematics curriculum.</td>
<td></td>
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<tr>
<td>i. Students should share their thinking and approaches to solving mathematics problems with other students.</td>
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<tr>
<td>j. Conceptual understanding is the most important goal of mathematics instruction.</td>
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<tr>
<td>k. Students learn mathematics best when the teacher demonstrates concepts and methods, and then provides students opportunities for practice and reinforcement.</td>
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<tr>
<td>l. Calculators help middle school students explore mathematical ideas and solve problems.</td>
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<tr>
<td>m. Learning mathematics requires that students actively engage in thinking, exploring and talking about their ideas.</td>
<td></td>
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<tr>
<td>n. Math is a subject in which natural ability matters more than effort.</td>
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<tr>
<td>o. Mathematics teachers should make sure that middle school students see lots of different ways to look at the same question or problem.</td>
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<tr>
<td>p. Much of middle school mathematics can be learned through exploration and discovery.</td>
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<tr>
<td>q. Most mathematics problems can be solved in only one way.</td>
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<tr>
<td>r. To solve most mathematics problems you have to be taught the correct procedure.</td>
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<tr>
<td>s. When students can’t solve problems, it’s usually because they can’t remember the right formula or rule.</td>
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</tbody>
</table>

2. How familiar are you with these National Council of Teachers of Mathematics (NCTM) Standards documents?

<table>
<thead>
<tr>
<th>Document</th>
<th>Not Familiar</th>
<th>Somewhat Familiar</th>
<th>Fairly Familiar</th>
<th>Very Familiar</th>
</tr>
</thead>
</table>

3. Indicate the extent of your agreement with the overall vision of mathematics education described in the NCTM Standards.

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>No Opinion</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

4. To what extent have you implemented recommendations from the NCTM Standards documents in your mathematics teaching?

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Not At All</th>
<th>Minimal Extent</th>
<th>Moderate Extent</th>
<th>Great Extent</th>
</tr>
</thead>
</table>
Section B: Teacher Background

5. Please indicate how well prepared you currently feel to do each of the following in your mathematics instruction.

<table>
<thead>
<tr>
<th></th>
<th>Not Adequately Prepared</th>
<th>Somewhat Prepared</th>
<th>Fairly Well Prepared</th>
<th>Very Well Prepared</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Take students’ prior understanding into account when planning instruction.</td>
<td></td>
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<tr>
<td>b. Develop students’ conceptual understanding of mathematics.</td>
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<tr>
<td>c. Provide deeper coverage of fewer mathematics concepts.</td>
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<tr>
<td>d. Make connections between mathematics and other disciplines.</td>
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<tr>
<td>e. Lead a class of students using investigative strategies.</td>
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<tr>
<td>f. Manage a class of students engaged in hands-on/project-based work.</td>
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<tr>
<td>g. Have students work in cooperative learning groups.</td>
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<tr>
<td>h. Listen/ask questions as students work in cooperative learning groups.</td>
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<tr>
<td>i. Use the textbook as a resource rather than the primary instructional tool.</td>
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<tr>
<td>j. Teach groups that are heterogeneous in ability.</td>
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<tr>
<td>k. Teach students who have limited English proficiency.</td>
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<tr>
<td>l. Recognize and respond to student cultural diversity.</td>
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<tr>
<td>m. Encourage students’ interest in mathematics.</td>
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<tr>
<td>n. Encourage participation of females in mathematics.</td>
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<tr>
<td>o. Encourage participation of minorities in mathematics.</td>
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</tr>
<tr>
<td>p. Involve parents in the mathematics education of their children.</td>
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<tr>
<td>q. Use calculators/computers for drill and practice.</td>
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</tr>
<tr>
<td>r. Use calculators/computers to explore concepts.</td>
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<tr>
<td>s. Use calculators/computers to collect and/or analyze data.</td>
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<tr>
<td>t. Use calculators/computers to demonstrate mathematics principles.</td>
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<tr>
<td>u. Use calculators/computers for simulations and applications.</td>
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<tr>
<td>v. Use the Internet in your mathematics teaching for general reference.</td>
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<tr>
<td>w. Use the Internet in your mathematics teaching for data acquisition.</td>
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<tr>
<td>x. Use the Internet in your mathematics teaching for collaborative projects with classes/individuals in other schools.</td>
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</tr>
</tbody>
</table>

6. Do you have the following degrees?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Working on it</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Bachelors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Masters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Doctorate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Please indicate the subject(s) for each of your degrees.

<table>
<thead>
<tr>
<th></th>
<th>Bachelor</th>
<th>Masters</th>
<th>Masters</th>
<th>Doctorate</th>
<th>Doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mathematics</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>b. Computer Science</td>
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<td></td>
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<tr>
<td>c. Mathematics Education</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>d. Elementary Education</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>e. Other Education (e.g., History Education, Special Education)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Other, please specify</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. In which of the following areas are you certified within the state you are currently teaching? (check all that apply).

<table>
<thead>
<tr>
<th></th>
<th>Check here if certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Elementary</td>
<td></td>
</tr>
<tr>
<td>b. Middle School (general)</td>
<td></td>
</tr>
<tr>
<td>c. Middle School (mathematics)</td>
<td></td>
</tr>
<tr>
<td>d. High School (general)</td>
<td></td>
</tr>
<tr>
<td>e. High School (mathematics)</td>
<td></td>
</tr>
<tr>
<td>f. Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>
9. Which of the following college mathematics content courses have you completed at the undergraduate or graduate level? Check the box preceding the course if you have successfully completed it as an undergraduate or graduate student. (Check all that apply)

<table>
<thead>
<tr>
<th>Mathematics for elementary school teachers</th>
<th>Probability and statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics for middle school teachers</td>
<td>Abstract algebra</td>
</tr>
<tr>
<td>Geometry for elementary or middle school teachers</td>
<td>Number theory</td>
</tr>
<tr>
<td>College Algebra/trigonometry/elementary functions</td>
<td>Linear algebra</td>
</tr>
<tr>
<td>Calculus</td>
<td>Applications/Modeling/Problem Solving</td>
</tr>
<tr>
<td>Advanced Calculus</td>
<td>History of mathematics</td>
</tr>
<tr>
<td>Differential equations</td>
<td>Discrete mathematics</td>
</tr>
<tr>
<td>Advanced topics in Geometry</td>
<td>Other upper division mathematics</td>
</tr>
</tbody>
</table>

10. Which of the following college education courses have you completed at the undergraduate or graduate level? Check the box preceding the course if you have successfully completed it as an undergraduate or graduate student. (Check all that apply)

<table>
<thead>
<tr>
<th>General methods of teaching</th>
<th>Instructional uses of computers/technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced methods of teaching mathematics</td>
<td>Supervised student teaching in mathematics</td>
</tr>
</tbody>
</table>

11. In what year did you last take a formal course for college credit in each of the following areas:

<table>
<thead>
<tr>
<th>Most recent year a course was taken in this area</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mathematics</td>
</tr>
<tr>
<td>b. The teaching of mathematics</td>
</tr>
</tbody>
</table>

12. Indicate the total amount of time you have spent on professional development in mathematics or the teaching of mathematics in the last 12 months. In the last 3 years. (Include attendance at professional meetings, workshops, and conferences, but do not include formal courses for which you received college credit.)

