IMPLEMENTATION OF INTEGRATED MATHEMATICS TEXTBOOKS IN SECONDARY SCHOOL CLASSROOMS

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by

MELISSA D. MCNAUGHT

Dr. James E. Tarr, Dissertation Supervisor

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The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

IMPLEMENTATION OF INTEGRATED MATHEMATICS TEXTBOOKS IN SECONDARY SCHOOL CLASSROOMS

presented by Melissa D. McNaught

a candidate for the degree of Doctor of Philosophy

and hereby certify that, in their opinion, it is worth of acceptance.

Professor James E. Tarr

Professor Douglas A. Grouws

Professor Barbara J. Reys

Professor Óscar Chávez

Professor David A. Bergin

For Mom and Dad,

Everything I am, I owe to you.

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"As we express our gratitude, we must never forget that the highest appreciation is not to utter words, but to live by them."

-John F. Kennedy-

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ABSTRACT

The study reports how 44 secondary school teachers implemented the first two courses of an integrated mathematics textbook series, *Core-Plus*. Textbook implementation was examined in relation to three components: (a) regular use of textbook; (b) use of a significant portion of the textbook; and (c) consistency with pedagogical orientation (Chval et al., 2009).

Although the majority of teachers used their textbooks frequently, on average they taught less than two-thirds of the textbook content during a school year. When teaching textbook content, teachers used supplemental or alternative materials in nearly 40% of lessons. Results indicate that teachers placed varying emphases on the four content strands. In year 1, the composition of the enacted and written curricula were similar, however teachers in year 2 placed more emphasis on algebra and functions at the expense of statistics and probability and discrete mathematics. Multiple data sources revealed that teachers were generally more faithful to the content contained within the textbook than with presentation of material. Few teachers spent the recommended number of instructional days on a given lesson, and most omitted key instructional components and particular types of homework assignments prescribed by *Core-Plus* authors.

Additional interview data were collected with regard to teaching assignments. Analyses revealed that the primary criterion for the assignment of teachers to integrated courses was ultimately an expression of their desire to do so.

Implications for research and practice are discussed and recommendations for future research are offered.

CHAPTER I: THE PROBLEM AND ITS BACKGROUND

Teachers are the ultimate decision makers with regard to content taught in secondary mathematics classrooms and research has shown that they rely on textbooks to help with those decisions (Ball & Cohen, 1996; Grouws & Smith, 2000; Robitaille & Travers, 1992; Weiss, Pasley, Smith, Banilower, & Heck, 2003). Because of the vital role that textbooks play in the classroom, they have been one focus of educational reform (Li, 2007); however, their impact is mediated by the way in which the teacher chooses to use or not use them. While textbooks may be a major source of students' opportunity to learn, not all opportunities will be enacted in the same way. For example, some teachers may use the textbook as a primary source for classroom instruction and make student assignments from the textbook with very little modification. In contrast, other teachers may use the textbook as a reference adapting its content and assignments to meet their personal preferences or specified school district objectives. In all cases, use of the textbook is filtered through the teacher as it is presented to the students and thus, the extent to which the textbook is implemented is of utmost importance when examining student learning with regard to specific textbooks (National Research Council, 2004).

Although textbooks have been influential in American classrooms, they have also been highly criticized (Seeley, 2003). Based on mathematics textbook content analyses, one common criticism is that the United States curriculum is "a mile wide and an inch deep" (Schmidt, Houang, & Cogan, 2002; Schmidt, McKnight, & Raizen, 1997). The data supporting this position were collected in the early 1990s at the secondary level and

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focused only on textbooks in widespread use at that time. During this time period, however, the United States was substantially involved in a reform movement sparked in part by the previously released *A Nation at Risk*, a report that proclaimed the demise of public education: “Our society and its educational institutions seem to have lost sight of the basic purposes of schooling, and of the high expectations and disciplined effort needed to attain them” (National Commission on Excellence in Education, 1983, p. 7). This document called for reform efforts in which schools were to “demand the best effort and performance for all students, whether they are gifted or less able, affluent or disadvantaged, whether destined for college, the farm, or industry” (p. 24). *A Nation at Risk* was followed by another influential report, *The Underachieving Curriculum* (McKnight et al., 1987), which called for “a fundamental revision of the U.S. school mathematics curriculum” (p. xii) by eliminating excessive repetition of topics and a more focused organization of the content. Moreover, it recommended a re-examination of the common approach of sorting students into different curricular paths, some of which offered little intellectual challenge. These reports were followed by an investment of energy, time, and money spent on mathematics reform with the idea that educators should be focusing on “mathematics for all.”

In response to the call for reform, the National Council of Teachers of Mathematics (NCTM) published its vision of school mathematics in *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). The vision represented a consensus that “all students need to learn more, and often different, mathematics and that instruction in mathematics must be significantly revised” (p. 1). The *Standards* document challenged many beliefs held by mathematics educators.

For example, the *Standards* recommended less emphasis on teacher-directed lecture and more emphasis on active student engagement in mathematical tasks through group work, class discussions, and individual presentations, thus "shift[ing] the focus away from memorization and rote application of procedures toward standards for performance that are based on conceptual understanding and reasoning" (Goldsmith, Mark, & Kantrov, 1998, p. 9). At the high school level, the *Standards* called for mathematical study that would "revolve around a core curriculum differentiated by the depth and breadth of the treatment of topics and by the nature of applications" (NCTM, 1989, p. 125). This shift away from memorization and rote application of procedures stimulated the development of new curricular materials to help teachers promote students' conceptual understanding of mathematics. In 1991, the National Science Foundation (NSF) funded the development of curricular materials which embodied the vision set forth by the *Standards,* (Senk & Thompson, 2003) and thus, the new programs were dubbed "standards-based" materials. The NSF-funded curricular materials have often been referred to as *reform-oriented* materials because they were produced in response to calls for reform.

In 2000, the *Standards* were updated, and published as *Principles and Standards for School Mathematics* (PSSM) (National Council of Teachers of Mathematics, 2000). The revision took account of recent research (Kilpatrick, Martin, & Schifter, 2003) and addressed some criticisms of the earlier *Standards* document. PSSM placed a greater emphasis on the importance of algorithms and computational fluency than the previous document. With regard to organizing curricula, the *Standards* elaborated their previous recommendation, emphasizing integration of mathematical topics:

> Mathematics comprises different topical strands, such as algebra and geometry, but the strands are highly interconnected. The

> interconnectedness should be displayed prominently in the curriculum. A coherent curriculum effectively organizes and integrates important mathematical ideas so that students can see how the ideas build on, or connect with, other ideas thus enabling them to develop new understandings and skills. (p. 15)

The organization of standards-based textbooks "portray[s] mathematics as a unified discipline by coherently integrating topics" (Robinson, Robinson, & Maceli, 2000, p. 119). Hence, the emphasis on integration of mathematics content in both *Standards* documents has resulted in NSF-funded secondary textbooks becoming known as *integrated* textbooks as well as *standards-based* textbooks.

In response to the call to elevate topics such as statistics, probability, and discrete mathematics to a more prominent position in the curriculum, authors of standards-based textbooks included new content. As a result, "some traditional material has been discarded or coverage has been reduced, allowing for more in-depth exploration of a traditional topic or investigation of some new mathematical ideas" (Robinson, et al., 2000, p. 120). Increased attention was given to the use of technology as a tool in investigating, conjecturing, and hypothesizing based on the assumption that available technology had changed the nature of problems important to mathematics and the way that mathematicians investigated those problems (NCTM, 1989). Designed around the notion that students should be *doing* mathematics (Goldsmith et al., 1998), "a salient feature of these NSF-funded curricula at every level is their emphasis on the sense-making activity of mathematics that requires reasoning and justification as part and parcel of understanding" (Robinson et al., 2000, p. 116).

The new content, emphases, and organization of these standards-based textbooks prompted a vocal critic group to dub the new curricular materials as "the new New Math" or “fuzzy math” (Grouws & Cebulla, 2000). Arguments reminiscent of the 1960’s New Math era were reincarnated as parents became concerned that the mathematics their students needed to know, especially basic skills, might not be learned. The recommendation to reduce emphasis on memorizing and practicing procedures has been misinterpreted to mean that learning procedures are not necessary. Furthermore, there was considerable parental backlash to standards-based curricula including websites demanding a change.

Some school districts have responded to criticisms by offering parallel curricular programs that provide secondary students opportunities to learn mathematics either through a sequence of courses that reflect an integrated approach to content or through the more conventional sequence of courses: Algebra I, Geometry, and Algebra II. However, this too raises issues because one consequence of parallel-curricular pathways is that it requires making decisions about which teachers will teach which type of course. Yet, among the curriculum critics are teachers who hold profound convictions about *what* and *how* mathematics content should be taught. These convictions affect the instruction that occurs within the classroom, and subsequently, the use of the textbook adopted by the school district. Other concerns arise when teachers are asked to teach with curricular materials they are not familiar with or feel unprepared to use. Schoenfeld (2004) asserted, “If teachers feel uncomfortable with a curriculum they have not been prepared to implement, they will either shy away from it or bastardize it” (p. 257). Furthermore, the effective use of curricular materials depends on the fit between a teacher’s particular skills, knowledge, and dispositions and the textbook in use. If a particular textbook does not align with a teacher’s preparation, interests, and preferences, she may not use the textbook as it is intended to be used. Thus, the method used to assign teachers to courses is an important variable to examine when studying teachers' use of mathematics textbooks and their impact on student learning.

