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# Curriculum Materials in Mathematics Education Reform: A Framework for Examining Teachers' Curriculum Development

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## ABSTRACT

This paper presents a model of teachers' construction of mathematics curriculum in the classroom or their *curriculum development* activities. The model emerged through a qualitative study of two experienced, elementary teachers during their first year of using a commercially published, reform-oriented textbook that had been adopted by their district (Remillard 1996). The aim of the study was to examine teachers' interactions with a new textbook in order to gain insight into the potential for curriculum materials to contribute to reform in mathematics teaching. The resulting model integrates research on teachers' use of curriculum materials (cf. Stodolsky 1989) and studies of teachers' construction of curriculum in their classrooms (cf. Doyle 1993). The model includes three arenas in which teachers engage in curriculum development: design, construction, and curriculum mapping. Each arena defines a particular realm of the curriculum development process about which teachers explicitly or implicitly make different types of decisions. The design arena involves selecting and designing mathematical tasks. The construction arena involves enacting these tasks in the classroom and responding to students' encounters with them. The curriculum mapping arena involves determining the organization and content of the entire curriculum into which daily events fit. Through articulating each piece of the model, the author highlights the complex and multidimensional nature of teachers' curriculum processes, identifies significant characteristics of each arena that have implications for textbook use and instructional change, and indicates areas that call for further understanding and research.

For at least a decade, mathematics educators have sought change in the curriculum and pedagogy of school mathematics (cf. National Council of Teachers of Mathematics 1989, 1991). An unresolved question in these efforts has been the role that curriculum materials can and should play. Curriculum materials were the primary vehicles used in the 1950s and 1960s to stimulate curricular change, but their "teacher-proof" approach has since taken much of the blame for the failure of these initiatives. Consequently, reformers have been cautious about relying too heavily on

curriculum materials in current efforts to change the nature of students' mathematics learning opportunities, focusing instead on teacher development.<sup>1</sup> Nevertheless, curriculum guides and textbooks continue to be a mainstay in American classrooms (Tyson-Bernstein and Woodward 1991). Furthermore, research on recent teacher development projects has revealed a need for teachers to have well-designed curriculum guidance (Brown, Smith, and Stein 1996). Exactly how this guidance should look is not clear because we have limited knowledge of how teachers interact with and use curriculum materials, particularly those designed to promote curricular and pedagogical change. Evaluations of new materials tend to focus on students' experiences and not the teacher's role in facilitating those experiences. The aim of this article is to contribute to knowledge of teachers' curriculum decisions in order to consider ways that curriculum materials might support change in teaching.

### **WHAT WE KNOW ABOUT TEACHER-CURRICULUM RELATIONSHIPS**

The question of *how* teachers interact with and use textbooks is relatively new. Textbooks were once viewed as accurate representations of classroom curriculum (Walker 1976). Implicit in this perspective is a view of the teacher as a conduit for curriculum, not a user or shaper of it. Observations of teachers using the "teacher-proof" materials of the 1950s and 1960s suggested that many teachers did not use the new curriculum materials as the authors had intended. Stake and Easley (1978) described adaptations to inquiry-based curriculum that reflected teachers' notions about teaching and the nature of the subject matter. Sarason (1982) observed teachers' struggles to understand the "New Mathematics" materials, noting a clash between their beliefs about mathematics and the ideals represented in the materials. Studies such as these illustrated the substantial role that teachers play in shaping the curriculum experienced by students.

Researchers have since examined teaching and textbook use, seeking further insight into teacher-text relationships. The perspectives and foci they have taken, however, vary considerably, resulting in incommensurable findings. Some researchers, for example, have focused on common textbook components and studied the characteristics of textbooks teachers tend to use. By comparing teachers' uses of topics, student pages, and teacher suggestions, Stodolsky (1989) found that teachers consistently adhered to the topics in their textbooks, but departed from many accompanying teaching suggestions, particularly those not found on the student's page. Freeman and Porter (1989) found that teachers used student exercises in texts considerably more than review sections, teacher directives, enrichment, and additional practice. Other researchers examined the beliefs underlying teachers' textbook use and concluded that teachers' knowledge of and views about mathematics (Graybeal and Stodolsky 1987; Thompson 1984), their perceptions of the text (Bush 1986; Duffy, Roehler,

and Putnam 1987; Remillard 1991; Woodward and Elliot 1990), their perceptions of external pressures (Floden et al. 1980; Kuhs and Freeman 1979), and their ideas about the purpose of school and the nature of learning (Donovan 1983; Stephens 1982) all influenced teachers' textbook decisions.

The coherence of these findings is further compromised by variation in researchers' conceptual categories of textbook use. Floden et al. (1981) and Bush (1986) viewed use as the extent to which teachers covered the topics and skills in their textbooks. Bush, for example, characterized pre-service teachers as following the text closely even though they claimed to "pick out the topics they [the texts] want to talk about, then I explain it freehand on the board" (25). Other researchers have focused on student activities and classroom formats in their examinations of textbook use (Durkin 1983; Graybeal and Stodolsky 1987). Still others have considered how the content is presented and represented, as well as the pedagogical and epistemological assumptions that underlie its presentation (Stephens 1982; Thompson 1984). These differences in what researchers examined reflect different conceptions of classroom practice and mathematics, which limit comparisons across findings.

From another perspective, researchers have argued that placing the teacher-text relationship at the center of analyses of teaching oversimplifies teachers' curricular decisions. For example, in a study of elementary teachers, Sosniak and Stodolsky (1993) found textbook use to be inconsistent across teachers and school subjects. Moreover, they found that teachers did not see texts as "blueprints" or "driving forces," but as "props in the service of managing larger agendas" (271). By capturing the role of the text in relation to teachers' varied responsibilities, these findings suggest a need for understanding teachers' larger curricular agendas and the role the textbook plays in them.

Research on what Doyle (1993) called the "curriculum process" considers teachers' larger agendas by focusing on how they enact curriculum in their classrooms. This research focuses less on the teacher-textbook relationship and more on the teacher-curriculum relationship. It often includes how teachers draw on resources like textbooks, but assumes that this process necessarily involves interpreting the meanings and intents of these resources (Doyle 1993; Golden 1988; Lemke 1990; Snyder, Bolin, and Zumwalt 1992). Implicit in studies of teachers' curriculum processes is a view that the *enacted curriculum* is more than what is captured in official policy documents or textbooks. It is the events teachers and students experience in the classroom (Clandinin and Connelly 1992; Gehrke, Knapp, and Sirotnik 1992).<sup>2</sup> From this perspective, studying the role of textbooks in teachers' mathematics teaching involves studying teachers' processes of constructing the enacted curriculum and the role that resources such as texts play in it.

In this article, I present a model of teachers' curriculum enactment in mathematics teaching. This model emerged through a qualitative study of two elementary teachers during their first year of using a commercially published, reform-oriented textbook that had been adopted by their dis-

trict (Remillard 1996). My aim in developing the model was to offer a broad theoretical framework that accommodates findings from various studies of teachers' curriculum activities and textbook use. In delineating this model, I hope to represent the complexity of teachers' curriculum processes and to highlight areas that call for further understanding and research. My work in this area rests on the assumption that knowledge of teachers' curriculum processes should inform the design of curriculum materials<sup>3</sup> intended to foster pedagogical change.