<table>
<thead>
<tr>
<th>Last 12 Months</th>
<th>Last 3 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. None</td>
<td>b. Less than 6 hrs</td>
</tr>
</tbody>
</table>

13. In the past 3 years, have you participated in any of the following activities related to mathematics or the teaching of mathematics?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Taken a formal college/university mathematics course. (Please do not include courses taken as part of your undergraduate degree.)</td>
<td></td>
</tr>
<tr>
<td>b. Taken a formal college/university course in the teaching of mathematics. (Please do not include courses taken as part of your undergraduate degree.)</td>
<td></td>
</tr>
<tr>
<td>c. Observed other teachers teaching mathematics as a part of your own professional development (formal or informal).</td>
<td></td>
</tr>
<tr>
<td>d. Met with a local group of teachers to study/discuss mathematics teaching issues on a regular basis.</td>
<td></td>
</tr>
<tr>
<td>e. Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications.</td>
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</tr>
<tr>
<td>f. Served as a mentor and/or peer coach in mathematics teaching, as part of a formal arrangement that is recognized or supported by the school district. (Please do not include supervision of student teachers.)</td>
<td></td>
</tr>
<tr>
<td>g. Attended a workshop on mathematics teaching.</td>
<td></td>
</tr>
<tr>
<td>h. Attended a national or state mathematics teachers association meeting.</td>
<td></td>
</tr>
<tr>
<td>i. Applied or applying for certification from the National Board for Professional Teaching Standards (NBPTS).</td>
<td></td>
</tr>
<tr>
<td>j. Received certification from the National Board for Professional Teaching Standards.</td>
<td></td>
</tr>
<tr>
<td>k. Taught an in-service workshop in mathematics or mathematics teaching.</td>
<td></td>
</tr>
<tr>
<td>l. Mentored another teacher as part of a formal arrangement recognized or supported by the school or district, not including supervision of student teachers.</td>
<td></td>
</tr>
<tr>
<td>m. Received any local, state or national grants or awards for mathematics teaching.</td>
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</tr>
<tr>
<td>n. Served on a school or district mathematics curriculum committee.</td>
<td></td>
</tr>
<tr>
<td>o. Served on a school or district mathematics textbook selection committee.</td>
<td></td>
</tr>
</tbody>
</table>
Questions 14-15 ask about your professional development in the last 3 years. If you have been teaching for fewer than 3 years, please answer for the amount of time that you have been teaching.

14. Considering all the professional development you have participated in during the last 3 years, how was each of the following emphasized.

<table>
<thead>
<tr>
<th>Professional Development</th>
<th>Not at all</th>
<th>Slightly</th>
<th>Somewhat</th>
<th>Quite a bit</th>
<th>To a great extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepening my own mathematics content knowledge.</td>
<td></td>
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</tr>
<tr>
<td>Understanding student thinking in mathematics.</td>
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<tr>
<td>Learning how to use inquiry/investigation-oriented strategies.</td>
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<tr>
<td>Learning how to use technology in mathematics instruction.</td>
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</tr>
<tr>
<td>Learning how to assess student learning in mathematics.</td>
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<tr>
<td>Learning how to teach mathematics in a class that includes students with special needs.</td>
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<tr>
<td>Learning how to use the textbook adopted by the district for middle school mathematics.</td>
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</tr>
</tbody>
</table>

15. Considering all your professional development in the last 3 years, how would you rate its impact in each of these areas?

<table>
<thead>
<tr>
<th>Professional Development</th>
<th>Little or no impact</th>
<th>Confirmed what I was already doing</th>
<th>Caused me to change my teaching practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepening my own mathematics content knowledge.</td>
<td></td>
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<tr>
<td>Understanding student thinking in mathematics.</td>
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<tr>
<td>Learning how to use inquiry/investigation-oriented strategies.</td>
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<tr>
<td>Learning how to use technology in mathematics instruction.</td>
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<tr>
<td>Learning how to assess student learning in mathematics.</td>
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<td></td>
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</tr>
<tr>
<td>Learning how to teach mathematics in a class that includes students with special needs.</td>
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</tr>
</tbody>
</table>

16. Within mathematics, many teachers feel better qualified to teach some topics than others. How well qualified do you feel to teach each of the following topics at the grade level(s) you teach, whether or not they are currently included in your curriculum.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Not Well Qualified</th>
<th>Adequately Qualified</th>
<th>Very Well Qualified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numeration and number theory</td>
<td></td>
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<tr>
<td>Computation</td>
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<td></td>
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<tr>
<td>Estimation</td>
<td></td>
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<tr>
<td>Measurement</td>
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<tr>
<td>Pre-algebra</td>
<td></td>
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<tr>
<td>Algebra</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Patterns and relationships</td>
<td></td>
<td></td>
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<tr>
<td>Geometry and spatial sense</td>
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<td></td>
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<tr>
<td>Functions (including trigonometric functions) and pre-calculus concepts</td>
<td></td>
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<tr>
<td>Data collection and analysis</td>
<td></td>
<td></td>
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<tr>
<td>Probability</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Statistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology (calculators, computers) in support of mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
17. For each class period you are currently teaching, give course title, the code-number from the list below that best describes the content addressed in the class, and the approximate number of students in the class. Please enter your answer in the spaces provided. If your school is not organized by "hours" use the blanks in the chart below to describe the classes you teach over the course of a week.

<table>
<thead>
<tr>
<th>Class Period</th>
<th>Your School's Course Title</th>
<th>Code Number</th>
<th>Grade</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} class</td>
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<tr>
<td>2\textsuperscript{nd} class</td>
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<tr>
<td>3\textsuperscript{rd} class</td>
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<tr>
<td>4\textsuperscript{th} class</td>
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<tr>
<td>5\textsuperscript{th} class</td>
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<tr>
<td>6\textsuperscript{th} class</td>
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<tr>
<td>7\textsuperscript{th} class</td>
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<tr>
<td>8\textsuperscript{th} class</td>
<td></td>
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</tr>
</tbody>
</table>

18. What is the district-adopted textbook for the second class listed above?

Title: ______________________________________________________
Publisher: _____________________________________________
First Author: ___________________________________________
Copyright date: _______________________

Course titles and codes to use in #17 above.

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6A</td>
<td>Remedial mathematics, gr. 6</td>
</tr>
<tr>
<td>6B</td>
<td>Regular mathematics, gr. 6</td>
</tr>
<tr>
<td>6C</td>
<td>Accelerated/pre-algebra mathematics, gr. 6</td>
</tr>
<tr>
<td>7A</td>
<td>Remedial mathematics, gr. 7</td>
</tr>
<tr>
<td>7B</td>
<td>Regular mathematics, gr. 7</td>
</tr>
<tr>
<td>7C</td>
<td>Accelerated/pre-algebra mathematics, gr. 7</td>
</tr>
<tr>
<td>8A</td>
<td>Remedial mathematics, gr. 8</td>
</tr>
<tr>
<td>8B</td>
<td>Regular mathematics, gr. 8</td>
</tr>
<tr>
<td>8C</td>
<td>Accelerated/pre-algebra mathematics, gr. 8</td>
</tr>
<tr>
<td>AA</td>
<td>Algebra I, gr. 6, 7 or 8</td>
</tr>
<tr>
<td>AB</td>
<td>Integrated mathematics, gr. 6, 7 or 8</td>
</tr>
<tr>
<td>XX</td>
<td>Other</td>
</tr>
</tbody>
</table>
Section B.2 Textbook use

19. How do you use your district’s adopted textbook?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>b.</td>
<td></td>
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<tr>
<td>c.</td>
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<tr>
<td>d.</td>
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<tr>
<td>e.</td>
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<tr>
<td>f.</td>
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<tr>
<td>g.</td>
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<tr>
<td>h.</td>
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<tr>
<td>i.</td>
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<td>j.</td>
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<td>k.</td>
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<td>l.</td>
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</tbody>
</table>

Section C: Your Mathematics Teaching in a Particular Class

The questions in this section are about a particular mathematics class you teach – the course and students you teach the SECOND period/hour of the day.