Statement of the Problem

Although we know textbooks are the centerpiece of mathematics instruction in U.S. schools (Grouws & Smith, 2000; Weiss, Banilower, McMahon, & Smith, 2001; Weiss et al., 2003), little is known about the relationship between implementation levels of specific standards-based textbooks and what mathematics students learn. Teachers may choose to move through the textbook sequentially or not; they may choose to cover most of the chapters of the textbook or not; they may supplement the textbook with materials from other resources or not. All of these decisions affect the extent to which standards-based textbooks are implemented and therefore influence the mathematics that students have the opportunity to learn. As part of curricular reform, new content has been added to textbooks that bring topics such as statistics, probability, and discrete mathematics to a more central position in the school mathematics curriculum. Moreover, established content such as algebra and geometry is presented in an integrated fashion than embodied in predecessors to standards-based textbooks. However, we know little about the relative emphasis teachers place on content embodied in standards-based textbooks. Furthermore, in order to understand how mathematics textbooks impact student learning one must also understand how teachers enact the textbooks in the classroom and how teachers are assigned to classrooms where integrated textbooks are in place.

Purpose of the Study

This investigation is an extension of a larger study known as the *Comparing Options in Secondary Mathematics: Investigating Curriculum* (COSMIC) project. The COSMIC project is a three-year longitudinal comparative study that addresses questions regarding the impact of two distinct organizations of secondary mathematics curricular materials on student learning. An underlying assumption of the COSMIC study is the notion that the same type of textbook used in different classrooms will be implemented in varying ways across teachers. Consequently, during the course of the COSMIC project, the extent to which the textbook is implemented in each classroom is carefully assessed and will subsequently be used in interpreting data analyses that examine student learning under each organization of content. In this extended study, the implementation of an integrated textbook is examined in relation to four content strands: (1) Algebra and Functions; (2) Geometry and Trigonometry; (3) Statistics and Probability; and (4) Discrete Mathematics. More specifically, this investigation focuses on how teachers' use of the first two textbooks of an integrated series provides students' opportunities to learn mathematics content. Attention is given to the extent to which teachers attend to the different content strands that have been included in integrated textbooks and to what patterns of textbook use exist among teachers using an integrated textbook series.

Research Questions

The research questions guiding this study are addressed at three levels: lesson level, course level, and department level. At the *lesson level*, the focus is on textbook use in relation to a common lesson. The *course level* is aimed at how teachers use their integrated textbook across the school year. At the *department level,* the focus is on the process of making decisions about which teachers are assigned to teach classes utilizing integrated textbooks. Specifically, the research questions are as follows:

Lesson Level

1. To what extent do secondary school mathematics teachers use integrated mathematics textbooks during lessons?
    a. How many instructional days are devoted to the teaching of lessons as compared to the textbook authors' recommendations for the number of class periods to be allocated to the teaching of lessons?
    b. What elements of textbook lessons are utilized during classroom instruction and what problems from textbook lessons are assigned for homework? How do these teacher decisions compare to author recommendations concerning the use of the elements?
    c. To what degree do teachers supplement the textbook content associated with lessons?

Course Level

2. To what extent do secondary school mathematics teachers provide students the opportunity to learn the *mathematics content embodied* in integrated mathematics textbooks?
    a. What opportunities are provided for students to learn the mathematics associated with the Algebra and Functions strand of integrated textbooks?
    b. What opportunities are provided for students to learn the mathematics associated with the Geometry and Trigonometry strand of integrated textbooks?

c. What opportunities are provided for students to learn the mathematics associated with the Statistics and Probability strand of integrated textbooks?
d. What opportunities are provided for students to learn the mathematics associated with the Discrete Mathematics strand of integrated textbooks?
e. Do students' opportunities to learn vary across the content strands embedded in integrated textbooks?

Department Level

3. How are secondary school mathematics teachers assigned to the courses they teach in schools that offer both a subject-specific curricular path and an integrated curricular path?
    a. How are teachers assigned to courses across curricular paths?
    b. How are teachers assigned to courses within an integrated curricular path?

Theoretical Considerations

Although textbooks play a prominent role in the teaching of mathematics in K-12 schools, prior research suggests that different teachers implement the same materials in different ways (Bowzer, 2008; Chávez, 2003; Tarr, Chávez, Reys, & Reys, 2006). Kilpatrick (2003) noted,

> Two classrooms in which the same curriculum is supposedly being "implemented" may look very different; the activities of teacher and students in each room may be quite dissimilar, with different learning opportunities available, different mathematical ideas under consideration and different outcomes achieved. (p. 473)

Thus, a difference exists between curriculum as represented in textbooks or other instructional materials and the curriculum that students experience in the classroom (Stein, Remillard, & Smith, 2007).

Figure 1 illustrates how the use of curricular materials and textbooks are only one part of a larger conceptual frame of curricular influences on student learning. Developed by

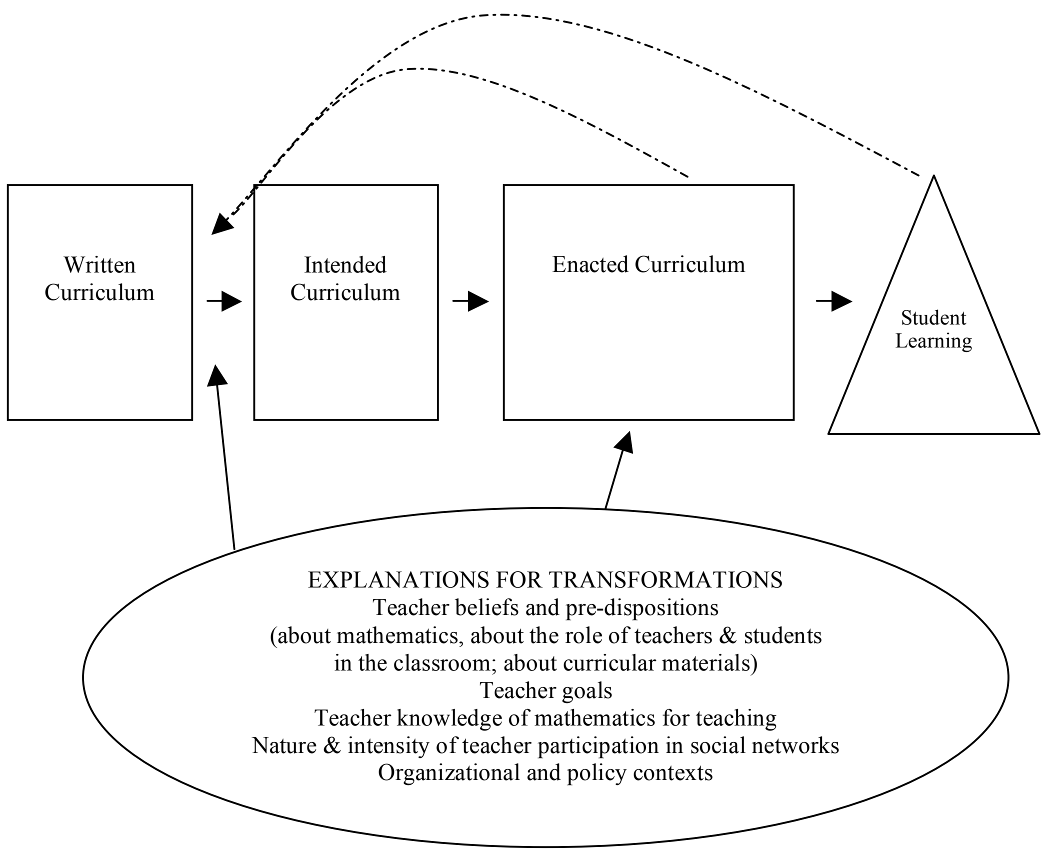


Figure 1: Temporal phases of curriculum (Stein, Remillard, & Smith, 2007, p. 322).

Stein, Remillard, and Smith (2007), this figure models curriculum as "unfolding in a series of temporal phases from the printed page (*the written curriculum),* to the teachers' plans for instruction *(the intended curriculum),* to the actual implementation of curricular-based tasks in the classroom *(the enacted curriculum)"* (p. 321). The oval represents factors that possibly influence the transition from one phase of the curriculum to another. For example, teacher beliefs and knowledge mediate the way they interpret the written curriculum and how they make decisions about what to use from the textbook and what to omit.

Within this conceptual framework, I examine the written curriculum in relation to the enacted curriculum, the process referred to by many scholars as *fidelity of implementation*. As an alternative to the concept of fidelity of implementation, Chval, Chávez, Reys, and Tarr (2009) introduced the construct they refer to as *textbook integrity,* which they define as follows:

> the extent to which the district-adopted textbook serves as a teacher's primary guide in determining the content, pedagogy and the nature of student activity over an identified period of time. We identified three essential components of textbook integrity: (a) regular use of the textbook by the teacher and students over the instructional period (in our case, the school year); (b) use of a significant portion of the textbook to determine content emphasis and instructional design over the school year; and (c) utilization of instructional strategies consistent with the pedagogical orientation of the textbook. (p. 72)

For a variety of reasons, the use of either *fidelity of implementation* or *textbook integrity* can be problematic. For example, the terms *fidelity* or *integrity* can be considered value-laden and thus may inadvertently imply the position that a textbook should be used exactly as written. However, there may be circumstances where it is prudent for a teacher to deviate from the content included in the textbook. For example, it could be that a teacher is aware that students have a deep knowledge of some particular mathematical topic, so it is appropriate to spend less instructional time on it. On the other hand, components from the textbook integrity framework are useful when characterizing textbook use within a classroom. For the purpose of this study, I refer to the relationship among these three components as describing *textbook implementation* rather than *fidelity of implementation* or *textbook integrity* (Figure 2).

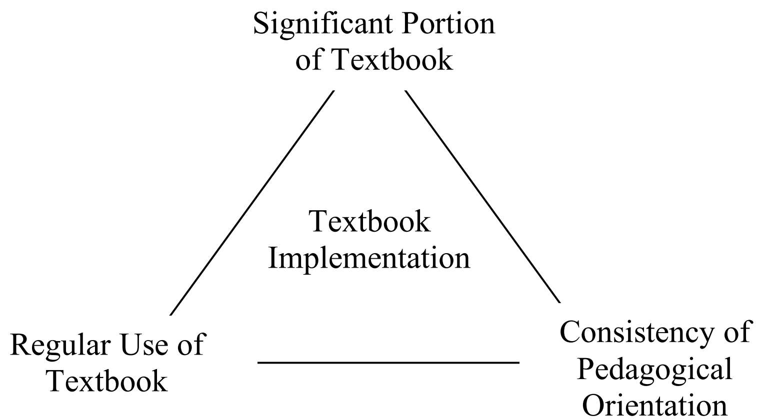


Figure 2: Components of textbook implementation (adapted from Chval et al., 2009).