### TEACHERS AS CURRICULUM DEVELOPERS

Regardless of how teachers draw on and use curriculum materials, their work in relation to planning and teaching mathematics can be viewed as *curriculum development*—the processes by which teachers develop curricular plans and ideals and translate them into classroom events. Through the curriculum development process, teachers plan and shape students' experiences in the classroom. The term "curriculum development" is often used to describe the writing of curriculum materials. In referring to teachers as curriculum developers, I suggest that the curriculum development process does not stop when textbooks are printed, but continues in the classroom. The term builds on Ben-Peretz's (1990) conception that there are two levels of curriculum development. The first level is what curriculum writers do when they conceptualize curricular plans and write them in resources for teachers. The second level is what teachers do as they alter, adapt, or translate textbook offerings to make them appropriate for their students. In her discussion of the teacher's role in curriculum development, Ben-Peretz referred to the deliberate actions of teachers engaged in "uncovering the potential of curriculum materials so that these can be reconstructed for particular students and for specific classroom situations" (xiv). My observations of two teachers suggest that the teacher's role as curriculum developer involves more than selecting and redesigning curriculum plans; it involves enacting those plans in the classroom with students. In a study of the relationship between mathematics instruction and students' thinking, Stein, Grover, and Henningsen (1996) observed distinctions between tasks teachers planned and their implementations of them in classrooms. These researchers found that teachers adjusted particular features and cognitive demands of reform-oriented tasks while students worked on them, illustrating the responsive, interactive, and emergent nature of the constructed curriculum. Even teachers who follow textbook suggestions as closely as possible make curriculum-development decisions.

Central to the model of teachers' curriculum development is an extension of the term *reading* beyond its conventional usage. Generally, reading refers to making meaning through engaging written text. Scholars of reading describe it as a dynamic and constructive process that involves interaction between the reader and the text, situated within a particular context (Pearson and Stephens 1994; Rosenblatt 1994). Lytle and Botel (1988)

refer to reading as “transactions with texts” in order to emphasize the interactive, ongoing nature of the reading process “to which readers bring prior knowledge, experiences, beliefs, and attitudes” (p. 22). In this process readers “use their existing knowledge and a range of cues from the text and the situational context in which the reading occurs” to make meaning (Dole et al. 1991, p. 241). My observations revealed that the meanings the teachers made through reading the text grew out of interactions between their beliefs and elements of the textbook and were situated in the larger context of their teaching.

The textbook, however, was not all the teachers *read* in the process of enacting curriculum. The teachers' curricular decisions also were influenced by the meanings they made from observing and interacting with their students engaged in mathematical tasks. From this perspective, the teachers read students' performances and the mathematical activities they engaged in, in addition to the written suggestions in the textbook. Later, I discuss reading and the process of curriculum construction in greater depth.

## **AN INTRODUCTION TO THE TEACHERS AND THE STUDY**

In this section, I introduce the model of curriculum development that grew out of my analysis of two fourth grade teachers, Catherine McKeen and Jackie Yarnell,<sup>4</sup> using examples from their practices to illustrate the various pieces of the model. Even though the particular factors that influenced each teacher's choices cannot be generalized, the model as a frame is relevant to both mathematics teaching and teachers in general. I begin by introducing the two teachers, their experiences with the textbook, and the empirical study that prompted the development of the model.

## **METHOD**

The study examined two elementary teachers' uses of the same reform-oriented mathematics textbook in the process of enacting curriculum. My aim was to consider how curriculum materials might foster changes in teaching by analyzing the relationships between teachers, textbooks, and the enacted curriculum. Using qualitative, interpretive methods, I undertook in-depth investigations of each teacher's curriculum development activities, including her interactions with the textbook. Over the course of one school year, I observed each teacher's mathematics instruction regularly, interviewing her before and afterwards about her intentions and reactions. Transcripts of the observations and interviews formed the corpus of the data for the study.

In order to look at the two teachers comparatively, I used case study methods (see Stake 1978; Yin 1994) to analyze and interpret data for each teacher and then to make comparisons between them. The cases were both

descriptive and explanatory; I drew on descriptive data to characterize each teacher's orientation toward textbook use and then used that characterization to explain her interactions with the textbook and its impact on her thinking and teaching. I followed the writing of the two cases with a cross-case analysis in which I examined patterns that cut across both. This analytical process involved developing themes and returning to the particular cases to check their validity.

The focus of this paper is the model that I constructed through the cross-case analysis. In order to situate the model in the two teachers' practices, I first provide an introduction to each teacher and an overview of their mathematics teaching across the year.

### **Introduction to the Teachers**

Catherine and Jackie taught in the same, mid-sized, predominantly working-class school district in the midwestern United States. Both had grown up locally, had received their professional preparation from the same university, and were veteran teachers of almost thirty years. Nevertheless, they had contrasting ideas about teaching mathematics and worked in school environments that offered radically different types of support and opportunity. As I describe later, these factors influenced their curriculum activities.

Catherine McKeen was typical of many elementary teachers and potential textbook users. As an experienced teacher, she had well-developed and fairly conventional ideas about what learning mathematics included. Computational mastery lay at the core of her instructional goals; careful guidance and repeated practice defined the route by which children would attain it. On the other hand, Catherine also found the new goals for mathematics teaching compelling. She claimed that students needed to learn to think and to apply computational knowledge in problem situations, and she wanted to incorporate problem solving into her teaching, but not at the expense of computational mastery. In describing the position that she and her colleagues held, Catherine said, "We'll do more problem solving and everything like that, but we feel they do need to know their multiplication tables" (interview, 11/19/92).

Catherine's teaching context was typical of many elementary schools. She had few formal opportunities to learn about reforms in mathematics education or to talk with colleagues about their practice. Most of what she learned about the reform movement or the new textbook came from district memos or lunchroom conversations with colleagues. Like many teachers in this position, she saw the new textbook as a tool to help her make necessary changes in her teaching. She was particularly intrigued by the section of complex problems called "Problems of the Day" and the emphasis on topics that took students beyond whole number operations, such as data and graphing, geometry, and fractions.

Catherine began the year selecting fairly conventional suggestions from the textbook, ignoring those that involved manipulatives or discussion.

Over time, however, her selections changed. Working with her students to solve complex problems in the text prompted Catherine to reassess her ideas about mathematics, what students needed to learn, their learning processes, and the reform agenda. In April she stated, "The more they're working on the problem solving, the more important it's becoming to me . . . the pressure is on us to help them think through these kinds of problems" (interview 4/3/93). As her ideas about teaching and learning mathematics shifted, so did her teaching and use of the text; both became more adventurous and responsive to students. Throughout the lessons observed in the spring, Catherine used a variety of conceptually oriented activities that she had tended to ignore in the fall.

Jackie Yarnell represented a less typical but increasing number of teachers who have embraced new ideas about teaching mathematics and who teach in settings that encourage such growth. When she first encountered the new textbook, she had already made significant changes in her mathematics teaching. She taught in a school that had focused on teacher development for several years. As a result, she had seen unconventional teaching practices, experimented in her own teaching, and discussed her observations and growth with colleagues. Over a short period of time, she had begun to reexamine many of her beliefs about teaching, learning, and mathematics. She had considered her experiences as a student in a new light and was determined to provide students with opportunities that she had not had—opportunities to think, invent solutions to problems, and share ideas with others. She also was engaged in a three-year experimental project in which she taught the same students from third to fifth grade.