20. What is the calendar duration of this mathematics class?

______ Full Year _____Quarter
______ Semester _____Trimester

21. Are students assigned to this class by level of ability?

_____ Yes
_____ No

22. Which of the following best describes the ability of the students in this class relative to other students in this school?

_____ Fairly homogeneous and low in ability
_____ Fairly homogeneous and average in ability
_____ Fairly homogeneous and high in ability
_____ Heterogeneous, with a mixture of two or more ability levels

23. Indicate the approximate number of students in this mathematics class who are formally classified as each of the following:

_____ Limited English Proficiency
_____ Learning Disabled
_____ Mentally Handicapped
_____ Physically Handicapped, please specify handicap(s):__________________________________________
24. Think about your plans for this mathematics class for the entire course. How much emphasis will each of the following student objectives receive?

<table>
<thead>
<tr>
<th>Objective</th>
<th>None</th>
<th>Minimal Emphasis</th>
<th>Moderate Emphasis</th>
<th>Heavy Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Increase students' interest in mathematics.</td>
<td></td>
<td></td>
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<tr>
<td>b. Learn mathematical concepts.</td>
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<tr>
<td>c. Learn mathematical algorithms/procedures.</td>
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<tr>
<td>d. Develop students' computational skills.</td>
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<tr>
<td>e. Learn how to solve problems.</td>
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<tr>
<td>f. Learn to reason mathematically.</td>
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<tr>
<td>g. Learn how mathematical ideas connect with one another.</td>
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<tr>
<td>h. Understand the logical structure of mathematics.</td>
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<tr>
<td>i. Learn about the history and nature of mathematics.</td>
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<tr>
<td>j. Learn to explain ideas in mathematics effectively.</td>
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<tr>
<td>k. Learn how to apply mathematics in business and industry.</td>
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<tr>
<td>l. Learn to perform computations with speed and accuracy.</td>
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<tr>
<td>m. Prepare students for standardized tests.</td>
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</tbody>
</table>

25. About how often do you do each of the following in your mathematics instruction?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Introduce content through formal presentations.</td>
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<tr>
<td>b. Pose open-ended questions.</td>
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<tr>
<td>c. Engage in whole-class discussions.</td>
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<tr>
<td>d. Require students to explain their reasoning when giving an answer.</td>
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<tr>
<td>e. Ask students to explain concepts to one another.</td>
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<tr>
<td>f. Ask students to consider alternative methods for solutions.</td>
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<tr>
<td>g. Ask students to use multiple representations (e.g., numeric, graphic, geometric, etc.).</td>
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<tr>
<td>h. Allow students to work at their own pace.</td>
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<tr>
<td>i. Help students see connections between mathematics and other disciplines.</td>
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<tr>
<td>j. Assign mathematics homework.</td>
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<tr>
<td>k. Read and comment on the reflections students have written (e.g., in their journals).</td>
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</tr>
</tbody>
</table>

26. About how often do students in this mathematics class take part in the following types of activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Listen and take notes during a presentation by the teacher.</td>
<td></td>
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<tr>
<td>b. Work in groups.</td>
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<tr>
<td>c. Read from a mathematics textbook in class.</td>
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<tr>
<td>d. Read other (non-textbook) mathematics-related materials in class.</td>
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<tr>
<td>e. Engage in mathematical activities using concrete materials.</td>
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<tr>
<td>f. Practice routine computations/algorithms.</td>
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<tr>
<td>g. Review homework/worksheet assignments.</td>
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<tr>
<td>h. Follow specific instructions in an activity or investigation.</td>
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<tr>
<td>i. Design their own activity or investigation.</td>
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<tr>
<td>j. Use mathematical concepts to interpret and solve applied problems.</td>
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<tr>
<td>k. Answer textbook or worksheet questions.</td>
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<tr>
<td>l. Record, represent, and/or analyze data.</td>
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<tr>
<td>m. Write reflections (e.g., in a journal).</td>
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<tr>
<td>n. Make formal presentations to the rest of the class.</td>
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<tr>
<td>o. Work on extended mathematics investigations or projects (a week or more in duration).</td>
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<tr>
<td>p. Use calculators or computers for learning or practicing skills.</td>
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<tr>
<td>q. Use calculators or computers to develop conceptual understanding.</td>
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<tr>
<td>r. Use calculators or computers as a tool (e.g. spreadsheets, data analysis).</td>
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</tbody>
</table>
27. About how often do students in this mathematics class use calculators/computers to:

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Practice skills.</td>
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<tr>
<td>b. Demonstrate math.</td>
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<tr>
<td>c. Play learning ga.</td>
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<tr>
<td>d. Perform sim.</td>
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<tr>
<td>e. Collect data</td>
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<tr>
<td>f. Retrieve or data</td>
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<tr>
<td>g. Solve problems</td>
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<tr>
<td>h. Assist in test</td>
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</tbody>
</table>

28. How often do you assess student progress in mathematics in each of the following ways?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Pre-assessment</td>
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<tr>
<td>b. Observe individual.</td>
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<tr>
<td>c. Observe group</td>
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<tr>
<td>d. Ask questions</td>
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<tr>
<td>e. Use assessments</td>
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<tr>
<td>f. Review homework.</td>
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<tr>
<td>g. Review notebooks.</td>
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<tr>
<td>h. Review portfolios.</td>
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<tr>
<td>i. Assign projects.</td>
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<tr>
<td>j. Have students</td>
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<tr>
<td>k. Give short tests</td>
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<tr>
<td>l. Give open-ended</td>
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<td>m. Grade tasks</td>
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<td>n. Have peer eval.</td>
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</tbody>
</table>

29. How much control do you have over each of the following for this mathematics class?

<table>
<thead>
<tr>
<th></th>
<th>No control</th>
<th>Very little control</th>
<th>Some control</th>
<th>A fair bit of control</th>
<th>Strong control</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Course goals</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>b. Textbook</td>
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30. How much mathematics homework do you assign to this mathematics class in a typical week?

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<th>0-30 min</th>
<th>31-60 min</th>
<th>61-90 min</th>
<th>91-120 min</th>
<th>2-3 hours</th>
<th>More than 3 hours</th>
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31. Are you using the **district-adopted textbook** for teaching mathematics to this class?

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32. What percentage of the time do you use the district-adopted textbook in this class?

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<th>&lt;25%</th>
<th>25-49%</th>
<th>50-74%</th>
<th>75-90%</th>
<th>&gt;90%</th>
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33. Do you use other textbook materials (other than the district-adopted textbook) in this class?