These three essential components provide the foundation for the research design of this study. The *regular use of the textbook* facet considers the regularity to which the textbook is used. The *use of a significant portion of the textbook* facet provides information regarding textbook coverage and the extent to which the content is supplemented or altered for each lesson. Finally, the *consistency with pedagogical orientation* facet considers how textbook lessons are presented to students and the way students are expected to engage with the textbook material during the mathematics class period. Because of the emphasis on active student engagement in mathematical tasks, this particular aspect of implementation is particularly important when studying the use of standards-based textbooks.

Definition of Terms

It is often the case that researchers use common terms but invoke different interpretations of their definitions during discussions. This study was designed using the following specific interpretations of commonly used terms.

Standards-based Textbook

The term *standards-based textbook* refers to a textbook that is "closely aligned with the philosophy and recommendations described in the three *Standards* documents published by the National Council of Teachers of Mathematics" (Bay, Reys, & Reys, 1999, p. 504).

Subject-specific Textbook

The term *subject-specific textbook* refers to a publisher-developed secondary mathematics textbook that organizes content primarily around a single mathematical strand, e.g., Algebra I, Geometry, or Algebra II.

Integrated Textbook

The term integrated textbook as used in this study, mirrors the description by Beal et al. (1990):

> An integrated mathematics program is a holistic mathematics curriculum [textbook] that–
>
> - consists of topics from a wide variety of mathematical fields and blends those topics to emphasize the connections and unity among those fields;
> - emphasizes the relationships among topics within mathematics as well as between mathematics and other disciplines;
> - each year, includes those topics at levels appropriate to students' abilities;
> - is problem centered and application based;
> - emphasizes problem solving and mathematical reasoning;
> - provides multiple contexts for students to learn mathematics concepts;
> - provides continual reinforcement of concepts through successively expanding treatment of those concepts;
> - makes appropriate use of technology. (p. 4)

The textbook series *Contemporary Mathematics in Context* (Coxford et al., 1998a) developed by the *Core-Plus Mathematics Project* represents the integrated mathematics textbook in this study because of its market share; it is the most popular textbook series in use among integrated textbook series (Weiss et al., 2003).

Lesson

The term *lesson* has a somewhat unique meaning in this study. In the *Core-Plus* program, each course consists of several *units,* with each unit including several *lessons,* and each lesson including several *investigations*. Therefore, the term *lesson* refers to a specific component of the integrated textbook as opposed to an instructional time period Because of the design of the *Core-*Plus program, a lesson typically spans several instructional days.

Supplemental and Alternative Materials

Teachers have a wealth of curricular resources from which to draw when teaching mathematics content. However, depending on the function they perform, these materials may *add to* or *substitute for* content contained within the district-adopted textbook. For the purpose of this study, materials are considered *supplemental* when they are used in conjunction with the textbook. For example, a teacher may use the textbook to teach particular content but decide to look for supplemental materials when they perceive students need additional practice beyond what is offered in their textbook. Another teacher might teach a portion of the textbook lesson and then develop her own worksheet to finish the lesson. In both cases, supplemental materials have been used in conjunction with the textbook. Conversely, materials are considered *alternative* when they are used as a substitute for the textbook. For example, a teacher may decide to teach a particular topic exclusively without using the district-adopted textbook. In this case, because the textbook was not used to teach the particular content, alternative materials were a substitute source of lesson content.

Limitations

The multilayered nature of education poses great complexities for researchers and thus compromises during the research process are inevitable. Naturally, limited resources and limited time present difficulties within the design of any study. Specific to this study, limitations stem from two sources: (1) the inherent shortcomings of data collection instruments and (2) the sample being limited to those secondary schools offering dual curricular options.

Several methods of data collection are employed in this study. When examined individually, each method inherently contains some limitations. For example, regarding the documents teachers are requested to complete, it is difficult to know whether the self-reported data accurately reflect the extent to which teachers are making use of their textbook and thus, self-reported data must always be interpreted with some degree of caution (Porter, 2002). Furthermore, when conducting researcher-subject interviews, the possibility exists that the subject experiences some error in recall or perhaps the subject reacts in some manner to the researcher and subsequently shares self-serving responses. The focus of classroom observations is limited to external behaviors and the possibility exists that those being observed behave in an atypical manner in the presence of the observer. Notwithstanding these flaws, considering the design of this study as a whole, the use of multiple methods provides various perspectives, and therefore, strengthens the overall study.

The second limitation stems from teacher participants being contained within schools where a dual curricular option program is in place (an integrated approach and subject-specific approach) and the *Core-Plus* program, *Contemporary Mathematics in Context* (Coxford et al., 1998a) adopted as the integrated approach to be investigated in this study. Although this particular group of participants is worthy of study, the generalizability of results must take this limitation into account.

Significance of the Study

Research has established that teachers rely heavily on curricular materials when making decisions regarding what content to teach. Furthermore, school districts can select from a large number of textbooks that differ in substantive ways from one another. Studies of how mathematics textbooks are used are needed in order for school personnel, curriculum developers, and policy makers to make informed decisions regarding curriculum. Moreover, student achievement in secondary school mathematics is significantly influenced by the manner in which a textbook is used, the mathematics content students are given the opportunity to learn, and the manner in which the mathematical learning is facilitated; however, our knowledge of the effects of different approaches to mathematical content in textbooks is limited. The construct of *opportunity to learn* has been examined extensively in relation to international tests while examining OTL for purposes that coincide with implementation fidelity have been seemingly ignored in K-12 curriculum intervention research (O'Donnell, 2008). Consequently, it is impossible to judge effectiveness of textbooks and draw inferences regarding student learning without knowledge about how those textbooks are being used (National Research Council, 2004). In light of new curricular materials being developed and used in classrooms, research results garnered from examining the degree the textbook is being implemented and the quality of its delivery have the potential to inform curriculum developers of ways to improve their programs (O'Donnell, 2008).

Summary

Research has shown that textbooks play an important role in determining the students' opportunity to learn mathematics. It is therefore important to know in detail how textbooks are being used with regard to specific mathematical content strands, namely Algebra and Functions, Geometry and Trigonometry, Statistics and Probability, and Discrete Mathematics. The following chapters further describe the details and results of this study. Chapter 2 outlines the development and the structure of the *Core-Plus* curricular program; this is followed by a review of literature related to written curriculum and its implementation. Chapter 3 describes the research methodology utilized in this study and the methods used for data collection and analysis. The results of the study are reported in chapter 4. Finally, chapter 5 discusses key findings from the study and delineates important implications, describes the limitations of the study, and outlines recommendations for future research.

CHAPTER II: REVIEW OF RELATED LITERATURE

One purpose of this study is to gain insight into the extent to which enacted mathematical content and instructional activity is attributable to the content embodied in standards-based textbooks, specifically *Core-Plus,* and to its pedagogical approach. In research, we must recognize that classrooms involve complex dynamic systems, and as part of this complexity, textbooks are only one factor influencing student learning. Teaching also plays a major role in shaping students' learning opportunities (Hiebert & Grouws, 2007). The way in which a teacher emphasizes different learning goals and topics contained within the textbook and the time they allocate for particular topics are all components of teaching and heavily influence *what* students learn and *how* they learn it. Teachers implement curricular materials with a great deal of variation. Therefore, it is important to keep in perspective what previous research has illuminated as possible issues and barriers associated with enacting standards-based curricula in the classroom. With these complexities in mind, this chapter provides insight into three issues. The first section provides an overview of the structure and the development of the *Core-Plus* curricular program via a contrast with more conventional mathematics textbooks. The second section reviews relevant research regarding the constructs of *implementation fidelity* and *opportunity to learn,* which inform the textbook integrity framework that provides the foundation for this study. The final section addresses the research on the assignment of teachers to the particular courses they teach.

Textbook Development

Although a teacher may have several to choose from, until recently most mathematics textbooks looked alike (Reys, Reys, & Chávez, 2004). Prior to the development of standards-based curricular materials, most mathematics textbooks commercially available were publisher-developed. That is, "their development was initiated and funded by the publisher with the help of staff editors and an invited set of authors" (Reys & Reys, 2006, p. 378). Reys and Reys (2006) assert that in reality, the invited authors typically play a minimal role in the actual writing of the textbook. In some cases, they serve in an advisory capacity helping to map out the table of contents for the series or provide a few sample lessons plans that are used as a prototype for the remaining lessons in the book so that in-house consultants can produce the textbooks quickly. Consequently, the invited authors maintain little long-term commitment to the materials.

Because developing and publishing a textbook is a costly process, publishers minimize the financial risks by tailoring their product to expected market preferences (Keith, 1991). Since no common set of state mathematics standards exists, publishers complete analyses of state standards to ensure that the content teachers are being held accountable for has been included in the textbook (Seeley, 2003). This produces textbooks that are repetitive and lengthy resulting in the characterization of "a mile wide and an inch deep" (Schmidt, McKnight, & Raizen, 1997) due to their shallow treatment of topics.

With regard to layout of lessons in secondary school textbooks, particular components of the textbooks may have different names but the structure among them is strikingly similar since they follow a pattern common to most American textbooks published in past decades. Lessons in commonly used publisher-developed secondary school mathematics textbooks are usually divided into sections containing the amount of material that can be taught in a class period (usually 45-60 minutes). Each section states the learning objective of the day followed by key concepts or definitions highlighted for emphasis. The pages are largely filled with worked out examples, with little narrative between them, followed by numerous exercises for the students to complete. This description is consistent to those conducted by others who have done similar examinations recently (e.g., Chávez, personal communication.)