Despite these experiences, Jackie believed that she still had much to learn about helping students become mathematical thinkers. She hoped that a recently revised textbook would help her do so. She expressed her hope early in the year by saying, "It's nice to have it right in the book . . . I was going out and hunting for problems that would make kids think" (interview, 9/24/92). She ended up being disappointed. Jackie found that the textbook failed to support her efforts to engage students in mathematical reasoning and discourse. Over the year, she looked to it less and less and to herself more and more. With each new topic she introduced, Jackie began by drawing on the textbook as a resource. She quickly replaced the textbook's guidance with her own decisions that responded directly to her analyses of her students' understandings and struggles. In the process, Jackie developed a deeper understanding of the mathematical ideas she taught and strengthened her pedagogical abilities. Over the year, I observed her move from a position of doubt about her mathematical and pedagogical choices to one of confidence. She saw her first move away from the text as "a big risk" (interview, 10/15/92). By the end of the year, she had developed enough confidence in her knowledge of important mathematical ideas that she boldly remarked, "Whenever I didn't feel that it [the textbook] was doing what I wanted to do, I did my own thing" (interview, 7/1/93).



## THE TEACHER'S ROLE IN CURRICULUM DEVELOPMENT

My analyses across the two teachers' mathematics teaching revealed patterns in their curriculum development activities. Drawing on these patterns, I constructed a model of the teachers' role in curriculum development. The model includes three arenas: the design arena, the construction arena, and the mapping arena. Each arena defines a particular realm of the curriculum development process about which teachers explicitly or implicitly make different types of decisions. The *design arena* involves selecting and designing tasks for students. Here the teachers consulted and interacted with the textbook most explicitly. The *construction arena* involves enacting these tasks in the classroom and responding to students' encounters with them. Both teachers' activities in this realm of decision making tended to be improvised and responsive, involving in-action decisions. Thus, the text did not play a central role in this arena. The *mapping arena* involves making choices that determine the organization and content of the curriculum. Unlike the first two arenas, the mapping arena is not directly related to daily, classroom events; rather, it impacts and is impacted by them. Decisions in this realm create the mathematical context in which the activities of the other two arenas occur.

In using these three arenas to delineate distinct aspects of the curriculum development process, I do not suggest that the choices teachers make in each occur serially or in isolation. A teacher's task selection, for example, usually includes intentional or de facto curriculum-mapping decisions. Similarly, the process of enacting any task is likely to lead to further task selection, as well as possible adjustments to the curriculum map. Figure 1 illustrates interrelationships among the three arenas, which I discuss in more detail below. I begin by describing the design and construction arenas, as they deal with the day-to-day components of mathematics instruction.

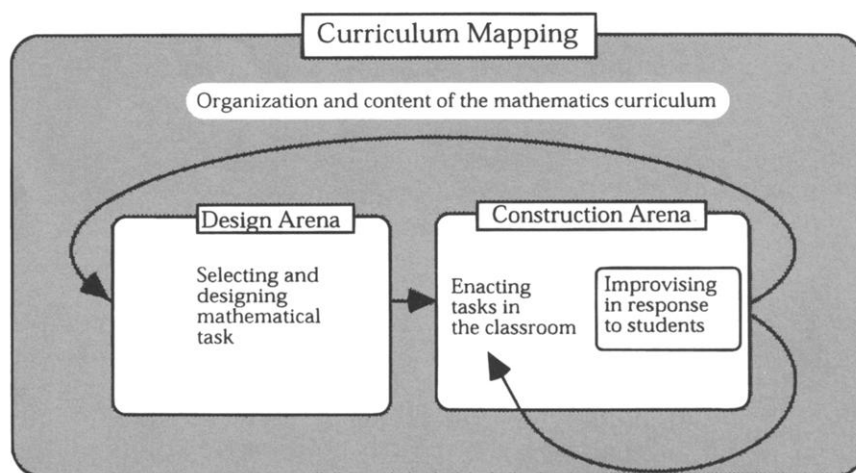


FIGURE 1. Overview of the Three Arenas and the Relationships Among Them

Then I discuss the mapping arena, which encompasses the first two. Although the mapping arena might logically belong first because it establishes the broader context in which the other activities are set, I discuss it last because it is most clearly understood in relation to the other two.

### TASK SELECTION IN THE DESIGN ARENA

A crucial component of a teacher's role in curriculum development is the process of selecting, altering, and constructing mathematical tasks to present to students. The tasks that a teacher selects, regardless of the extent to which they differ from those described in the textbook, represent the teacher's assumptions about content (what students should learn) and pedagogy (how they should learn it). Thus, through the task-selection process, teachers either give purpose to proposed activities in the text or create their own. Teachers' task-selection choices are influenced by their ideas about mathematics, students, and their learning, as well as by the teaching context and available resources. The role that these factors play in this process is exemplified by the strikingly different ways Catherine and Jackie used their textbook.

Below, I characterize and compare the two teachers' approaches to task selection. In accounting for their differences, I argue that underlying them are different ways of *reading* the textbook, which are in turn influenced by the ideas teachers bring with them. A number of researchers have observed that teachers' ideas about mathematics, students, teaching, and learning influence what text suggestions they used (Freeman and Porter 1989; Putnam 1992; Remillard 1991; Sosniak and Stodolsky 1993) and how they interpret and use them (Donovan 1983; Stodolsky 1989; Stephens 1982). As I describe below, the construct of reading demonstrates how these factors work together in the task-selection process.

**Two approaches to task selection: Appropriation and invention.** The two teachers illustrate distinct approaches to task selection: appropriation and invention. These classifications are not the only possible approaches, but they provide one portrait of the variation in reading and using a text in the design arena. I will briefly describe each teacher's approach before discussing the differences in reading the text that undergirded them.

For many of the mathematics topics Catherine taught, she selected or *appropriated* tasks from the textbook. She was committed to incorporating reform-related topics into her mathematics instruction and trusted the text to provide tasks that embodied these topics. Thus, she drew tasks directly from the textbook and presented them to students. The tasks she chose included the problems of the day and many basic exercises on the students' pages. Even when she did not fully agree with or understand the intent behind the particular tasks, she used them because they represented aspects of the reforms she sought to add to her teaching. In the process of using them,

she gave them her own purpose, which often was for the students to complete them successfully, producing the answers printed in the teacher's guide.

Catherine's use of the "Problems of the Day" illustrates her tendency to appropriate tasks. Each morning she copied a problem from the textbook onto a specifically designated blackboard. She gave students approximately five minutes to work on the problem when they arrived at school. She then collected their papers before walking the class through the solution. This process was brief and focused on a single approach, usually generated by Catherine.

Unlike Catherine, Jackie did not select tasks from the text. She used the text as a source of mathematical and representational ideas from which she adapted and *invented* her own tasks. These ideas ranged from mathematical concepts or relationships to concrete ways to represent or explore them. Because she believed the reforms were aimed at developing students' understandings of mathematical ideas and relationships, she rejected tasks that required only rote skills and she invented tasks that focused on ideas she believed were important. The tasks she designed engaged students in exploring mathematical ideas, discussing their understandings with one another, and developing their own solutions to problems. For example, in one lesson, Jackie reviewed the explanations and tasks on a page in the text and concluded that the central idea was the relationship between the values of the places in the base-10 system (e.g., that 140 hundreds was another way to show 14,000). She believed this idea was crucial for students to understand, but felt the tasks on the page were unhelpful since they merely asked students to show these equivalencies by filling in blanks such as  $300 = \underline{\quad}$  tens. Thus, she invented a task that required students to use drawings of base-10 blocks to illustrate and even "prove" the relationships written in the text.