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34. If you answered “YES” in #33:
   a. what other textbook materials do you use for this class:  
      ____________________________________________________________
   b. explain why you use other textbook materials for this class  
      ____________________________________________________________

35. Estimate the percentage of the district-adopted textbook you will "cover" in this class?
   ___ < 25%   ___ 25-49%   ___ 50-74%   ___ 75-90%   ___ >90%

36. How would you rate the overall quality of the district-adopted textbook for this class?
   ___ Very Poor    ___ Poor    ___ Fair    ___ Good    ___ Very Good

37. Briefly describe 2 strengths and 2 weaknesses of the district-adopted textbook for this class.
   Strengths:  ______________________________________________________
   Weaknesses: _____________________________________________________

38. Do you feel well prepared to use the district-adopted textbook?  ___ Yes    ___ No

39. What role do textbook materials (district-adopted or other materials) play in your teaching? (check all that apply)
   __ Help me plan daily instruction.  __ Serve as source of example problems.
   __ Serve as a source of homework problems. __ Help determine the sequence of topics.
   __ Serve as a source of assessment items.  __ Provide activities to explore math topics.
   __ Help parents know what their child is studying.  __ other (specify: ____________________)
   __ Serve as a resource for individual student work. __ other (specify: ____________________)

Section D: Your Most Recent Mathematics Lesson in This Class

The final set of questions refer to the last time you taught mathematics to your second group of students of the day. Do not be concerned if this lesson was not typical of instruction in this class. (Please enter your answers as number of minutes (i.e., 30 minutes)

40. How many minutes were allocated to the most recent “typical” mathematics lesson?  ______ minutes

41. Of these minutes, how many were spent on the following: (The sum of the numbers below should equal your response in 40)
   a. Daily routines, interruptions, and other non-instructional activities.  Minutes
   b. Teacher led discussion/lecture. 
   c. Individual students working on their own. 
   d. Small groups of students working together to solve a problem or complete a task. 
   e. Other (specify:_________________________)
   __________________________
   __________________________
   __________________________
   __________________________
42. Which of the following activities took place during that mathematics lesson? (Check all that apply.)

- Lecture
- Discussion
- Students completing textbook/worksheet problems
- Students doing hands-on/manipulative activities
- Students reading about mathematics
- Students working in small groups
- Students using calculators
- Students using computers
- Students using other technologies
- Test or quiz
- Other (please specify: ____________________________)

Section E: Demographic Information

43. Your name: __________________________________________

44. Your school: __________________________________________

45. Indicate your gender: ___ Male ___ Female

46. In what year were you born? ______

47. How many years have you taught (any grade or subject) prior to this school year? ______

48. How many years have you taught middle school (grades 6-8) mathematics prior to this school year? ______

49. When did you complete this questionnaire? Date: ______ / ______ / ______

THANK YOU!
APPENDIX B

Textbook Diary
Use this "textbook" diary to record use of materials to support instruction and learning in your 2nd math class of the day. "Textbook" as used below refers to the district-adopted mathematics textbook. Continue this diary until you have 10 entries (10 consecutive lessons). If there is a day when you are absent or have some other interruption (e.g., school assembly), skip that day but continue with the log until you have 10 entries.

<table>
<thead>
<tr>
<th>Date</th>
<th>General topic of lesson</th>
<th>What did you do to plan this lesson?</th>
<th>Textbook pages used by TEACHER (unit &amp; pages)</th>
<th>Textbook pages used by STUDENTS during the lesson (unit &amp; pages)</th>
<th>Homework from textbook assigned (unit &amp; pages)</th>
<th>Other print materials used by TEACHER</th>
<th>Other materials used by STUDENTS</th>
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<th>What materials did you use?</th>
<th>Textbook pages used by TEACHER during the lesson (unit &amp; pages)</th>
<th>Textbook pages used by STUDENTS during the lesson (unit &amp; pages)</th>
<th>Homework from textbook assigned (unit &amp; pages)</th>
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APPENDIX C

Observation Tool
Middle School Mathematics Study
Observation Tool

Observer: ___________________________  Time Lesson Begins: ____________
Teacher: ___________________________  Time Lesson Ends: ____________
School: ___________________________  Textbook: ________________________
Grade: ___________________________  Chapter/Unit: ______________________
Date of Observation: ________________  Lesson (pages): ________________

BEFORE THE LESSON - Pre-observation Interview With Teacher

[NOTE: Collect this information in advance of the observed lesson – either as part of a conversation with the
teacher prior to the lesson or ask the teacher to respond to these questions in writing prior to the lesson. If
the latter, see attached form for this purpose.]

1. What are the major mathematical topic(s) to be addressed in this lesson?

2. In what way will the textbook be used in this lesson?

3. Where is this activity generally situated in the development of a unit? (For example, day 1 (introduction)
of x days need to complete the unit)?

DURING THE LESSON – Lesson flow

Describe the main activities that occurred during the class period and the amount of time devoted to each activity.
Use sheets that follow for the “Lesson Tape” notes.
AFTER THE LESSON - Use of Textbook Materials

After the lesson is completed, review your notes from the Lesson Flow Sheets and then complete the following sections.

1. Did students use the district textbook during the lesson? Yes No

If yes, what unit? ______________________ What pages? ______________________

Provide a general description of how the students used the text materials (e.g., for seatwork, exercises, to view diagrams or other material, etc.)

__________________________________________________________________________

Were materials other than the district textbook used by the students? Yes No

If yes, please describe these materials:

__________________________________________________________________________

2. Did the teacher use materials from the district textbook series? Yes No

If yes, what unit? ______________________ What pages? ______________________

Provide a general description of how the teacher used the text materials (e.g., for selecting problems to demonstrate, for homework assignments, or showing diagrams, etc.)

__________________________________________________________________________

Were materials other than the district textbook used by the teacher? Yes No

If yes, please describe these materials:

__________________________________________________________________________

3. Was an assignment given to students? Yes No

If yes, what materials were used? __ textbook __ other (describe): ______________________

How were these materials used? ______________________

__________________________________________________________________________

In your opinion, to what extent did the district-adopted textbook influence the content and presentation of the lesson?

Content: ___ A great deal ___ Somewhat ___ Very little ___ Not at all ___ Can’t tell
Presentation: ___ A great deal ___ Somewhat ___ Very little ___ Not at all ___ Can’t tell
For the next two sections please refer to the Observation Scale Descriptors packet.

C. Classroom Events

1. The lesson provided opportunities for students to make conjectures about mathematical ideas.
   Supporting examples:
   
   | 1 | 2 | 3 |

2. The lesson fostered the development of conceptual understanding.
   Supporting examples:
   
   | 1 | 2 | 3 |

3. Connections within mathematics were explored in the lesson.
   Supporting examples:
   
   | 1 | 2 | 3 |

4. Connections between mathematics and students' daily lives were apparent in the lesson.
   Supporting examples:
   
   | 1 | 2 | 3 |

5. Students explained their responses or solution strategies.
   Supporting examples:
   
   | 1 | 2 | 3 |

6. Multiple strategies were encouraged and valued.
   Supporting examples:
   
   | 1 | 2 | 3 |

7. The teacher valued students' statements about mathematics and used them to build discussion or work toward shared understanding for the class.
   Supporting examples:
   
   | 1 | 2 | 3 |

8. The teacher used student inquiries as a guide for instructional mathematics investigation or as a guide to shape the mathematics content of the lesson.
   Supporting examples:
   
   | 1 | 2 | 3 |

9. The teacher encouraged students to reflect on the reasonableness of their responses.
   Supporting examples:
   
   | 1 | 2 | 3 |

D. Pupil Pursuits

1. Student exchanges with peers reflected substantive conversation of mathematical ideas.
   
   | 1 | 2 | 3 | 4 |

2. Interaction among the students reflected collaborative working relationships.
   NA | 1 | 2 | 3 | 4 |

3. The overall level of student engagement throughout the lesson was serious.
   
   | 1 | 2 | 3 | 4 |
Post-observation Interview With Teacher

1. Did the lesson achieve the intended purpose cited in the pre-observation interview? Please elaborate.

2. What parts of the student or teacher district-adopted textbook did you use for today’s lesson?

3. Were materials other than the district-adopted textbook used to prepare or teach today’s lesson? If so, why were other materials used?