During the development process, textbooks are generally not piloted in classrooms before being sold (Tyson-Bernstein, 1988). Once a publisher-developed textbook has been adopted, publishers generally do not systematically gather evidence about student learning in reference to those particular materials (Reys & Reys, 2006). Furthermore, new editions are frequently revised primarily to be kept up-to-date but the new edition is often merely a cosmetically altered version of the older edition with minimal changes to content and instructional design (Tyson-Bernstein & Woodward, 1991).

In contrast to publisher-developed textbooks, the NSF-funded *Core-Plus* curricular program was developed by a curriculum development team comprised of mathematics educators and teachers knowledgeable about research on learning and teaching, the field of mathematics, and the public schools. This team developed the materials using a cycle of curricular material design, development, field-testing, evaluation, and revision (Fey & Hirsch, 2007). As a result, this curricular program offers "an approach to mathematics teaching and learning that is qualitatively different from conventional practice in content, priorities, organization, and approaches" (Hirsch, 2007, p. 1). Thus, the authors considered professional development for teachers as part of their responsibility when developing the program and deemed it necessary for the program's effective implementation.

In accordance with the *Standards* (NCTM, 1989, 2000), the *Core-Plus Mathematics Project* (CPMP) was developed as a curricular program for all students. According to the authors, the curricular program was designed around the belief that "the essence of mathematics is its concepts and reasoning methods for making sense of observations and experiences in the real world" (Fey & Hirsch, 2007, p. 130). Moreover, CPMP addresses the *Standards* call for increased attention to contextual problems and the utilization of technology to enhance conceptual understanding. The first three courses of *Core-Plus* are intended for both college- and employment-bound students. They were written from a *zero-based* perspective meaning the authors designed each course by answering the question, "If this is the last mathematics students will have the opportunity to learn, is the most important mathematics included?" (Schoen & Hirsch, 2003, p. 312). Course 4 includes content designed to prepare students to be successful in college mathematics.

Mathematical Content and Processes of Core-Plus

The mathematical content contained in each course is unified around four strands of mathematics: Algebra and Functions, Geometry and Trigonometry, Statistics and Probability, and Discrete Mathematics. Each unit of a course is developed by integrating these four mathematical strands in three main ways. First, the strands are integrated through common topics such as functions, data analysis and curve fitting. Next, themes concerning change, shape, and representation are woven through the strands. Finally, the units emphasize mathematical processes by including activities embedded within problem situations in order to increase student understanding and learning with the idea that "exploration and experimentation precede and complement theory" (Schoen & Hirsch, 2003, p. 314). True understanding of the abstract theory, the authors maintain, can be more easily accessed after investigation and application of problem situations. Through this exploration and experimentation students not only learn specific facts and procedures but also develop mathematical habits of mind (Cuoco, Goldenberg, & Mark, 1996) such as visualizing, identifying and explaining patterns, justifying and proving, and optimizing. The idea behind this integration is to provide a balanced approach to both content and processes. Lastly, the use of technology allows for focus on multiple representations to promote mathematical understanding without becoming bogged down by manipulations.

Structure of Core-Plus Courses

In the *Core-Plus* program, each course is designed to encompass one academic year of school mathematics. Each course consists of seven *units*. Each unit is comprised of four to five 1-2 week *lessons* in which major ideas are developed through *investigations* of contextualized problems. Each course concludes with one culminating *Capstone* activity that is designed to help students pull together and apply the concepts and methods developed throughout the course.

Each multi-day *lesson* contains a four-phase instructional cycle of in-class classroom activities as well as out of class activities. The sequential components of the in-class activities are *Launch*, *Explore*, *Share and Summarize*, and *Apply*. At the end of each lesson are out-of-class exercises, known as MOREs (Modeling, Organizing, Reflecting, Extending), tasks that complement and extend the learning from the lesson. The structure of *Core-Plus* lessons necessitates examination of teachers' implementation of each of the four lesson components.

Launch. The purpose of the *Launch* component is to provide a context for the *investigations* that follow in the Explore portion of the lesson (Coxford et al., 1998b). After reading an opening scenario, students participate in an activity entitled *Think About This Situation* intended to be used in a whole class discussion format. This activity is designed to generate student interest and set the stage for the lesson. It also serves as a tool for teachers to informally assess student knowledge prior to the start of the lesson

Explore. The purpose of the *Explore* component is for students to investigate the mathematics in the lesson in small groups (Coxford et al., 1998b). This is an opportunity for the students to work together to engage in mathematical processes such as gathering data, looking for patterns, constructing models and meanings, and making and verifying conjectures. During this time, the teacher becomes a facilitator by circulating from group to group providing guidance, encouragement, and support; clarifying or asking questions; giving hints; or drawing group members into discussion to help groups work more collaboratively.

Share and Summarize. The purpose of the *Share and Summarize* component is to bring the whole class together to provide an opportunity to share student thinking across small groups and to discuss the mathematics learned from the Investigation (Coxford et al., 1998b). A *Checkpoint* is included in the *Share and Summarize* to help guide class discussion.

Apply. The purpose of the *Apply* component is to reinforce student learning through individual practice. This component contains the *On Your Own*, a series of questions intended to be used by teachers *during class* to assess students' level of understanding. In addition to the classroom activities, the *Core-Plus* textbook provides MORE (Modeling, Organizing, Reflecting, Extending) problems that are intended to be *out-of-class exercises* to help students reinforce and extend the knowledge they acquired during the lesson. Table 1 describes the types of tasks included in this set of exercises.

Table 1

Description of MORE problems in Core-Plus textbooks

Type	Description
Modeling	Modeling tasks are related to, or provide new contexts to which students can apply the ideas and methods that they have developed in the lesson.
Organizing	Organizing tasks offer opportunities for integrating the formal mathematics underlying the mathematical models developed in the lesson and for making connections with other strands.
Reflecting	Reflecting tasks encourage thinking about thinking itself, about mathematical meanings, about processes, and promote self-monitoring and evaluation of understanding.
Extending	Extending tasks permit further, deeper, or more formal study of the topics under investigation.

Core-Plus Curriculum Evaluation

As part of its curriculum development evaluation cycle, the *Core-Plus* textbook authors conducted small-scale local trials of pilot versions of each course in 19 Michigan high schools. The pilot test data guided further development of the textbooks. After one year of pilot testing, the textbooks were refined and the revised materials were then nationally field-tested in 11 states the following year. During the field-testing, teachers were asked to provide detailed feedback to the authors that shed light not only on the strengths and weaknesses of the design of the materials but also on their feasibility for use within the classroom. Throughout this process, teachers shared their challenges and problems as they implemented the textbooks underscoring the need for professional development to help teachers as they try to implement materials that support student-centered rather than teacher-directed instruction (Fey & Hirsch, 2007). Ultimately, the field tests guided revisions of the materials until their publication and provided evidence of the program's impact on student learning (Schoen & Hirsch, 2003).

Summary

Throughout the structure of the curricular program and the integration of mathematical strands, the *Core-Plus* authors built upon the theme of "mathematics as sense-making" (Coxford et al., 1998b, p. 1). This program was thus designed with the hope that its enactment in the classroom would help proliferate the vision of high school mathematics portrayed in the NCTM *Standards.* The design incorporates a student-centered instructional model making this curricular program radically different from that previously seen in publisher-developed textbooks. Furthermore, the financial backing from National Science Foundation allowed the authors more freedom to field-test and refine their product than is possible in the traditional market-driven textbook publishing industry. However, in order to understand how these curricular materials impact teaching and learning, one must also understand how teachers enact the materials in the classroom.

Textbook Implementation

The *textbook implementation* framework guiding this study is composed of three essential components derived from Chval's et al. (2009) characterization of *textbook integrity*: (1) regular use of the textbook by teachers and students over the instructional period; (2) use of a significant portion of the textbook to determine content emphasis and instructional design over the school year; and (3) utilization of instructional strategies consistent with the pedagogical orientation of the textbook. Although these three components together provide the structure of the framework, other researchers have studied these components individually and under alternative names such as *content coverage, opportunity to learn,* or *implementation fidelity*. The following discussion is designed to provide readers with an overview of the existing literature related to the three components of textbook integrity albeit researched under different labels. For organizational purposes, the three components are examined individually with the realization that all three components are necessary for describing textbook implementation.

Regular Use of the Textbook

Historically, textbooks have played a key role in mathematics instruction (Bagley, 1931; Grouws & Cebulla, 2000; Robitaille & Travers, 1992). Tyson and Woodward (1989) purported, based on evidence from numerous studies, that textbooks structure 70 to 90 percent of classroom instruction. More recently, in a national survey of K-12 mathematics and science teachers, Weiss et al. (2001) found that reliance on a commercially produced textbook was highest at the 9-12 grade levels. Furthermore, 66% of the 9-12 mathematics classes surveyed reported that they cover 75% percent or more of their textbook. Grouws, Smith, and Sztajn (2004) corroborated this information as part of their examination of NAEP teacher questionnaires. They reported that more than two-thirds of students at both Grades 4 and 8 have teachers who stated that students did mathematics problems from their textbooks on a daily basis. Studies indicate that teachers' use of their textbook is prevalent internationally as well as nationally. Mullis et al. (2000) reported in *Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade* that, "according to 55 to 59 percent of the students, discussing homework and working independently on worksheets or textbooks were also frequent activities in class" (p. 200).

As part of their examination of 39 middle school teachers' use of textbooks, Tarr, Chávez, Reys, and Reys (2006) surveyed teachers and asked them to estimate how frequently the textbook would be used in planning and implementing mathematics instruction. Over one-half (51%) of the teachers reported that the textbook would be used in 90% or more of the instructional days. Almost 90% estimated that they would use their textbook at least three-fourths of the time. Tarr et al. followed up the teacher surveys by asking teachers to complete a Textbook Use Diary documenting their use of the textbook during a specified mathematics chapter. These diaries revealed that 39% of the teachers used the textbook for 90% of the documented instructional days and over 70% of the teachers used their textbook at least 3 out of every 4 days.