**Different readings of the textbook.** The differences between Catherine's and Jackie's approaches to task selection can be traced to different ways of reading the text. In the design arena, reading the text involved a series of tacit decisions about what to attend to and how to interpret it. In addition to bringing their own meaning to what they read, which is how some researchers have accounted for different uses of texts (Donovan 1983; Stodolsky 1989; Remillard 1991; Stephens 1982), Catherine's and Jackie's approaches to task selection illustrate two less-frequently-discussed differences in reading the text.

First, the two teachers each attended to some parts of the text and dismissed others. Catherine tended to pay attention to suggestions related to exercises and activities on the students' pages. She read the student text and the related steps described in the margins of the teacher's guide. She rarely read the supplementary pages in each chapter that offered interactive and problem-solving activities related to the concepts in the lesson, and she did not read the chapters on basic computation skills. As Table 1 indicates, Catherine used textbook suggestions associated with daily lessons in all but one observed lesson and supplemental suggestions only once. In

TABLE 1  
The Teachers' Patterns in Reading the Textbook During Task Selection

	Number of lessons observed	Number of lessons involving text	Number of lessons including item from . . .		
			Student page	Margin of student page in teacher's guide	Supplemental pages of teacher's guide
Jackie	14	4	3	4	4
Catherine	15	14	14	14	1

contrast, Jackie tended to skip the suggestions related to activities on the students' page, drawing on these suggestions during only four of fourteen observed lessons. She also used suggestions in the teacher's guide during four of the fourteen lessons (see Table 1).

In keeping with these tendencies, Catherine introduced her students to a fraction unit by skipping the "chapter opener" that used a realistic example to introduce the meaning of fractions, but did not have a page of student work associated with it. She started instead with the first lesson in the chapter, which included a page of exercises in the student's text and proceeded through the chapter, one lesson per day. Jackie, in contrast, had her class spend the first three days of the unit on exploratory tasks that she adapted from those suggested in the chapter opening. She then went on to invent her own fraction tasks, and as a result, she did not get to many of the pages in the chapter at all.

A second difference in the two teachers' readings of the text was more subtle. They read similar suggestions for different purposes. When Catherine looked at a suggestion in the text, she looked for tasks she might appropriate, steps to follow, and things to do. Most often she focused on exercises for students to complete or questions to ask them. As her teaching became more conceptually oriented, she focused her reading on concept-building tasks, such as using counters to find fractions of various numbers or writing and answering questions about fractions. Jackie interpreted similar suggestions in the text as attempts to address particular mathematical ideas or concepts and paid little attention to the actual tasks. In preparation for a place value lesson in mid-September, Jackie examined the tasks on the pages of the text, which offered a series of fill-in-the-blank questions. Dismissing these questions, she focused on the underlying concept that she believed students should understand—the relationship between 1s, 10s, 100s, and 1,000s. With this idea in mind, she developed her own task that involved students in representing four digit numbers in multiple ways and justifying their results to the class. Whereas Catherine's reading provided her with a set of activities to have students do, Jackie's reading resulted in a relationship or idea that she used to invent a task.

**The role of the teachers' beliefs in reading the textbook.** The factors that figured most significantly in the different ways the teachers read the text

were: (a) how each thought about the contents and nature of the mathematical terrain, and (b) the views each held about teaching and learning. Examining how these factors influenced the teachers' readings sheds light on the processes through which teachers' beliefs figure into task selection. Below, I discuss these two categories of beliefs and how they contributed to the differences in the teachers' readings of the text. I then consider how differences in their teaching situations and specific characteristics of the text also contributed to this process.

As I have mentioned, Catherine and Jackie had different views about the mathematical terrain, including the content and nature of mathematics, the reforms, and learning. These views contributed to their expectations of the text and directed their reading of it. Catherine believed mathematics was a collection of topics. From her perspective, the reform agenda added new topics, such as problem solving, graphing, and geometry, to a curriculum that focused on computational skills. She did not believe the reforms recommended changes in conventional mathematics topics. Consequently, in her reading of the text, she focused on the problem-solving tasks and the suggestions for teaching noncomputational topics, while continuing to teach computational procedures as she always had.

The relationship between Catherine's ideas about the mathematics reforms and what she looked at in the text also was evident in the changes she made over the year. As she developed a greater appreciation for particular emphases of the reforms, she changed what she was willing to read and try in the textbook lessons. Initially, she concentrated on tasks that provided students with independent practice of skills they had learned. As she began to value reasoning and exploration in learning mathematics, however, she started to select and appropriate more activities that afforded students opportunities to explore underlying mathematical meanings.

Catherine's use of the textbook was also influenced by her view of learning. She believed students learn from being told or shown what to do and that it was her responsibility to show them each step to follow. As she said early in the year, "I would like them to feel as if they had been *taught*, instead of just being introduced and then you just kind of struggle through on your own" (interview, 11/19/92). Similarly, she expected the text to provide her with the same type of guidance in teaching new mathematical topics. She wanted it to tell her what tasks to give students and what steps to follow. In fact, Catherine was frustrated when the text did not provide her with sufficient guidance in helping students arrive at its intended conclusions. For example, she pointed out places in the text that suggested the teacher "elicit" a particular response from students and complained, "It doesn't go into a lot of ideas on how to get the children to come to this conclusion" (interview, 11/19/92).

Like Catherine, Jackie's view of mathematics and the ideas underlying the reforms also shaped what she looked at in the text and the mathematical ideas she was willing to consider. But rather than a sequenced list of rules and procedures, she viewed mathematics as a body of related ideas and relationships that needed to be understood, not memorized. As she

saw it, the real power of mathematics was in "seeing there are things you can build upon" (interview, 10/15/92). She believed the reform agenda emphasized understanding concepts and relationships and, thus, called for significant revision in what most people thought knowing and learning mathematics included. Thus, in reading the text, Jackie focused on conceptual ideas and relationships.

Jackie's view of mathematics also led her to selectively ignore parts of the text. For example, in perusing the chapter on addition and subtraction, she noted but skipped the initial work on estimation. She believed estimation was an application of addition and subtraction rather than a tool to develop understanding of these operations. She explained, "I thought before they are ready to estimate, let's actually do some [addition and subtraction]" (interview, 10/22/92). Consequently, she dismissed the idea completely.

Jackie's ideas about teaching and learning also differed substantially from Catherine's. She believed learning occurred through puzzling over problems, inventing solutions, exploring relationships, and articulating them to others. "If they can explain it, then that really shows their understanding" (interview, 10/15/92). To her, good teaching involved putting students in complex situations and "letting them puzzle," explore, and develop possible solutions. She also believed teachers should follow students' thinking and build on their ideas, rather than impose a rigid curricular plan. Likewise, Jackie believed that a good text should not impose a particular sequence or set of pedagogical steps. Just as she used tasks or problems to spark exploratory activity in her mathematics lessons, Jackie read the text to spark mathematical or pedagogical ideas in herself. She used the text as a "jumping-off point" (interview, 7/1/93) for exploring good mathematical tasks.