Additional Information

Please feel free to add any comments or information that you think would be of relevant in describing the classroom that you observed (in particular, the use of textbook or other curriculum materials).
Please prepare a brief response to the questions below prior to the scheduled observation. Give the completed page to the observer.

1. What are the major mathematical topic(s) to be addressed in this lesson?

2. What are the major goals for students?

3. In what way will the textbook be used in this lesson?

4. Where is this activity generally situated in the development of a unit? (For example, day 1 (introduction) of x days need to complete the unit)?
LESSON FLOW RECORDING SHEET

Teacher: ___________________ School: ___________________

Take notes describing the activities of the teacher and students occurring during the class period. Provide a time stamp in the "Time" column to correspond with the events (record a time stamp at least every 4 minutes). Indicate use of any instructional materials (by teacher or student) in the last column.

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Observation Scale Descriptors

C.1. The lesson provided opportunities for students to make conjectures about mathematical ideas.

This scale measures the extent to which the lesson provided opportunities for students to make conjectures about mathematical ideas. There are three types of conjectures that students might make. One type of conjecture involves the student in making a guess about how to solve a particular problem based on experience solving problems with similar solution strategies. For example, students were solving problems in which they used properties of similar triangles. When asked to determine the height of a tree, students conjectured that an appropriate solution strategy would involve similar triangles. The students made a connection between the new problem and problems that they had previously solved. A second type of conjecture occurs when a student makes a guess about the truthfulness of a particular statement and subsequently plans and conducts an investigation to determine whether the statement is true or false. For example, a 12-year-old student disagreed with a statement that she was half as tall as she is now when she was 6-years old, and proceeded to support her argument by comparing her present height with heights of 6-year-old children. A third type of conjecture is a generalization. A generalization is created by reasoning from specific cases of a particular event, is tested in specific cases, and is logically reasoned to be acceptable for all cases of the event. For example, given that a beam is constructed of rods in the following configuration,

![Diagram of a beam constructed of rods](image)

students are asked to describe the relation between the number of rods and the length of the beam (Wijers, Roodhardt, van Reeuwijk, Burrill, Cole, & Pliigge, 1998). Using a table to organize their reasoning, students described the pattern that emerged, explained how the pattern fit the given diagram, and generated formulas for the relationship. In this situation, students reasoned from specific cases, tested and supported their ideas with evidence from drawings and the table, and described the relation in a formula.

1. Students had few, if any, opportunities to make conjectures in this lesson. The teacher generally did not solicit or encourage conjectures. There were no significant examples of students making connections between a new problem and problems previously seen, investigating the validity of their own guesses, looking for patterns, or making generalizations.

2. Students had some opportunity and/or encouragement to make conjectures. When observed, they were generally prompted by the teacher or offered by students with minimal followed-up.

3. Conjectures of at least one of the types described were observed on several occasions. Students were encouraged to make connections between a new problem and problems previously seen, to investigate the validity of their own guesses, to look for patterns, and/or to make generalizations.
C.2. The lesson fostered the development of conceptual understanding.

Conceptual knowledge is described as the “facts and properties of mathematics that are recognized as being related in some way” (Hiebert & Wearne, 1986, p. 200), or as a network of relationships that link pieces of knowledge (Hiebert & Lefevre, 1986). In the primary grades, for example, students learn the labels for whole-number place-value positions. If this information is stored as isolated pieces of information, the knowledge is not conceptual. If this knowledge, however, is linked with other information about numbers, such as grouping objects into sets of ten or counting by tens or hundreds, then the information becomes conceptual knowledge. The network of relationships about place value grows as other pieces of knowledge related to place value, such as regrouping in subtraction, are recognized. Procedural knowledge, in contrast, is described as having two parts. One category comprises the written mathematical symbols, which are devoid of meaning and are acted upon through knowledge of the syntax of the system. A second category is composed of rules and algorithms for solving mathematics problems, step-by-step procedures that progress from problem statement to solution in a predetermined order. Procedural knowledge is rich in rules and strategies for solving problems, but it is not rich in relationships (Hiebert & Wearne, 1986).

Instruction that fosters the development of conceptual understanding engages students in creating meaning for the symbols and procedures they use. Problems or questions posed by the teacher or in text materials may direct students’ attention to linking procedural and conceptual knowledge. In addition and subtraction of decimals, for example, lining up the decimal points should be linked with combining like quantities. Instruction might explicitly bring out the relationships between lining up the decimal point in addition and subtraction and lining up whole numbers on the right side for the same operations (Hiebert & Wearne, 1986).

1. The general focus of the lesson was on the development of procedural knowledge. The teacher emphasized student acquisition of skills or procedures with little, if any, attention to the development of conceptual understanding.

2. The general focus of the lesson was on the development of a mathematical concept or relationship rather than procedures or skills. However, the teacher did not actively engage students in building connections between new ideas and prior knowledge. The learning activities of the lesson generally did not appear to foster conceptual understanding.

3. The continual focus of the lesson was on building connections between disparate pieces of information or linking procedural knowledge with conceptual knowledge.
C.3. Connections within mathematics were explored in the lesson.

This scale measures the extent to which instruction addressed mathematical topics thoroughly enough to explore relationships and connections among them. A low rating is given when the mathematical topic of the lesson was covered in ways that gave students only a surface treatment of its meaning, and instruction treated this topic in isolation of other mathematical topics. A high rating is given when the mathematical topic of the lesson was explored in enough detail for students to think about relationships and connections among mathematical topics. Rather than examining fragmented pieces of information, students looked for and discussed relationships among mathematical ideas, expressed understanding of mathematical topics, or provided explanations of their solution strategies for relatively complex problems in which two or more mathematical ideas were integrated.

Topics can be thought of in two different ways. First, topics can be broad areas of mathematics such as probability, area, and ratios, as in the following problem. Students are asked to determine the probability of a frog jumping from a cage and landing on white or black floor tiles and to express this probability as a fraction or percent (Jonker, van Galen, Boswinkel, Wijers, Simon, Burnil, & Middleton, 1998). In solving this problem, students use area, number, and probability concepts. Second, connections can be made among more narrowly defined areas such as a lesson involving the solution of quadratic equations. In this lesson, connections can be made between factoring, completing the square, or using the quadratic formula. Even though these problems connect mathematical topics, instruction may not focus on discussing or developing these connections. The rating should reflect both the problems and instruction.

1. The mathematical topic of the lesson was covered in ways that gave students only a surface treatment of its meaning. The mathematical topic was presented in isolation of other topics, and the teacher and students did not talk about connections between the topic of the lesson and other mathematical topics.