These investigations support the notion that textbooks are used frequently, however, the majority of these studies have focused exclusively on subject-specific textbooks; studies regarding teachers' specific use of standards-based materials are limited. In a pivotal study at the middle grades level, Tarr et al. (2006) examined teachers' use of both traditional and standards-based materials. By using their Textbook Use Diary design, my study provides additional information, and more specific, regarding teachers' use of standards-based textbook materials at the secondary school level.

Use of a Significant Portion of the Textbook

With this particular component, the focus shifts from *how often* a textbook is used to *how much* of it is used over the course of a school year. How much of the textbook is used is examined through an adaptation of the *opportunity to learn* (OTL) construct. In general, the conception of OTL revolves around the notion that students have been afforded a chance to learn, or at least study, a particular topic. Although researchers agree that this construct does have an impact on student achievement, they disagree on precisely how OTL should be conceptualized and measured. This construct gained popularity when it was used during the First International Mathematics Study (FIMS) to examine the relationship of curricular and instructional factors to mathematics achievement on international tests. "One of the factors that may influence scores on an achievement examination is whether or not the students have had an opportunity to study a particular topic or learn how to solve a particular type of problem presented by the test" (Husen, 1967, p. 162).

In the FIMS study, OTL was measured through teacher questionnaires, which asked teachers to indicate how appropriate they felt the test items were for their particular students. Three options were given for the teachers to rank each test item: (1) All or more (at least 75 percent) of this group of students have had an opportunity to learn this type of problem; (2) Some (25-75 percent) of this group of students have had an opportunity to learn this type of problem; and (3) Few or none (under 25 percent) of this group of students have had an opportunity to learn this type of problem. Responses were then used to create an OTL scale score for each item. Ultimately, this approach to OTL was based on teachers' perceptions and subsequent criticisms focused on the vagueness of the question posed. Floden (2002) reported the use of the phrase "this type of problem" created issues in that "teachers might be interpreting the question as asking whether they expected students to be able *to get the problem right*, rather than whether they had *worked on* the corresponding topics" (p. 240). These OTL questions posed to teachers were slightly modified for the Second International Mathematics Study (SIMS) and the Third International Mathematics and Science Study (TIMSS) to make the intent of the question more clear but the focus remained on whether a student had been exposed to particular mathematical content.

In the decades that have followed the First International Mathematics Study, OTL gained prominence beyond that of international comparative studies. Throughout these studies, OTL has been interpreted and measured in various ways. In some cases, researchers consider OTL in terms of how much emphasis a topic is given within written materials while others consider OTL as the time devoted to a topic during instruction (Törnroos, 2005).

Törnroos' (2005) examination of nine Finnish textbooks provides one example of considering OTL in relation to written materials. In his study, he compared three different methods for gathering data on OTL and reported the correlations between the OTL data and student achievement. The first approach measured OTL as the proportion of the textbook dedicated to different topics. In other words, each topic received a value between 0 and 1 that indicated the proportion of the textbook the topic accounted for. This method is similar to the one used in the textbook analysis conducted in connection with TIMSS (Schmidt, McKnight, Valverde, Houang, & Wiley, 1997). The second approach to OTL used the data drawn from the TIMSS teacher questionnaires. These questionnaires asked teachers to choose from among five options to indicate whether and how they had taught a particular topic. The options were: (1) *taught before this year*; (2) *taught 1-5 periods this year*; (3) *taught more than 5 periods this year*; (4) *not yet taught*; and (5) *I don't know*. During the data analysis, these categories were collapsed into *taught this year* and *not taught this year* after results revealed there were no significant differences between options 2 and 3. Ultimately, the proportion of teachers in the category *taught this year* was used as an estimate of the opportunities to learn offered by the textbook that the teachers had been using in instruction. The last approach to OTL involved examining the textbooks in relation to the 162 mathematics items included in the TIMSS 1999 assessment. Each test item was assigned one of these codes: 0, 1 or 2. A code of 0 meant that there was inadequate material contained in the textbook for students to answer the item correctly while a code of 1 meant that some information was included that a student could apply to answer the item but problems similar to the item were not found. A code of 2 meant that the textbook contained adequate information for the student to answer the item correctly and problems similar to the item were included in the textbook. Moreover, two approaches were also used to examine achievement scores. The first analysis was based on average percentage scores of correct answers and the second analyses used standardized scores that took into account the relative difficulty of the items.

The results of the various correlations between the OTL measures and student achievement differed according to the textbook under consideration. For example, for one grade 7 textbook, there was a statistically significant correlation between the teacher questionnaire approach to OTL and both approaches for analyzing achievement measures. In contrast, for a different grade 7 textbook, there were no statistically significant correlations between OTL and achievement. These analyses were followed by examining the results of the seventh-grade books combined with the results on the Grades 5-6 textbooks. Using only the item-based textbook approach to OTL (third approach), researchers created one aggregate variable for one grade 7 textbook that took into account the grades 5-6 textbooks and another aggregate variable consisting of all the analyzed textbooks. These two aggregates revealed relatively high correlations when compared to student achievement, r = 0.42 and r = 0.36 respectively.

With these results, the author concluded that examinations between OTL and student achievement must be based on a period longer than one year. Furthermore, Törnroos asserted that textbooks seemed to work well as estimated measures of OTL but that it mattered in what way the estimations were made. The first approach based on proportions did not reveal any correlations, however the item-based analyses of the same textbooks yielded relatively high correlations. As this study revealed, different measures of OTL yield different results.

Tarr et al. (2006) considered the emphasis given to various content strands when examining students' OTL by conducting analyses of the set of lessons contained in the respective textbooks in relation to middle school teachers' use of textbooks. These analyses revealed notable differences between the composition of the standards-based curricular materials and the publisher-developed materials with regard to the relative emphasis placed on four content strands: (a) Number and Operation, (b) Geometry and Measurement, (c) Algebra, and (d) Data Analysis and Probability. Although the portion devoted to Algebra was similar across textbook types, the standards-based materials focused less on Number and Operation while placing more emphasis on Geometry and Measurement and Data Analysis and Probability.

Tarr et al. found that both groups of teachers taught approximately 60-70% of the textbook lessons and described this use of the content by calculating an *emphasis index* for each teacher for each strand. This *emphasis index* was computed by dividing the number of lessons in Number and Operations taught by a teacher divided by the number of lessons within the textbook. An index greater than 1 indicated more emphasis was placed on a content strand than would be expected given the composition of the textbook while an index less than 1 indicated less emphasis than would be expected. When considering these lessons by content strand, teachers from both groups emphasized Number and Operation and Algebra significantly more than Geometry and Measurement and Data Analysis and Probability. Thus, the distribution of enacted material differed significantly from the distribution of content within the written material.

Other conceptions of OTL expand the construct beyond the boundaries of the classroom by recognizing that learning opportunities can occur both inside and outside of the classroom. However, according to Törnroos (2005), in the discipline of mathematics, most conceptual learning occurs in the classroom.

> Mathematics seems to be a very suitable school subject for use in studies of the effects of opportunities to learn, because learning mathematics can be considered a very "academic" process. That is, after the most basic mathematics skills have been acquired, it can be assumed that much of mathematics learning takes place at school (e.g. OECD, 2003). In their everyday life students do often meet objects related to mathematics (e.g. graphs in newspapers and geometrical shapes), but the mathematical ideas underlying these objects are often learned in the classroom (e.g., equations and areas of polygons). (p. 317)

Thus, OTL in mathematics can reasonably be considered within the boundaries of the classroom.

Other researchers have conceptualized OTL as multidimensional. Brewer and Stacz (1996) described OTL in terms of three subcomponents: (1) curriculum content; (2) instructional strategies; and (3) instructional resources. In essence, these three components capture a more expansive view of OTL by considering various aspects of the classroom environment such as coverage of topics to which students have been exposed, the way in which the teachers convey the materials to their students (e.g., questioning strategies, classroom organization, allocation of time within a class period) and noting other books and supplies (e.g., equipment, calculators) that might have been used. In contrast to this magnanimous view, the National Research Council (2004) purveys a more limited view of OTL, equating it with content coverage and considering it as one component of implementation fidelity.

Regardless of the exact phrasing used, conceptions created or methods of measurement, researchers agree that it is important to document the mathematics students are afforded opportunities to learn and to describe what mathematics instruction looks like in the classroom. Nonetheless, educational research is still in need of better conceptual models to resolve the ambiguities associated with OTL and how it is measured. This study offers an example of how OTL can be measured with respect to a specific written curriculum and particular content strands that can be subsequently used in analyses of student learning.

Examining Consistency with Pedagogical Orientation

Although a teacher may choose to use a textbook regularly and cover a significant amount of content contained within the textbook, no guarantee exists that the textbook will be used in the manner in which it was intended by its authors. Thus, another important component of textbook implementation is the examination of *how* teachers use the textbook during mathematics instruction.

Arbaugh, Lannin, Jones, and Park-Rogers (2006) examined how the instructional practices of 26 grades 8-12 teachers implementing the *Core-Plus* program differed. They methodology they used included one classroom observation per teacher and teacher interviews. The researchers' intent was not to examine the association between instructional practices and student learning outcomes, but rather to understand the instructional practices of teachers implementing this particular program. Furthermore, the authors purported that teacher beliefs serve as a mitigating factor when implementing curricular materials, and consequently, should be considered when examining differences among instructional practices. Their findings indicated that some teachers "took over the thinking" for the students and provided them with step-by-step instructions on how to solve the challenging problems contained in the standards-based textbook. The teachers served the role of mathematical authority and often adapted the textbook problems in a way that decreased the level of cognitive demand (Stein, Smith, Henningsen, & Silver, 2000) required to complete the problem as written. According to Arbaugh et al., these teachers focused on the correctness of answers and did not discuss the underlying mathematical concepts. They expressed doubt that their students could learn from a problems-based textbook such as *Core-Plus* claiming that it depended upon the type of student using the text. Furthermore, these teachers perceived themselves as poor in facilitating student discourse and small group interactions. In contrast, those teachers who allowed students to find their own solutions and encouraged students to investigate mathematical relationships expressed confidence that their students could learn from curricular materials of this type. They were less likely to lower the cognitive demand required for tasks. They also believed that they could learn to use the textbook as intended by the authors and that students would ultimately benefit from learning mathematics using the *Core-Plus* textbook.