**The role of the teaching context.** The different classroom and school contexts, described earlier, also played a role in the teachers' task-selection processes by contributing to both their beliefs and their reading of the text. The professional development opportunities in Jackie's school supported her approach to using the new textbook. These opportunities prompted her to rethink her views of mathematics and learning, encouraging her to focus on mathematical ideas and non-routine tasks in her reading of the textbook. Catherine's school context provided her few opportunities to learn about ideas related to the reforms. Her involvement in this study, however, played an influential role in her teaching context. My regular visits led her to "look at more of the suggestions in the book" (interview, 6/25/93). Our conversations required her to articulate stances that she said she "had never put into words" (written reflection, 4/93), prompting her to reflect on her ideas about mathematics and students' learning.

**Task selection and the role of the textbook.** These descriptions illustrate how teachers can read the same textbook differently in the curriculum design process. The teachers' ideas about mathematics and learning led

them to construct different relationships with the text and to read it differently. In addition, my analyses suggest that certain characteristics of the textbook itself may have facilitated the variation in their readings.

In order to meet the approval of a range of potential purchasers, the textbook was designed to offer many choices, some more closely aligned with the goals of the reforms than others. In addition to providing a complete set of daily lessons, including more activities than a teacher could use in a single day, the text offered a variety of supplemental, exploratory, and problem-solving tasks. Together, these offerings formed a loosely connected collection of tasks with minimal guidance in interpreting or selecting among them. From one perspective, this variety was an advantage because it increased the possibility that a range of teachers would find aspects of it appealing and useful. On the other hand, the variety increased the likelihood that teachers would choose haphazardly or select elements they were already familiar with, thereby weakening the text's ability to support reform-related practices consistently.

The textbook's mode of communication with teachers also increased the possibility that they would read its suggestions differently. Like most textbooks and curriculum guides, the text contained a set of instructional tasks and actions for teachers to implement. In essence the textbook communicated with teachers by speaking *through* them, rather than *to* them. For example, it recommended that teachers pose particular problems or elicit specific responses. Nevertheless, it did not explain the value of these problems or guide teachers in supporting students' work with them. Thus, the text represented the reforms in terms of tasks or activities, focusing merely on the observable aspects of teaching. By not talking *to* teachers, the text failed to address the less visible aspects of teaching, such as decision making, leaving the teachers to draw on practices they were most familiar with.

### **TASK ENACTMENT AND ADAPTATION IN THE CONSTRUCTION ARENA**

A second arena of curriculum development is the construction arena, in which teachers and students transform planned tasks into actual classroom events. This arena is comprised of all interactions in the classroom, planned or unplanned, that influence, shape, or contribute to the enacted curriculum. Teachers' activities in this arena are aimed at initiating and sustaining students' work with the selected tasks; this is reminiscent of what Yinger (1988) called "a three-way conversation between teachers, students, and problem" (p. 86). Although students' activities as well as the teachers' actions are critical in this arena, the focus of my analysis was on the teacher's role in curriculum development. I will therefore discuss the students' part in shaping curriculum through the eyes and actions of the teacher.

A central activity of the construction arena is *task adaptation*, the unrehearsed adapting and adjusting of tasks in order to facilitate students' work with them. In fact, most of Catherine's and Jackie's activities in the class-

room were adaptive in nature. Regardless of how they used the textbook to select tasks, enacting them involved both teachers in making on-the-spot decisions about how to adapt their curricular plans in response to things that students said or did.

Because of the interactive nature of teaching, adapting tasks is an inherent part of enacting them (Cohen 1989; Jackson 1986; Lortie 1975). Nevertheless, this need for adaptation seems to be particularly prevalent for teachers developing practices associated with current reforms. The reforms suggest an approach to teaching mathematics that depends highly on students' ideas and insights (Ball 1994; Flick 1995; Heaton 1994). Instruction aimed at making students' thinking central tends to foster unanticipated student ideas and perspectives through which the teacher must navigate. Furthermore, the nature of any change requires teachers to operate without familiar routines. Many of the concepts, skills, and tasks presented in the textbook were unfamiliar to Catherine and Jackie. Thus, it was difficult for them to anticipate and plan for students' responses. They had to rely on ongoing assessments of students to guide their activities in this arena.

Examination of how teachers construct curriculum by adapting tasks illuminates the origins and development of the enacted curriculum and its relationship to guidance found in textbooks. Below, I describe patterns in both teachers' task enactment and adaptation processes. Despite the differences in the tasks they selected or why they selected them, activities involved in enacting them were strikingly similar.

**The activities of task enactment.** For both teachers, enacting tasks included two types of activities: (a) *reading* students' performances and the tasks they were engaged in and (b) *improvising* in response. Even though these activities were distinct in nature, the teachers did not always engage in them sequentially. For example, each teacher occasionally invented tasks that served as both responses to unanticipated events in the classroom and as ways to read their students further.

The most evident part of Jackie and Catherine's task enactment activities was their *reading of students' performances*, that is, observing and listening to students in order to assess their understandings, struggles, and progress. They used their goals for the task and their ideas about what it means to know mathematics to guide their assessments of students. Jackie focused on her students' understandings of specific mathematical ideas. She carefully noted their explanations of their solutions in order to decide how to challenge them further. During the place value lesson on September 16, for example, Jackie rarely accepted correct or incorrect responses from students without accompanying explanations. While one student drew a representation of 1,400 on the chalkboard, Jackie insisted: "Now tell us what you are doing." The student explained that he took 1 thousand, 3 hundreds, and 10 tens. Jackie pushed him further, "And that equals a thousand, four hundred? Can you prove this?" (observation, 9/16/92). Later, Jackie explained to me that she was trying to "make sure he really



understands what he is doing" (interview, 9/16/92). Jackie also used students' daily journal entries to read their understandings. She asked students to respond to questions like: "What did today's class help you understand?" (observation, 9/16/92).

Catherine's focus, particularly at the beginning of the year, was on helping students "be successful" without becoming too frustrated. Thus, she paid attention to what they were doing and whether it was likely to lead them to the correct answer. Later in the year, as her perspectives on students' learning of mathematics changed, Catherine began to focus her reading on what students understood and were thinking, sometimes spontaneously veering from suggestions in the text to probe students' responses. For example, during a fraction lesson on April 6, a student began to answer a question incorrectly, but then changed his answer midstream and offered a correct response. Rather than affirming his correct answer and moving on, Catherine asked, "Why did you change your mind?" (observation, 4/6/93). After listening to his explanation, she continued with the next question. Later, Catherine explained that she wanted to find out if he "really understood why" (interview, 4/7/93).

In addition to reading students, both teachers *examined and analyzed the tasks* students were engaged in, particularly those that caused them to struggle. Because this reading was aimed at helping students with the task, it was guided by the teachers' ideas about learning and about what students needed to know. In order to help students confront some of the more complex Problems of the Day, Catherine, for example, spent much time analyzing these problems. She considered what they involved, how she would do them herself, and how she would articulate the intuitive approaches she used to her students.