2. Some connections among mathematical topics were present in the lesson. The teacher or students briefly mentioned that the topic was related to others, but these connections were not discussed in detail by the teacher or the students.

3. Connections among mathematical topics were discussed by teacher and students during the lesson, or connections were clearly explained by the teacher. The mathematical topic of the lesson was explored in enough detail for students to think about and describe relationships and connections among mathematical topics.
C.4. **Connections between mathematics and students' daily lives were apparent in the lesson.**

This scale measures whether connections between mathematics and students' daily lives were apparent in text problems or discussed by the teacher or students. Examples of problems that foster such connections are estimating the sale price of an item or determining the amount of ingredients required to serve four people when a recipe serves seven. In contrast, word problems such as "Bart is two years older than Lisa. In five years Bart will be twice as old as Lisa. How old are they now?" are devoid of connections between mathematics and students' lives.

1. **Real life connections between the mathematics under study and students' daily lives were not made explicit within the lesson.**

2. **Specific examples of real life connections between the mathematics under study and students' daily lives were presented by the teacher or noted by student(s). However these opportunities were limited in scope or were only marginally attended to by the teacher.**

3. **Real life connections between the mathematics under study and students' daily lives were made explicit within the lesson by the teacher or noted by students. The teacher elaborated on these real life connections in ways that underscored the importance of the topic and/or generated interest in the topic.**
C.5. Students explained their responses or solution strategies.

This scale is intended to measure the extent to which teachers encourage students to elaborate their solutions by justifying their approach to a problem, explaining their thinking, or supporting their results, rather than simply stating answers.

1. The teacher generally did not encourage students to elaborate on answers or solution strategies. Rather, students simply stated answers to problems or questions posed by the teacher and the teacher accepted these answers without further probing.

2. The teacher sometimes encouraged students to explain how they arrived at an answer, but these explanations generally focused on the execution of procedures for solving problems rather than an elaboration on their thinking and solution path.

3. The teacher generally encouraged students to explain their responses or solution strategies. Although this was not the case for every student response, students did have opportunities to elaborate on their solution strategies orally or in written form by justifying their approach to a problem, explaining their thinking, or supporting their results.
C.6. Multiple perspectives/strategies were encouraged and valued.

This scale measures the extent to which students were asked to consider different perspectives in approaching the solution to a problem. In a classroom where multiple strategies are encouraged and valued, students spend much of their time discussing different strategies in a substantive manner, and this discourse is an important element within the classroom. Multiple strategies might be elicited by the teacher during whole-class or small-group discussion in which students explicitly share their strategies. The task itself might clearly involve students in solving the problem in different ways (e.g., find the discount in another way), or the task may require students to consider alternative approaches for successful completion (e.g., list as many ways as you can to calculate 15 x $1.98).

1. The teacher did not generally encourage students to offer different perspectives and/or strategies to solving problems. Generally, if a correct solution was offered by a student, the teacher accepted it and moved on.

2. Different perspectives or strategies were occasionally elicited from students or mentioned by the teacher. However, this did not appear to be a regular occurrence. For example, additional methods were sought when a particular “standard” method of solution had not yet been mentioned by a student.

3. The teacher encouraged students to view problems or mathematical situations from multiple perspectives and to learn from each other’s viewpoints. When appropriate, alternative strategies were solicited and discussed as an important elements of classroom instruction.
C.7. The teacher valued students' statements about mathematics and used them to build discussion or work toward shared understanding for the class.

This scale is intended to measure the ways in which the teacher uses student responses during instruction. Teachers can give credence to students' responses by inviting students to listen carefully to other students, to ask each other questions that clarify meaning, and to compare other students' strategies with their own. Teachers can also use student responses to pose questions that stimulate further discussion, to illustrate a point, or to relate them to other aspects of the lesson.

1. Generally, the teacher sought limited responses from students - correct answers or brief indications that they understood the material presented. The majority of the teacher's remarks about student responses were short comments such as "Okay," "All right," or "Fine" that often ended further dialogue. Little or no attempt was made to use students' responses to further discussion with the individual student or with the class.

2. The teacher responded to student questions or comments by providing a direct answer. In some cases a student response or question would prompt a brief exchange between the teacher and one or more students. The purpose of this exchange was generally to answer the question at hand rather than to elicit a student's thinking processes or solution strategies or to engage the class in discussion of the question.

3. The teacher used students' statements about mathematics to prompt additional class discussion or to extend the ideas of the lesson in some way. The teacher opened up discussion about the student response by asking other students questions such as: "Does everyone agree with this?" or "Would anyone like to comment on this response?"
C.8. The teacher used student inquiries as a guide for instructional decisions or as a guide to shape the mathematical content of the lesson.

Occasionally a student's inquiry can be used to introduce the topic of the lesson, supplement a lesson, or connect the lesson to students' lives. In other cases, a student's question or response may provide a starting point for a rich mathematical journey. A student's question about whether the sum of the angles of every triangle is always 180°, for example, might lead to a discussion of non-Euclidean geometry. This scale measures the teacher's responsiveness to student inquiries and the teacher's flexibility in using these inquiries in ways that enhance the lesson.

1. The teacher generally accepted student comments or questions and responded with simple statements acknowledging the comment/question or evaluating the correctness of the comment/question. The teachers response to student comments or questions did not appear to alter the planned lesson.

2. The teacher responded thoughtfully to student comments and generally used the comment or question to continue discussion or provide other students opportunities to respond or comment. The flow of the lesson, however, did not appear to be changed directly by the comment or question.

3. The teacher utilized student comments and questions in making decisions about how to proceed with the lesson. In at least one instance it appeared that the planned lesson was re-directed based on student comments or questions.
C.9. **The teacher encouraged students to reflect on the reasonableness of their responses.**

An unreasonable response refers to a response that is mathematically distant from the correct answer and might even be distant from an answer that students recognize as reasonable in contexts outside the classroom. One explanation for unreasonable responses is that students do not check the reasonableness of their answers. Although this may be true in some cases, unreasonable responses may also be the result of the lack of connections between symbols and their meaning. Evaluating the reasonableness of a solution involves connections between conceptual and procedural knowledge. These connections are especially significant at the end of the problem-solving process. Lining up decimal points when adding or subtracting decimals, for example, without connecting the process to place value concepts, may lead to unreasonable responses. Students might rely on rules or procedures to obtain correct answers and not have the conceptual knowledge to help them evaluate reasonableness of the answer (11iebert & Wearne, 1986). This scale is intended to measure whether the teacher encouraged students to reflect on the reasonableness of their answers and whether the discussion involved emphasis on conceptual understanding.

1. The teacher rarely asked students whether their answers were reasonable. If a student gave an incorrect response, another student provided or was asked to provide a correct answer.

2. The teacher asked students if they checked whether their answers were reasonable but did not promote discussion that emphasized conceptual understanding.

3. The teacher encouraged students to reflect on the reasonableness of their answers, and the discussion involved emphasis on conceptual understanding.
D.1. Student exchanges with peers reflected substantive conversation of mathematical ideas.

With this scale we are attempting to capture the quality of student communication. Substantive conversation by students is characterized by interaction that is reciprocal, involving listening carefully to others’ ideas in order to understand them, building conversation on them, or extending the idea to a new level. Substantive conversation also promotes shared understanding of mathematical ideas and the use of higher order thinking, such as applying ideas, making comparisons, or raising questions. In contrast, student exchanges with little or no substantive conversation involve reporting facts or procedures in ways that do not encourage further discussion of ideas.