The Arbaugh, Lannin, Jones, and Park-Rogers study revealed how the beliefs the teacher held about their students and their own level of self-confidence could impact how curricular materials are used and their perception of their ability to use it. Furthermore, the study provided insight into how teachers use textbook tasks during instruction supporting the need for examining not only *what* content is used but also *how* it is used.

In a larger study, Manouchehri and Goodman (1998) conducted ethnographic research to investigate other variables that seemed to enhance or impede middle school teachers' use of materials, the obstacles teachers faced when they attempted to implement new curricular materials and alternative teaching strategies and the strategies teachers used to deal with prevailing challenges. The researchers monitored the implementation of middle-level standards-based materials of 66 middle school teachers over two years. The participants of this study varied greatly in terms of professional development experiences and ranged in teaching experience from 2 to 26 years. On the basis of the eight observations of classroom instruction per teacher during a 6-month period and personal interviews, the researchers asserted that the teachers' knowledge of the content and their familiarity with the innovative pedagogical practices appeared to have a strong influence on how the teachers perceived and used the materials. More specifically, the more experience that the teachers had teaching with traditional approaches, the more they questioned the value of the mathematics contained within the standards-based program. In addition, the beginning teachers who had experienced these types of materials in their pre-service program displayed the most enthusiasm toward the programs but expressed concerns regarding their own adequacy in facilitating investigations and classroom discourse. Ultimately, only 20 of the 66 teachers reported using the materials routinely in their classes after the first five months of the project. Teachers reported barriers to implementation such as parents' resistance to change, lack of knowledge about the long-range content goals of the programs, lack of understanding of how to deal with students' thinking and misconceptions, balancing skill development with conceptual understanding, changing the classroom culture, and lack of adequate time for planning and instruction.

These barriers not only create uncomfortable situations for teachers but also teachers may find themselves in unfamiliar territory when considering their new role in the presence of innovative materials. The focus on small-group work and student exploration of mathematical concepts requested of teachers in standards-based materials is often beyond their own experiences as both a student and a teacher. This, in turn, can affect their sense of *self-efficacy*, which can impact the way in which they respond to the materials. Simply put, teacher efficacy is a teacher's belief that s/he can have a positive influence on student learning. Smith (1996) asserted that maintaining teacher efficacy during reform is difficult, and thus, limiting to the impact of the reform movement. Smith purported that teachers build their sense of efficacy on a "teaching by telling" philosophy. This philosophy helps teachers feel comfort through a neatly laid lesson plan maintaining a manageable knowledge base that they have studied extensively, and allows them to control the learning environment. Thus, teachers are the primary agents in student learning which increases teaching efficacy. In contrast to this, implementing standards-based textbooks has the potential to threaten this efficacy by broadening the knowledge bank in which the teachers must be familiar, opening the possibility of not knowing all the content, and removing the structure that teaching by telling can provide. Consequently, when teachers feel their sense of efficacy being threatened, they tend to retreat to more familiar, comfortable methods in order to preserve their efficacy.

Self-efficacy aside, teachers' ideas about mathematics and how it is learned as well as their views about teaching also affect how they interact with curricular material. Collopy (2003) investigated two veteran elementary teachers' use of and learning while piloting *Investigations in Number, Data, and Space* (Technical Education Research Center, 1995). Both teachers taught in schools with large populations of at-risk students and described their students as below average. Before the school year, the teachers attended the same two-day workshop regarding the *Investigations* materials facilitated by other elementary teachers in the district. Throughout the school year the teachers did not participate in outside professional development nor receive guidance or feedback on their use of the curricular materials. However, the *Investigations* program provided teacher support by including items in the teacher materials such as summaries of the mathematical content in each unit, detailed descriptions of the activities for students, and suggestions for questions to ask students.

Both teachers reported that expectations related to state mandated testing programs drove them to supplement with mathematical content not included in the *Investigations* curricular materials and both teachers reported that they read all the sections containing the content for teachers. Beyond these similarities, their implementation styles varied. The teacher who taught 26 years was confident of her mathematics knowledge and her ability to teach mathematics. She believed that the essentials of fifth grade mathematics remained the same no matter what curricular materials are used. Consequently, while implementing the materials, she selectively chose topics and activities included in the materials. Collopy reported that this teacher taught in the prototypical traditional manner and the teacher self-described her style as “walking the students through” by demonstrating algorithms followed by students working problems individually at their desks. Because of her instructional method, she found it necessary to adapt the *Investigations* lessons. This particular teacher’s view of the curricular materials was as a resource that provided a sequence of lessons and instructional materials. Ultimately, this teacher ceased using the *Investigations* materials and reverted to using a more conventional textbook. In contrast, the other teacher who had been teaching 11 years made considerable changes to her instructional methods as she implemented *Investigations.* Collopy reported that the teacher’s methods shifted from a focus on procedures and correct answers to more conceptual understanding and reasoning.

In another study of similar focus, Remillard and Bryan (2004) examined how eight elementary teachers used the same *Investigations* lessons. Drawing on interviews and visits, they characterized the teachers with regard to the extent to which they used the structure of the curricular material, its mathematical content, and its pedagogical suggestions. Two teachers who relied primarily on their own teaching routines and other resources were characterized as using the curricular materials *narrowly and intermittently*. These teachers tended to incorporate selected tasks from the materials into previously established routines. Two teachers who relied on the curricular materials as a general guide for structure and content were classified as *adopting and adapting*. In other words, they often used the tasks contained in the materials but used their own teaching strategies to implement them into the classroom. The remaining four teachers were identified as *thorough piloting* the materials. These teachers used the materials as their primary guide for teaching and tended to read and follow the pedagogical suggestions. What these categories suggest is that the same tasks can be used quite differently by teachers depending on whether they adapt them to their own teaching styles or implement them using the pedagogical suggestions offered by the materials. These studies highlight how two teachers can use the same materials quite differently depending on their views of the nature of mathematics. The results underscore the need to assess teachers' views about the nature of mathematics and also the extent and nature of their professional development.

Drawing on the work of Remillard and Bryan (2004) as an extension to the COSMIC project, Bowzer (2008) examined the use of curricular materials by a group of teachers assigned to teach from two types of curriculum in secondary schools where dual curricular paths were in place. Using a case-study design, Bowzer examined the pedagogical consistency of teachers teaching from both an integrated textbook and a subject-specific textbook within the same school day and how they negotiated their role as curriculum implementers in light of the differences in the textbooks from which they have been asked to teach.

Bowzer found substantial differences in the amount of group work within Integrated Math I classes and Algebra I classes. Based on classroom observations, teachers utilized small group work encouraging exploration and discovery during an Integrated Math I class but tended to return to teacher-led discussion and lecture during an Algebra I class. As such, this was often in conflict with what teachers stated to be best practices with regard to fostering student learning. In general, teachers' instructional practices were typically aligned with the instructional approach contained within the textbook in use.

As these studies suggest, the use of particular tasks varies among teachers based on factors such as beliefs, familiarity, self-efficacy and textbook design. Thus, the alignment to the pedagogical orientation of the textbook is an essential element when researching textbook implementation. Furthermore, these studies reinforce the value of observational data in documenting how the teacher enacts the written curriculum. Therefore, in my study, the consistency of pedagogical orientation is examined via classroom visits.

Implementation Fidelity Studies

Textbook integrity provides one framework for documenting teachers' use of written curriculum in their classroom. Previous studies describe this use by using the construct *implementation fidelity*. Generally, implementation fidelity refers to the degree of alignment between the author's intentions for using the textbook and its enactment by the teacher in the classroom (Remillard, 2005; Stein, Remillard, & Smith, 2007). It is often used as a frame to describe the alignment of what activities or lessons teachers put into practice and what is contained within the curricular materials. However, implementation fidelity research has been prominent in the field of public health research but has been considered much less frequently in K-12 curriculum research (O'Donnell, 2008). Moreover, O'Donnell asserted that several definitions of fidelity in K-12 research are often in reference to instructional quality rather than the examination of the effectiveness of curriculum interventions. Drawing on hallmark studies in public health research, O'Donnell conceptualized implementation fidelity as two stages of implementation research: *efficacy studies* and *effectiveness studies*.

Efficacy studies help establish that a program can lead to desired outcomes under the most favorable conditions. According to O'Donnell,

> An efficacy study's examination of fidelity focuses on whether a program is implemented at all (i.e., did the program get delivered) and to what degree (i.e., what was the program's quality of delivery?), and it uses the answers to these questions to improve the program. (p. 41)

In essence, efficacy studies help establish what components are critical features of the program and what can be done to improve the quality of the actual implementation of the program. In contrast, effectiveness studies complement efficacy studies by determining whether a program achieves its outcomes where mediating factors can be identified. In other words, "variations in fidelity are measured in a natural setting and then related to student outcomes" (p. 42). Once a program has been proven efficacious, effectiveness studies can provide evidence of the programs' impact on student outcomes in relation to the level of implementation of the program.

This notion of whether a mathematics curriculum was established as effective was central to the National Research Council's charge in 2002, to evaluate the quality of the evaluations that had previously been conducted on the NSF-funded mathematics curricular materials as well as others. Specifically, the committee members were asked to "determine whether the currently available data are sufficient for evaluating the effectiveness of these materials" (NRC, 2004, p. 1). One criterion they used when examining the studies was whether any measure of implementation fidelity was reported. The committee emphasized that if researchers are assessing student learning in relation to a specific curriculum, one must first document how that curriculum is implemented in order to draw inferences regarding student learning in reference to that curriculum. Through their exhaustive search of studies, the committee identified 63 comparative studies to evaluate. Out of these studies, 33 of 63 did not report any measure of fidelity and out of the remaining 30 studies, only 1 study reported and adjusted for implementation fidelity when interpreting their outcome measures. The committee found that from the evaluation studies available, curricular effectiveness of any of the programs evaluated could not be determined. They recommended the following standard be used when determining effectiveness:

> For a curricular program to be designated *scientifically established as effective,* a collection of scientifically valid evaluation studies addressing its effectiveness should (1) establish that a curricular program **and its implementation** [emphasis added] produce positive and curricularly valid outcomes for students, and (2) convincingly demonstrate that the positive outcomes are due to the curricular intervention. (p. 192)

This recommendation helped bring to the forefront the importance of the implementation component in effectiveness studies.