Jackie reexamined the tasks her students worked on primarily to help her interpret their errors. Although she had designed most of the tasks she assigned, students' unexpected solutions or struggles prompted her to reexamine the particular task for insights into their responses. During one lesson, for example, Jackie was surprised by the difficulty her students had in determining fractions of numbers. Her analysis of the situation took her beyond the students to examine the tasks she had given them previously. She realized that she had seldom asked them to find a nonunit fraction of a number, such as  $\frac{2}{3}$  of 24. Jackie determined that she had been fooled into believing that her students understood fractions by their success in finding unit fractions of numbers such as  $\frac{1}{3}$  of 24. Jackie suspected that they had merely recognized that they could divide the total number in the group by the denominator to get the correct answer but did not really understand the meaning of fractions.

The contrast between what the two teachers looked at when reading tasks was similar to the contrast in how they read the text. When Catherine assessed the tasks her students were struggling with, she focused on what they were being asked to do and what she could do to help them. Jackie focused on the conceptual requirements of the task and what it might indicate about students' understanding. These perspectives influenced their

interpretations of what was going on in their classrooms and contributed to what they decided to do in response.

Despite the difference in what they paid attention to, both teachers' readings in this arena prompted them to see their students and the mathematics in new ways. The process of assessing students' thinking prompted them to examine students' understandings and approaches that were different from their own. Assessing the tasks students engaged in allowed them to examine the underlying mathematical ideas. As a result, they began to look at the mathematics and their students' abilities differently. Catherine discovered new approaches to solving complex problems and developed a new appreciation for these problems and for her students' alternative solutions. Jackie developed a greater understanding of both the complexity of topics like place value and fractions, and her students' partial understandings of them. So, although their readings in this arena were influenced by their own ideas about mathematics and students' learning, they also prompted growth in these ideas.

The process of responding to students' encounters with the tasks involved a form of *improvisation* or on-the-spot curriculum construction. Both Catherine and Jackie drew on the outcomes of their readings, as well as their goals and their ideas about learning and knowing mathematics, in order to make improvised decisions. Their improvisations often involved selecting a new task and presenting it to students. Improvisation also included deciding whether to continue or conclude the work on a particular task or idea; thus it sometimes resulted in a return to the design arena.

Improvisation was an intentional feature in Jackie's teaching. She wanted her instruction to be responsive to students and to follow their understandings and interests. Even though she began each lesson by presenting students with a particular task, her purpose was to launch a discussion about the mathematical ideas involved. Jackie used her assessment of her students' understandings to guide her responses. She frequently responded to students' answers with: "Show me how you know that." She listened to them articulate their ideas and then constructed new questions to push them even further or to prompt them to reexamine their thinking. For example, Jackie improvised by inventing a new question when she noticed her students' haphazard and inaccurate approaches to a combination problem. The problem asked students to consider the possible scores a child would get if she threw three darts at a dart board containing three scoring rings: one worth five points, one worth three, and one worth one. Most students did not approach the problem systematically, recording solutions such as 3-1-3 and 3-3-1 as two different scores, although both totaled seven. Jackie assessed what the task asked of students with respect to her intention that it would help students develop systematic and efficient approaches to solving problems with multiple solutions. She then posed a new question: "How do you know when you have them all?" With this question, Jackie adapted the initial task to focus the students more directly on her goal of developing systematic approaches to solving problems.

Improvisation was not a deliberate characteristic of Catherine's teaching at the beginning of the year, but she frequently found herself in situations that required it. The need to improvise arose when she confronted unanticipated students' difficulties. For example, when Catherine saw her students struggle with the Problem of the Day, she distributed calculators and took the time to develop what she called a "lesson in three-step problems." She walked students through the steps of the problem, which included figuring out which operation and numbers to use (observation, 12/19/92). This lesson was not inspired by the task or the text, but by Catherine's assessment of her students' encounters with the problem.

**Task adaptation and the role of the textbook.** A characteristic common to both teachers' adaptations of tasks was the minor role the textbook played. Regardless of how they used the text to design curriculum, neither teacher relied on it to enact and adapt curriculum. Rather, both drew on their own personal resources to assess students, examine tasks, and improvise responses, even when they had taken the original task from the textbook. Jackie in particular illustrated this tendency. Once she posed a task to students, she generally initiated a series of improvisations that lasted the entire lesson. Although Catherine returned to the text for new tasks more frequently within a single lesson, she infrequently drew on the text while enacting them.

The minor role the textbook played in shaping the activity in the construction arena seems characteristic of this aspect of teaching. In order to enact tasks, teachers must read students and improvise in response (Heaton 1994; Flick 1995; Lampert 1990; Yinger 1987). Because textbook writers cannot predict students' responses to tasks, their ability to directly shape the enacted curriculum is limited. Most textbooks focus on the tasks and questions to pose and correct answers to expect in the construction arena. They do not attend to the improvisational and responsive activities central to this arena.

The construction arena, more than the others, captures the interactive nature of teaching. The enacted curriculum is the product of teachers' interactions with students around particular tasks (Yinger 1988) and cannot be predetermined by textbook writers or teachers. In other words, the tasks that teachers select in the design arena of curriculum development are not blueprints for curriculum; they are only seeds. The paths that their growth takes are determined by teachers' responses to students' interactions with them. In the following sections, I discuss the relationship between the design and construction arenas and their impact on a third arena of curriculum development, curriculum mapping.

## **THE RELATIONSHIP BETWEEN THE DESIGN AND CONSTRUCTION ARENAS**

As the discussion so far suggests, the relationship between the design and construction arenas varied for both Catherine and Jackie. The most obvi-

ous relationship was sequential; after selecting tasks in the design arena, the teachers enacted and adapted them in the construction arena. What followed the activity in the construction arena depended on the teacher and how she read the situation.

The three courses most frequently taken by these two teachers are represented with arrows in Figure 2. The first course (represented by the arrow marked with both teachers' names) involved remaining in the construction arena during all or part of a lesson and improvising in response to students. When taking this course, both teachers focused their efforts on sustaining students' work on a particular task by asking questions, guiding students' work, and often reframing the task.

Another course taken by both teachers was to return to the design arena during or between lessons. Catherine was more likely to return to the text for new tasks, as is represented by the lower arrow, and did so multiple times in a given lesson. Jackie tended to return to the design process only in preparation for a new lesson. Furthermore, unless beginning a new topic, she tended not to return to ideas in the text in designing subsequent tasks, relying instead on information gleaned from reading her students and their activities. As a result, she read less and less of the textbook as she proceeded through a topic.

**THE CURRICULUM MAPPING ARENA**

The design and construction arenas involve the day-to-day decisions that directly impact the enacted curriculum. They exist within a third analytical realm, the curriculum mapping arena, which involves decisions that effec-