1. There were no exchanges between peers in small groups or as a formal part of the general discourse within a large-group setting.

2. Student exchanges with peers reflected little or no substantive conversation of mathematical ideas.

3. Most students only asked one another for a clarification of directions given by the teacher or simply accepted someone’s answer without an explanation of how it was found. Few students asked how a solution was found or asked for a clarification of another student’s answer.

4. Most of the students asked their classmates for a description of how they solved a particular problem, discussed alternative strategies, and/or questioned how classmates arrived at a solution.
D.2. Interactions among students reflected collaborative working relationships.

The collaborative nature of the classroom can be thought of as students working together, exchanging ideas, and finding solutions to the same problem. This includes providing assistance to one another, making sure that everyone understands and is working on the same problem, exchanging ideas, and seeking help from each other when it is needed. Student collaboration can occur in a small-group or large group setting. If the major focus of the lesson is on providing students with individual work, then NIA should be selected.

N/A. The main purpose of the lesson was to give students needed individual practice, or students spent nearly all of the class period involved in independent work.

1. None of the students were working together in small groups or in a large-group setting. If students were working in small groups, then one student typically gave answers to other members of group without explanation of why certain procedures were used.

2. Few students were sharing ideas or discussing how a problem should be solved in small groups or in a large-group setting. Although students physically sat together, there was little exchange of ideas or assistance. Many of the students in a group were working on different problems and at different paces.

3. Some students were exchanging ideas, or providing assistance to their classmates; however, a few students relied on other members of the group to solve problems. Contributions to solving problems were not made equally by all students.

4. Most students were involved with their classmates in solving problems and made sure that other group members were caught up and understood the problems before moving on to the next problem.
D.3. The overall level of student engagement throughout the lesson was serious.4

This scale measures the extent to which students remained on task during the lesson.

1. Disruptive disengagement. Students were frequently off task, as evidenced by gross inattention or serious disruptions by many. This was the central characteristic during much of the class.

2. Passive disengagement. Students appeared lethargic and were only occasionally on task carrying out assigned activities. For substantial portions of time, many students were either clearly off task or nominally on task but not trying very hard.

3. Sporadic or episodic engagement. Most students, some of the time, were engaged in class activities, but this engagement was inconsistent, mildly enthusiastic, or dependent on frequent prodding from the teacher.

4. Widespread engagement. Most students, most of the time, were on task pursuing the substance of the lesson. Most students seemed to take the work seriously and were trying hard.
APPENDIX D

Interview for (MS)$^2$
(MS)$^2$ Teacher Interview
Instructions to Interviewers

The goal of the teacher interview is to learn the teacher's perceptions of the district-adopted textbook and about how it is used to teach mathematics in their classrooms. The interview is intended to complement the observations and the textbook-use diary.

The Teacher Interview is organized into 5 sections. It begins with an opening question followed by a series of questions (2–5) focused on how the textbook is used by the teacher for planning and teaching, and how it is used by the students. In the next section (6–9) teachers are asked about the relevance or usefulness of the textbook. Questions 10-12 seek an assessment of the overall quality of the textbook including strengths and weaknesses. The final question is meant to provide another opportunity (following up on Question 1) of what the teacher believes is the role or importance of the textbook.

While this set of questions should provide a general guide for the interview, there may be additional questions that seem logical given a particular response of the teacher. The interviewer should feel free to follow certain question lines as they occur based on the overall goals of the interview.

Logistics:

Schedule the interview in advance and allow at least 30 minutes for the interview. Find a quiet place to conduct the interview. The interview should be recorded on audio-tape. Inform the teacher that the audio-tape is used so that you can concentrate on the questions and responses and do not have to take notes during the interview. It will be used to help you summarize the responses following the interview and will be archived in the project office in Missouri. However, the interview is anonymous in that responses will not be reported by teacher name.

After the interview, the interviewer should complete the Interview Summary Form attached (preferably, typing it into the Word electronic file), by writing a summary for each response, highlighting the most salient features of the response. If the teacher said something that you feel should be quoted (e.g. because it is particularly significant, because it is something that set the tone for the whole interview, ….), write the quote in the summary, if it is short enough. If not, specify how to find it on the tape (e.g. “About 2:35 min into the response, from where she says ‘My textbook is a tool…’ until she says ‘… as I always say to my students’”). After the last question, write a summary of anything that you consider relevant that was not addressed in the questions’ summary, but that it is important for us to notice.

Please send the Interview Summary Form (hard copy) and the audio-tape to the Project staff in Missouri. Also, please send the Interview Summary Form (electronic Word copy) as an attachment to Barbara Reys (reybs@missouri.edu).

If possible, please conduct all interviews in November or December.
A. Opening Question
1. If you could design the ideal math textbook for yourself, what would it look like? What would it contain? How would it be organized? [Follow up questions: How would it be different than the district-adopted textbook you use? In what ways would it be the same as the district-adopted textbook you use?]

B. Teacher use of textbook and other resources for planning and presenting mathematics instruction.
2. In what ways do you use the district-adopted mathematics textbook in planning or teaching a mathematics lesson? [Probe how the textbook was used plan both the course and to plan the most recent lesson. Possible follow-up questions: Does the textbook influence what you teach, when you teach it, and/or how you teach a concept or skill? Do you use all of the activities, problem sets in the textbook? If not, how do you decide what to use and what to skip?]
3. How often do you use the district-adopted textbook? How often do your students use the district-adopted textbook?
4. What parts or features of the textbook do you use most often? What parts or features of the textbook do your students use most often?
5. Do you use materials or resources other than the district-adopted mathematics textbook to plan or deliver mathematics instruction? If so, what are they? Why do you use these materials rather than the district-adopted textbook? About how often do you use other resources?

C. Teachers perception of relevance/usefulness of district-adopted textbook
6. How important is the district-adopted textbook for planning or teaching mathematics in your classroom?
7. What role does the district-adopted textbook play in assisting you in teaching mathematics lessons? What role does it play in helping your students learn mathematics?
8. To what extent do you agree with the statement, “The textbook determines what gets taught”? [Follow up questions: In what ways does the district-adopted textbook influence what you teach? What other things influence what you teach?]
9. In what ways does the district-adopted textbook influence how you teach? What other things influence how you teach?
D. Teachers rating of quality of district-adopted textbook.

10. How do you rate the overall quality of the district-adopted textbook?

11. What do you think are the strengths of the district-adopted textbook?

12. What do you think are the weaknesses of the district-adopted textbook?

E. Closing Question

13. Please complete the following statement:
   - A good mathematics textbook should …

[NOTE: Yes, this is similar to question #1. The idea is to bring the interview back full circle – as a result of responding to the other questions, the teacher may want to add something to the earlier response. This question allows for this by asking the same question in a different way.]
Post-observation Questions

The purpose of these interviews is to better understand the teacher’s view about how did the lesson go, and how, if at all, this departed from what was planned. These question will complement those in the Observation Tool (Appendix C)

1. Were there any ways in which the lesson was different from what you had planned?
2. Would you say that this lesson was a typical lesson with this group?
3. What was the main idea in this lesson?
4. Would you do anything differently if you were to teach this lesson again?