Although the study presented here is not an evaluation of curriculum, the significance of an implementation component when studying a curriculum's effectiveness underscores the need for resolving the ambiguity associated with the measurement of the implementation of a curriculum. Furthermore, previous literature on teachers' use of textbooks has been relatively broad rather than specific to particular mathematics content strands. This research offers an example of how implementation can be examined using the three components of textbook implementation and expands the literature to include consideration of particular mathematical strands.

Teacher Assignment to Courses

There is a notable lack of empirical research about how administrative decisions are made regarding who will teach particular mathematics courses. Although studies that examine teacher assignment at the high school level are indeed rare, there have been a few studies that examine decision-making at the elementary level.

Glasman and Heck (1987) hypothesized that elementary principals assign teachers to a classroom with regard to three factors: (a) criteria that principals believe are pertinent to making a decision; (b) types of data that principals can gather as evidence in making a decision; and (c) the actual evaluating of data with respect to the decision-making criteria. The researchers further delineated the criteria within the first factor into three domains: (a) teacher attributes; (b) school-wide concerns; and (c) political/organizational concerns. Criteria within *teacher attributes* include variables such as individual teaching skills, years of teaching experience, the principal's evaluation of the teacher's classroom teaching performance, and the teachers' attitudes toward their students, parents, and the curriculum. *School-wide criteria* include the overall staffing requirements of the school and the ability of the teacher to work productively with other teachers at the same grade level. *Political* or *organizational concerns* refer to external factors impacting decisions such as educational accountability, fiscal restraints, or parental requests. Within the second factor, Glasman and Heck hypothesized that the data sources principals might use for evidence include student achievement information, classroom observation, frequency of discipline referrals, or general observations of professional experiences. The last factor refers to the evaluation of data with regard to each of the criteria outlined in the first factor.

Drawing on the preceding literature, Heck, Marcoulides, and Glasman (1989) tested a proposed model of four factors relating criteria and data that was hypothesized to influence principal's decision-making: internal politics (teacher desires and negotiating), external politics (parent desires), school-wide and other organizational concerns, and the matching of teacher characteristics with student needs. Using structural equation modeling with questionnaire data from 169 California elementary school principals, the authors were able to verify that elementary principals' beliefs about teacher and student matching, internal political concerns, parental input and organizational concerns all directly influence their decisions regarding teacher assignments. The principals gather data indirectly about teachers' performance, competences, attitudes, and their ability to meet the instructional needs of students and use it to influence the decisions made. Thus, in this particular study, researchers found that teacher assignment decisions are made on multiple criteria and specific data.

This study was followed by another study based on the same theoretical considerations by Heck and Marcoulides (1989), which examined the impact of district and school situational variables on teacher assignment. Three school populations (small, medium, and large districts) were compared via questionnaire responses. The findings revealed that the school size did not affect the process of teacher assignment whereas the structural size of the district did so. The principles in the larger districts reported less reliance on political concerns (teacher or parent pressures) when making decisions.

More recent literature with regard to teacher assignments to classrooms has focused on the credentials that a teacher brings to the classroom. The No Child Left Behind Act (2002) called for greater accountability for schools and greater proficiency for students. In order to impact student achievement, NCLB called for a highly qualified teacher in every classroom. A highly qualified teacher must meet three criteria: (a) hold a bachelor's degree; (b) be certified in the area in which s/he is teaching; (c) be able to demonstrate content knowledge in the subject s/he teaches. The impetus for including this component of NCLB is based on studies that offer evidence that teachers are "one of the most critical factors in how well students achieve" (U.S. Department of Education, n.d.). Thus, under NCLB, the role of the principal is to consider whether a teacher satisfies these criteria.

Certainly, researchers agree that teachers do indeed make an important difference when fostering student learning (Good, Biddle, & Brophy, 1975; Good & Grouws, 1979; Hiebert & Grouws, 2007). Importantly, some teachers are particularly effective in promoting student learning year in and year out with different groups of students. Nevertheless, identifying what teacher characteristics are effective is difficult. Hiebert and Grouws (2007) noted,

> Although laypersons in the street often have quick answers based on recollections of their favorite teachers, documenting particular features of teaching that are consistently effective for students' learning has proven to be one of the great research challenges in education." (p. 371)

Indeed, the teacher's role in directing the development of students' mathematical knowledge is complex. The responsibility is difficult to fulfill because it involves simultaneously fostering students' knowledge accumulation and developing their mathematical abilities. A teacher must bring these together while considering students' abilities and backgrounds. Thus, with a dearth of research evidence, school administrators face tough choices when assigning teachers to fulfill these responsibilities. Few studies have provided insight on decision-making structures associated with placement of teachers (Krei, 1998). My search of the literature indicates a particular dearth of studies at the secondary school level with regard to teacher assignment to classrooms and even more specifically, mathematics classrooms.

Summary

Although curricular materials play a strong role in what mathematics students learn and how they learn it, no curricular program is self-enacting. Ultimately it is teachers who make decisions that determine students' learning opportunities and many factors influence the degree to which a teacher implements a textbook in a manner consistent with authors' intent. Teachers' rely on textbooks to guide their planning and instruction and thus, the choice of textbook will inevitably impact instruction. This instruction, in turn, affects what students learn. Since achievement may be examined to determine whether the chosen curriculum is effective, it is imperative for curriculum research to continue to refine the conceptualization of textbook implementation, how it can be measured, and what such measures tell us about the teaching and learning of mathematics. The intent of this study is to use a *textbook implementation* framework to capture differences in how teachers use textbooks in secondary school classrooms.

Although this study does not examine student learning, it does take account of how student learning in secondary school mathematics is influenced by the way in which a textbook is used, the mathematics content students are given the opportunity to learn, and the manner in which the mathematical learning is facilitated. Hence, it is important to consider how these textbooks are developed given this potential power of influence over mathematical learning. Furthermore, research has shown than teachers do make a difference in the classroom but a dearth of research exists on how teachers are assigned to classrooms in the first place.

The collection of studies reviewed in this chapter underscore the necessity of considering not only what part of the curriculum is used but also how well its use aligns with the textbook authors' intentions. The design of this study outlined in the next chapter reflects the need to examine both *what* a teacher uses from the curriculum and *how* it is used.

CHAPTER III: METHODOLOGY

This study is an extension of a larger research project known as the *Comparing Options in Secondary Mathematics: Investigating Curriculum*. Utilizing data collection tools from the larger study and additional tools developed for this extension, I examined the extent and the manner in which secondary school teachers use integrated mathematics textbooks in their daily teaching. In addition, I examined the procedures and rationale administrators used in assigning teachers to courses using an integrated mathematics textbook.

The design of the study, data collection methods, and data analysis approaches are described in this chapter. The data sources included surveys, Textbook Use Diaries, Table of Content Records, classroom observations and interviews. These instruments are described in this chapter and a discussion of how the data were analyzed concludes the chapter.

The Comparing Options in Secondary Mathematics Project

The *Comparing Options in Secondary Mathematics: Investigating Curriculum* (COSMIC) project is an NSF-funded research project that involves a three-year longitudinal comparative study of integrated mathematics curricula and subject-specific mathematics curricula on mathematical learning. The primary goal of the COSMIC project is to evaluate secondary school students' mathematics learning using multiple measures of student achievement while carefully attending to curriculum implementation via classroom observations, Textbook Use Diaries (TUD), Table of Content (TOC) Records, teacher surveys and interviews.

Preliminary work for the COSMIC project began in 2005 with data collection starting in the Fall of 2006 and continuing through the 2008-2009 school year. Assistance in identifying candidate schools to participate was garnered from state mathematics supervisors, notices in the NCTM *News Bulletin*, recommendations of colleagues at various universities, and textbook distributors. In all, six school districts are participating in the COSMIC study, all of which offer a dual curricular option program (an integrated approach and subject-specific approach) allowing students to choose freely between the two options rather than be assigned via past achievement. The rationale for using districts with this design is to decrease threats to internal validity and increase the comparability of the samples. In other words, the surrounding conditions and events of each district are more likely to be similar for each curricular option.

The district locales varied from rural to urban settings and the student bodies in the secondary schools within the districts ranged from high-middle socioeconomic (SES) backgrounds to schools where many students were from low SES families. Descriptive data of the school student population are included in Table 2 as well as details regarding the ethnic diversity in each district.

Although one of the criteria used to determine the district sample was that an integrated program was in place, content analyses of several integrated mathematics programs have revealed that all integrated programs are not necessarily similar in structure or content (Martin et al., 2001). Thus, the most widely used of the integrated programs in secondary schools, the *Core-Plus* integrated textbook, *Contemporary Mathematics in Context* (Coxford et al., 1998a), was chosen to represent the integrated curriculum option. The curriculum for the subject-specific approach was identified once the pool of schools and classes were identified. Within the districts identified, several subject-specific curricula were used with the most popular being the Glencoe Publishing Company textbook, *Algebra I* (Holliday et al., 2005) and the McDougal Littell Publishing Company textbook, *Geometry* (Larson, Boswell, & Stiff, 2001). The final criterion for choosing districts to include in the project was the districts' willingness to participate and whether *Core-Plus* textbooks were in use and would likely be maintained for the duration of the project.