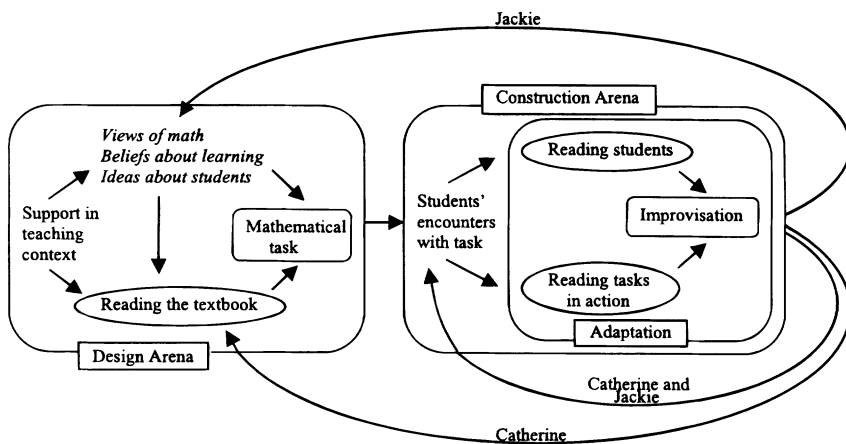


FIGURE 2. Model of the Design and Construction Arenas in Catherine's and Jackie's Teaching, Illustrating the Relationship Between Each Arena and the Influential Factors Within Each

tively define and organize the mathematics curriculum as a whole and determine the content, sequence, and timing of its topics. It is important to note that the domain of this arena is less distinct than those of the other two. In fact, curriculum mapping occurs through decisions related to task selection and enactment. The model includes this third arena because the outcome of these daily decisions constitutes an analytically distinct aspect of curriculum development. Teachers' decisions that shape their curriculum maps, whether conscious or unconscious, tend to go unnoticed because they are often byproducts of decisions about daily classroom events in the other two arenas and are made over time as teachers decide how to move through different mathematical topics. Textbooks offer a curriculum map that organizes mathematical topics into sections, each including specific concepts or skills. Teachers map the curriculum when they decide how or whether to use these structures. For example, a teacher might skip the chapter in the textbook on place value, spend twice as long on it, or combine it with another topic, as Jackie did. Teachers also map the curriculum when they elect to go through each chapter in sequence, taking one lesson each day as Catherine did, or when they abandon the text altogether and develop alternative maps.

**Components of curriculum mapping.** Analyses of the two teachers' mapping decisions suggested two categories of decisions, which I have called: (a) topic determination, and (b) content determination. Teachers' topic-determination decisions designate the broad categories or topics into which the mathematics curriculum is divided, such as multiplication, fractions, and geometry. Teachers' content-determination decisions outline the concepts or skills addressed in a given topic, the sequence in which the topics are taught, and the amount of time devoted to each. The decisions that Catherine and Jackie made during their fraction units illustrate the distinctions between these two components of the curriculum mapping arena. Both teachers included fractions as a topic in their curriculum, but for each teacher the mathematical content differed, as well as the amount of time devoted to it.

Catherine and Jackie's topics were difficult to detect. Both used the thirteen chapters that organized the contents of the textbook, which suggests that they deferred to the text in determining the topics of their mathematics curriculum. It is important to note, however, that the view of the mathematics topics that each teacher held was similar to the list of topics in the textbook.<sup>5</sup> Thus, the textbook may have reinforced their beliefs about these topics, rather than influenced them.

The teachers' content decisions, including how it was sequenced and paced, were more evident and varied than their topic decisions. These occurred during transitions from the construction arena to the design arena. It was at these points, depicted in Figure 2, that they made choices about how to proceed, both from one task to the next, and from one lesson to the next. As a set, these decisions created the structure of mathematics content within each topic.

The major difference between Jackie and Catherine's content-determination decisions lay in how they used the textbook. Catherine's decisions about the content and structure of each topic, except computation, were heavily guided by the textbook. She generally led students sequentially through the lessons in each chapter, allowing the text to establish the topic's mathematical content, sequence, and pace. She covered one textbook lesson each day, sometimes hurrying the class along in order to finish or assigning what remained as homework. She was careful not to select tasks that would demand too much time. By spring she spent more time on exploratory activities, but she still skipped other exercises in order to complete one page per day.

Jackie made content decisions independent of the guidance of the textbook. She used assessments of students and her own sense about the important mathematical ideas to guide much of her content mapping, including when and how she consulted the text. She focused on the mathematical ideas that were important to her, and established a sequence and pace that reflected students' needs, frequently spending several days on concepts the text addressed in a single lesson. When Jackie felt pulled between following the text and following students, she always followed students.

The differences in the two teachers' tendencies to follow the content map in the textbook were related to the differences in the demands and opportunities in their teaching situations. Several factors in Jackie's teaching context encouraged her to rely on her own ideas and reading of students in making content mapping decisions. First, her recent professional development activities had drawn her attention to student understanding, making it a focal concern. Moreover, she had broadened her understanding of mathematics to the degree that she felt prepared to make such decisions. Also, teaching the same group of students for three years freed her to think about the curriculum in a three-year, rather than single year, segment. Thus, she did not feel pressured to address all topics in the textbook in one year. Catherine, on the other hand, felt pressure that many teachers feel, to teach her students particular skills before the school year ended.

**Curriculum mapping and the role of the text.** I concluded each of the previous sections with a discussion of the role that the textbook played in that particular arena. The textbook's role in the curriculum mapping arena was difficult to discern for these two teachers, due to the nature of the arena and the contents of the particular text. Textbooks generally offer one possible way to categorize topics and organize their contents, sequence, and pace. Teachers decide whether to follow that plan or veer from it. Unlike the design arena, where the teachers read, interpreted, and used the same text differently, the mapping arena seemed to allow fewer degrees of possibility for interpretation. The textbook provided a starting place, an initial image of the curriculum, that teachers used or replaced. Thus, when it was involved in any part of the teacher's curriculum mapping, its involvement was generally direct, in that the pieces the teachers accepted were done so with fidelity.

This being said, the extent to which the textbook actually influenced the teachers' curriculum mapping decisions remains unclear. The close match between the curriculum map offered by the textbook and each teacher's belief could suggest that the text played a strong role in both teachers' topic choices and almost all of Catherine's content-determination decisions. Yet, considering the similarities between the views of mathematics represented in the text and those implicit in conventional practices, it is likely that the familiarity of the list of topics in the text facilitated the teachers' use of it. To develop a fuller understanding of the role textbooks might play in this arena, researchers need to examine teachers' use of curriculum materials that present less conventional curriculum maps.

### **PERSPECTIVES ON TEACHERS' CURRICULUM DEVELOPMENT**

As I mentioned previously, studying teachers' textbook use involved studying their curriculum development processes. The model presented here illuminates fundamental aspects of this process, contributing to knowledge of the relation between teaching and textbook use and highlighting areas that call for further research. From a theoretical perspective, the model offers a framework for examining teachers' curriculum-construction activities that represents the multiple dimensions of teaching and that includes teachers' interactions with textbooks and the roles their beliefs play in this process. From an empirical perspective, the detailed application of the model for two teachers reveals patterns in their curriculum processes that have implications for studies of teaching and teachers' textbook use more generally. In this section, I discuss three specific aspects of teaching mathematics and textbook use that the previous analysis of teachers' curriculum development illuminates: (a) the multiple dimensions of textbook use, (b) the unique nature of the construction arena, and (c) the role and importance of the activity of reading in shaping the enacted curriculum.

#### **Multiple Dimensions of Textbook Use**

Earlier, I discussed the ambiguity in the literature about the meaning of the construct "textbook use." Researchers have defined use differently and have focused on different aspects of practice when assessing the role the text played. Moreover, much of the research has focused on teachers' interactions with texts in isolation, rather than as part of teaching as a whole. This model of teachers' curriculum development situates teachers' textbook use within a larger, more complex context. It highlights the multiple aspects of the curriculum process that can offer breadth and depth to researchers' perspectives on teaching. As I discuss below, the three arenas add breadth to the way the activities of teaching are discussed in the literature and offer frames for looking more deeply at the details of the process.