First interview

The purpose of this first interview is to learn about the teacher’s personal history as related to mathematics learning and about his/her conceptions of mathematics and mathematics teaching.

I want to thank you for agreeing to be part of this study. The purpose of this study is to learn about how teachers use their textbooks. During this first interview I want to know what have been your experiences as a mathematics teacher and what do you think about mathematics and mathematics teaching.

1. How did you become a middle school mathematics teacher? [Probe for any decisions or choices made in college, and ask about certification, if it is not mentioned by the teacher.]
2. How did you learn the mathematics you needed to know to be a mathematics teacher? [Probe for what mathematics is important to know for teaching and for mathematics courses in college.]

3. Did you enjoy mathematics in school?
   — What did you particularly enjoy about it?
   — What did you not enjoy about it?

4. What do you think the goals of middle school mathematics should be? Why are these things important?

5. What is the most important thing you would like your students to learn from their mathematics class this year?

6. In your classroom, what would you consider to be the factor that contributes the most to students’ learning? [Probe for examples.]

7. Think about a student of yours that is very good at math. Tell me about this student. [Probe for what makes her/him good at math, what does it mean to be good at math.]

8. Think about a student who is not good at math. Tell me about this student. [Probe for what makes her/him “not good at math.”]

9. Is there anything else that you think I should know about you and that I didn’t ask?

Thank you very much for your time. I look forward visiting your classroom.
Second interview

The purpose of the second interview is to learn about the teacher’s view about the textbook, about the support—or lack of it—that he/she has received to use the district’s adopted textbook, and about how he/she uses the textbook. The questions might change depending on the observations done during the week.

Thank you very much for taking the time to talk with me about your teaching and for allowing me to observe your classroom. In this last interview I would like to know what are your views regarding your district’s adopted textbook and how do you use it.

1. Regardless of the particular textbook that you are using this year, in what ways do you think a textbook should help you in your teaching?

2. What professional development experiences did you have prior to adopting the textbook that you use?

3. What professional development experiences have you had since then?

4. How have these experiences influenced your teaching? [Probe for examples.]

5. How has your district’s adopted textbook helped you to plan your course? [Probe for examples from both summer and academic year activities.]

6. Based on your experience, how would you describe your district’s adopted textbook to someone else? What features stand out to you?

7. How has your district’s adopted textbook affected your teaching? [Probe for what has he/she learned from the textbook.]

8. What characteristics of your textbook have been most helpful to you?
9. What aspects have been least helpful? Why?

10. When you plan a lesson, how do you pick the activities that the students will experience in the classroom?

11. When students’ reactions are not what you expected, what do you do? In what ways can this affect the lesson? [Probe for examples.]

12. Is there anything you would like to tell me that would help me better understand how you use your textbook?

I deeply appreciate your time and willingness to collaborate in this study.

Third interview

The purpose of this third interview is to address some issues that were not covered in the first two interviews, in particular some issues related to the influence of the currently adopted textbook in the teacher’s evolving practice.

I want to thank you again for your participation in this study. During this last interview I want to address some issues that we haven’t discussed before in detail.

1. Tell me, with as much detail as possible, how did you use to teach with your previous book (from planning at the beginning of the year to evaluating what students learned at the end of the year).

2. In what ways is that different from what you do now?

3. What are your long term goals in terms of your students learning mathematics?

4. How do you want your students to see math by the end of the year? What impression of mathematics would you want them to have?
5. What characteristics would define a great teacher of mathematics?

6. Do you see your teaching evolving as you get more experience with this textbook? If so, in what ways?

7. If you could get all the support you want (from your district, your school, the publishers) in terms of professional development, what would you like to have?

8. If you had the opportunity to learn more mathematics,

   (a) what would you like to learn?

   (b) how would you like your teacher to be?

   (c) what kind of things would you like to do?
### Textbook-Use Diary

**Gr. 6**

Use this "Textbook" diary to record use of materials to support instruction and learning in your 2nd math class of the day. *Textbook* as used below refers to the district-adopted mathematics textbook. Continue this diary until you have 10 entries (10 consecutive lessons). If there is a day when you are absent or have some other interruption (e.g., school assembly), skip that day but continue with the log until you have 10 entries.

<table>
<thead>
<tr>
<th>Date</th>
<th>General topic of lesson?</th>
<th>1) What did you do in this lesson?</th>
<th>2) What materials did you use?</th>
<th>Textbook pages used by TEACHER (unit &amp; pages)</th>
<th>Textbook pages used by STUDENTS during the lesson (unit &amp; pages)</th>
<th>Homework from textbook assigned (unit &amp; pages)</th>
<th>Other print materials used by TEACHER</th>
<th>Other materials used by STUDENTS</th>
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</thead>
<tbody>
<tr>
<td>10/30</td>
<td><strong>Graphs</strong> Maximum and Minimum Numbers</td>
<td>Read Activity 4, Clear View Graphing, Visuals 4A-B, Activity Sheet 7, 8, 9</td>
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<td>Activity Sheet 3, 4, 5</td>
<td>Visual 5A-B, Visuals 5A-B</td>
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<td>Activity Sheet 10, 11</td>
<td>Visuals 7A-B, Visuals 7A-B</td>
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<td>W.S. 5-3</td>
<td>Visuals 7A-B, Visuals 7A-B</td>
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University of Missouri (MS) Study (6/02/02)
APPENDIX G

Classroom Observation Summary
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<td><strong>Pages</strong></td>
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<td>homework assigned form text, working through investigation 4.3 from text</td>
<td><strong>Students used text</strong></td>
<td>Students read aloud and listened as teacher read, introduced central problem of lesson, reviewed homework questions form text, next assignment</td>
<td></td>
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</tr>
<tr>
<td><strong>Students used other</strong></td>
<td>calculators</td>
<td><strong>Teacher used text</strong></td>
<td>Teacher read from text, selected demonstration g problems and form of lesson from text, assigned homework from text</td>
<td></td>
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<tr>
<td><strong>Teacher used other</strong></td>
<td>Overhead projector</td>
<td><strong>Assignment</strong></td>
<td>students worked to find possible factors and multiples for numbers given in the text (with in problem context ) used calculators to check</td>
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<tr>
<td><strong>Impact on content</strong></td>
<td>A great deal</td>
<td><strong>Impact on presentation</strong></td>
<td>A great deal</td>
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<tr>
<td><strong>Textbook was used...</strong></td>
<td>calculators - always encouraged here word wall- factors, multiples (though not specific referred to in this lesson)</td>
<td></td>
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<tr>
<td><strong>Other materials?</strong></td>
<td></td>
<td><strong>Textbook use (code)</strong></td>
<td>Most of lesson guided by textbook</td>
<td></td>
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</tr>
</tbody>
</table>
Vita

Óscar Chávez was born in 1963 in Mexico City. He studied mathematics at the National University (Universidad Nacional Autónoma de México) in Mexico City. From 1987 to 1999 he taught grades 7th through 12th at Logos Escuela de Bachilleres.

In 1999 he moved to Columbia, Missouri to attend graduate school at the University of Missouri, where he received a M. A. in mathematics in 2001 and a Ph. D. in mathematics education in 2003. He is currently a post-doctoral fellow at the University of Missouri in the College of Education. He lives with his wife Marcela and his children Alejandro and Julia in Columbia, Missouri.