The model contributes clarity to the literature on textbook use by delineating three arenas of the curriculum development process, offering a

broader picture of teaching. The research on teachers' uses of texts has treated teaching as one homogeneous activity, focusing on single aspects of teaching, such as topic determination, task selection, or task enactment. As a result, researchers have observed only partial images of teachers' textbook use and have conceptualized it in a variety of ways, such as following or subverting texts, as selectively incorporating text suggestions into one's teaching, or as interpreting textbook offerings in the process of using them.

The model of teachers' curriculum development presented here suggests that teaching is multidimensional. Since each dimension requires different types of decisions and support, teachers are likely to use textbooks differently in each arena. This perspective illuminates how particular conceptualizations of textbook use are more plausible in particular arenas than in others. For example, discussions about teachers following or subverting their textbooks are more germane to the mapping arena than the other two because the curriculum maps most textbooks offer tend to be less open to interpretation than the many suggested lessons and tasks. On the other hand, the nature of the design arena, particularly its focus on selecting and designing tasks within particular topics, allows for considerable teacher interpretation of a text's suggestions. Because decisions in the construction arena are often impromptu responses to students, researchers examining teachers' textbook use in this arena are likely to focus on the extent to which teachers incorporate ideas from their texts into their classroom practice. In short, the model of curriculum development illustrates that examining the role a textbook plays in a teacher's practice requires differentiating among its roles in each of these three arenas.

Moreover, by delineating the activities specific to each arena, the model helps to uncover characteristics of curriculum development that have received little attention in discussions of textbook use. Below I discuss two aspects of the process that this model helps to capture and articulate: the nature of the construction arena and the activity of reading. Both offer insights to understanding teachers' curriculum development activities and the potential for change.

### **The Nature of the Construction Arena**

The arena model of teachers' curriculum development illuminates the unique challenges of the construction arena. Although many studies have focused on how teachers use texts, few have examined textbook use with respect to the process of enacting curriculum plans in the classroom. Those that have (Donovan 1983; Remillard 1991; Stein, Grover, and Henningsen 1996; Stephens 1982) hinted at the tensions teachers confront between "using" the materials and attending to students' actions and responses in the classroom. This tension, also felt by Catherine and Jackie, has been overlooked by researchers focusing on how teachers use texts in general without attending to differences between particular aspects of teaching. By delineating characteristics unique to each arena, this model allows for the examination of variations among different aspects of teaching. In particu-



lar, it highlights the unique demands the construction arena places on teachers, emphasizing its responsive nature and its dependence on students. By capturing the improvisational nature of this arena, this model helps to explain why the text played only an indirect role during this part of both Catherine's and Jackie's teaching.

A better understanding of the construction arena and the factors that shape it are crucial for considering the role curriculum resources might play in reform. Reform documents, in addition to outlining new curricular goals, call for change in how students encounter and learn mathematics. Because the construction arena is where curriculum is actually enacted, its activity is a key target of the current reform agenda. This view of the construction arena raises questions about what determines the enacted curriculum and the text's role in it. Merely identifying topics to add to the curriculum or tasks to pose to students does not determine how teachers enact them in the classroom. Stein, Grover, and Henningsen (1996), for example, found that during the task-enactment process, teachers tended to make reform-inspired tasks less conceptually oriented and cognitively demanding. The model of the construction arena, particularly its interactive nature, brings to the fore the need for greater understanding of this aspect of the curriculum construction process.

### **The Importance of Teachers' Reading**

The model of curriculum development highlights reading as a key activity in both Catherine's and Jackie's curriculum decisions. Reading involves the active process of constructing meaning of various phenomena with an eye toward action. Thus, a teacher's role in curriculum development involves reading curriculum resources, students' performance, and events in the classroom in order to design and enact curriculum. Even though the reading process was influenced by the teachers' beliefs and contextual resources, it also influenced their beliefs and reading. In fact, it was during the interpretive and interactive process of reading that the teachers encountered new and potentially challenging ideas about teaching and learning mathematics.

Understanding the nature of the reading process is important to understanding teachers' curriculum development and curriculum reform for three related reasons. First, reading is the intellectual process most closely connected to teachers' curriculum decisions. Thus, change in the enacted curriculum must occur through change in how or what teachers read. Second, reading is a process in which teachers use their beliefs to make sense of new phenomena and events. Thus, the construct of reading as an interpretive tool illustrates how teachers' personal resources influence, without completely determining, their curriculum decisions. In this sense, the model builds on previous research that links teachers' decisions and their beliefs by illustrating how teachers' beliefs, curriculum resources, and particulars of the context interact as teachers construct curriculum. Last, because reading involves an active process of sense making, it has the

potential to foster change in teachers' beliefs. Even though the teachers' beliefs influenced what they paid attention to and their interpretations of it, the activity of making meaning of unfamiliar events also prompted them to consider new perspectives. Thus, teachers' reading should be a primary focus of efforts to change the enacted curriculum. Moreover, fostering reading also might be one route for such change to occur.

## CONCLUDING THOUGHTS

The initial question underlying this study was how curriculum materials might contribute to classroom practice associated with reform in mathematics education. The model of teachers' curriculum development presented in here offers initial insights into this question and reveals directions for further research. The model illuminates the multiple dimensions of teaching, which brings the question of teachers' use of curriculum materials to the fore. Historically, curriculum developers have focused primarily on providing activities of students by speaking through teachers. The model reveals that students' encounters with new curriculum are mediated by a variety of teachers' decisions. These decisions evolve from a complex interplay between the teachers' particular readings of the textbook and students' performances and their beliefs about mathematics teaching and learning. Curriculum developers and others seriously committed to change in mathematics curriculum and pedagogy need to attend to the teacher's role in developing curriculum. Doing so requires knowledge of the unique characteristic of the arenas of curriculum development and the factors that influence teachers' decisions in each.

## NOTES

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1. The emphasis on teacher development is based on the assumption that opportunities for teachers to unlearn old ideas and practices and learn new ones are requisite for change in teaching (Ball 1994; Cohen and Barnes 1993). This focus on teachers does not mean that curriculum development has been abandoned in current reform efforts. Indeed, the National Science Foundation as well as private funding agencies have committed significant amounts of money to new curriculum development. Moreover, commercial textbook publishers have also responded to calls for change by increasing emphasis on problem solving and conceptual understanding.

2. In her analysis of how teachers enact curriculum in story-reading lessons, Golden (1988) referred to the teachers' instructional moves and themes as "instructional texts," which she contrasted with the written texts the teachers used to guide the lesson. Instructional texts, she argued, offer the teacher's interpretation of the written text.
3. In this paper, I use the terms textbooks and curriculum materials interchangeably. Many practitioners and curriculum developers prefer to distinguish between the two, designating curriculum materials as alternatives to textbooks that have reputations of leading teachers and students lock step through pages of computational practice. I do not make this distinction because my focus is on understanding how teachers interact with these resources. Furthermore, commercial textbooks have recently undergone substantial change as publishers attempt to respond to reform pressures.
4. As per my agreement with these teachers, the names I am using for them, their schools and the district are pseudonyms.
5. Even though the commercially published text was designed to be responsive to current reform initiatives, it presented a fairly conventional image of the topics in the mathematics curriculum. Disregarding the additions of one or two topics (e.g., graphing and data) and terms like "understanding" in chapter titles, the thirteen chapters did not suggest a radically new view of the mathematics curriculum.

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