Table 2

Demographics of schools within the districts studied

District	Number of Students	Students on free/ reduced lunch	Ethnicity				
			White	Black	Hispanic	Asian/ Pacific Islander	American Indian/ Alaskan Native
B							
School 80	1089	21.7%	90.1%	1.3%	6.3%	1.7%	<1%
C							
School 10	686	44.2%	92.6%	<1%	4.2%	2.2%	<1%
I							
School 70	1766	50.8%	81.2%	8.2%	6.0%	3.9%	<1%
R							
School 90	2172	24.6%	51.8%	4.4%	37.8%	1.7%	4.2%
T							
School 20	1291	29.7%	92.3%	1.2%	3.6%	1.2%	1.6%
School 25	1391	27.8%	94.4%	<1%	2.2%	1.1%	1.9%
School 30	1276	17.1%	95.1%	<1%	1.8%	1.6%	<1%
School 35	1511	21.2%	95.2%	<1%	2.2%	1.1%	1.3%
W							
School 40	1151	18.5%	74.2%	16.3%	5.6%	3.7%	<1%
School 45	942	43.8%	45.5%	43.5%	10.3%	<1%	<1%
School 50	1164	38.5%	51.4%	30.9%	14.7%	2.8%	<1%
School 55	939	36.0%	61.3%	25.9%	11.0%	1.4%	<1%
School 15	1267	9.8%	85.0%	10.7%	2.7%	1.4%	<1%
School 60	1744	22.8%	70.6%	18.5%	9.0%	1.4%	<1%
School 65	1518	33.9%	53.0%	34.3%	11.1%	1.3%	<1%
School 75	1972	11.6%	78.2%	13.7%	5.3%	2.6%	<1%
School 85	1317	38.7%	33.4%	51.2%	14.8%	<1%	<1%

The Study

Due to its broader perspective, the COSMIC study was not designed to provide detailed insight into issues regarding the relative emphasis teachers of integrated curriculum placed on various content strands. The purpose of the study reported here was to gain an in-depth understanding behind students' opportunity to learn mathematics from an integrated textbook with respect to the content strands contained within the integrated textbook and to explore how teachers are assigned to teach classes using integrated textbook materials. Specifically, the following research questions were investigated:

Lesson Level

1. To what extent do secondary school mathematics teachers use integrated mathematics textbooks during lessons?
    a. How many instructional days are devoted to the teaching of lessons as compared to the textbook authors' recommendations for the number of class periods to be allocated to the teaching of lessons?
    b. What elements of textbook lessons are utilized during classroom instruction and what problems from textbook lessons are assigned for homework? How do these teacher decisions compare to author recommendations concerning the use of the elements?
    c. To what degree do teachers supplement the textbook content associated with lessons?

Course Level

2. To what extent do high school mathematics teachers provide students the opportunity to learn the *mathematics content embodied* in integrated mathematics textbooks?
    a. What opportunities are provided for students to learn the mathematics associated with the Algebra and Functions strand of integrated textbooks?
    b. What opportunities are provided for students to learn the mathematics associated with the Geometry and Trigonometry strand of integrated textbooks?
    c. What opportunities are provided for students to learn the mathematics associated with the Statistics and Probability strand of integrated textbooks?
    d. What opportunities are provided for students to learn the mathematics associated with the Discrete Mathematics strand of integrated textbooks?
    e. Do students' opportunities to learn vary across the content strands embedded in integrated textbooks?

Department Level

3. How are secondary school mathematics teachers assigned to the courses they teach in schools that offer both a subject-specific curricular path and an integrated curricular path?
    a. How are teachers assigned to courses across curricular paths?
    b. How are teachers assigned to courses within an integrated curricular path?

Triangulation

Triangulation of data was used to increase the validity and reliability of the findings from the study. Triangulation is defined as "the use of multiple sources of data, multiple observers, and/or multiple methods" (Ary, Jacobs, Razavie, & Sorensen, 2006, p. 505). In this study, multiple sources of data were related to each other in order to support (or contradict) any interpretation of the data and to answer the research questions from various points of view. Table 3 provides a summary of the data sources used to address each research question.

Table 3

Data sources for answering each research question

Research Question	Primary Data Sources	Secondary Data Sources
To what extent do secondary school mathematics teachers use integrated mathematics textbooks during lessons?	Textbook-Use Diaries	Classroom Visit Protocols
To what extent do secondary school teachers provide students the opportunity to learn the *mathematics content embodied* in their integrated mathematics textbook?	Table of Contents Records	Classroom Visit Protocols
How are secondary school mathematics teachers assigned to the courses they teach in schools that offer both a subject-specific curricular path and an integrated curricular path?	Administrator Interviews	Department Chair Interviews

Participants

The teacher participants for the study were 44 teachers from the school districts included in the COSMIC study. At each site, all teachers teaching *Core-Plus* Course 1 during year 1 and *Core-Plus* Course 2 during year 2 were asked to participate. All agreed to participate. Table 4 displays the number of teacher participants by district. It should be noted that three of these teachers participated during both years of the study, consequently the numbers contained in the table sum to 47 participants rather than the actual 44 participants.

Table 4

Sample for the study reported here

District	Year 1 Teachers	Year 2 Teachers
B	4	2
C	1	1
I	4	7
R	1	2
T	6	7
W	5	7
Total	21 [14 Female; 7 Male]	26 [20 Female; 6 Male]

Since the study occurred within schools that offer two types of curricular paths, it was conceivable that teachers teach from both curriculum types within one school day. This was indeed the case. Among the 21 teachers participating during the first year, 10 teachers taught from both program types throughout the day and among the 26 teachers participating during the second year, four teachers taught daily from each of the two program types. However, only information gathered from their courses using integrated curriculum is reported here.

School administrators participated in the study in order to address the research questions at the department level. In particular, the focus of these questions was on gathering information about the assignment of teachers to classrooms where the use of integrated curriculum was expected. In all cases the principal was responsible for making these decisions; however, in some cases the district curriculum coordinator or department chairs were allowed to offer recommendations. A total of 12 interviews of administrators were conducted to address this research question.

Background of teacher participants

In order to obtain information regarding the background of teacher participants, two teacher surveys were adapted from the 2000 National Survey of Science and Mathematics Education (Weiss et al., 2001) and administered to all participating teachers. The purpose of the *Initial Teacher Survey* (ITS) was to gather information about teacher demographics (e.g., name, years of experience, degrees obtained, teaching assignment) as well as their beliefs about mathematics teaching and learning, their familiarity with NCTM *Standards*, indications of their level of preparation to teach mathematics and their professional development activities (see Appendix A). The *Midcourse Teacher Survey* (MTS), completed approximately mid-year, focused on teachers' use of the textbook during instruction, perception of the quality of the textbook, use of particular instructional practices (e.g., small group instruction), use of graphic calculators, assignment of homework, and use of assessments (see Appendix B). The information garnered from these surveys was used to describe the teacher participants.

Teaching experience. As part of the Initial Teacher Survey, teachers were asked to provide the number of years they had taught any grade or subject. This experience ranged from 0 to 28 years. The mean for overall teaching experience of the participating teachers was 10.2 years during year 1, but it increased slightly to 11.04 during year 2. This experience included a mean of 8.79 years during year 1 and 10.31 years during year 2 of teaching middle school or high school mathematics. Thus, nearly all the teachers had taught mathematics during the majority of their teaching experience.

Teaching credentials. Eight of the 21 (38%) participating teachers during year 1 and 14 of the 26 (54%) participating teachers during year 2 held master's degrees. Of these, most degrees were in an education-related field (e.g., curriculum and instruction, administration, or teaching). Of those holding only a bachelor's degree, most reported the degree to be within the domains of mathematics, mathematics education, or engineering. Exceptions to this were two teachers participating during year 1 who reported undergraduate degrees in home economics and elementary education. Another exception occurred in year two with one teacher reporting a degree in political science. All teacher participants, with the exception of one participant during year 2, were licensed to teach mathematics at some grade level. This exception was a co-teacher within a regular classroom who held a certification in special education for grades 9-12. The remaining teachers held certifications varied around grades levels with some including elementary and middle grades (K-9), others including middle and high school grades (6-12) to those exclusive to high school (9-12).

Familiarity with and implementation of NCTM Standards. In addition to the demographic questions, teachers were asked a series of three questions addressing the extent to which the NCTM *Standards* were considered within each teacher's classroom. The first question asked, "How familiar are you with the *Principles and Standards for School Mathematics*" (National Council of Teachers of Mathematics, 2000)? This particular question was of interest because the integrated textbooks were based on the NCTM *Standards* documents (NCTM, 1989). As might be expected, most teachers expressed some degree of familiarity. Only five teachers reported no familiarity with the *Standards*. The second item in this series of questions asked teachers to indicate the extent of their agreement with the overall vision of mathematics education described in the NCTM *Standards*. If teachers reported some familiarity in the previous question, then they would proceed to this question and respond by choosing their level of agreement. For those teachers familiar with the *Standards*, most reported some degree of agreement with the *Standards.* The final item in the series asked teachers to what extent they had implemented recommendations from the NCTM *Standards* documents in their mathematics teaching. These data revealed that most teachers felt that they implemented the *Standards* to at least a moderate extent. Figure 3 displays the relationship between teachers' familiarity with and implementation of NCTM *Standards* disaggregated by school year.

Teacher Familiarity

	Not at All	Minimal Extent	Moderate Extent	Great Extent	Not Applicable
Very Familiar			■■	●●●● ■■■■■■	
Fairly Familiar			●●● ■■■■	●● ■■■■■	■
Somewhat Familiar	■	● ■■■■	●● ■■■■	●●	
Not Familiar				●	●● ■■■

● Year 1
■ Year 2

Degree of Implementation

Figure 3: Relationship between teachers' familiarity with and implementation of NCTM *Standards*.

Use of integrated textbook. On the Midcourse Teacher Survey (MTS), teachers were asked a series of three questions concerning their use of the textbook. The first question inquired how many years teachers had been using the integrated textbook. The second question asked teachers to select how well prepared they were to use the integrated textbook. The majority of the teachers reported being either somewhat or very prepared (Figure 4).

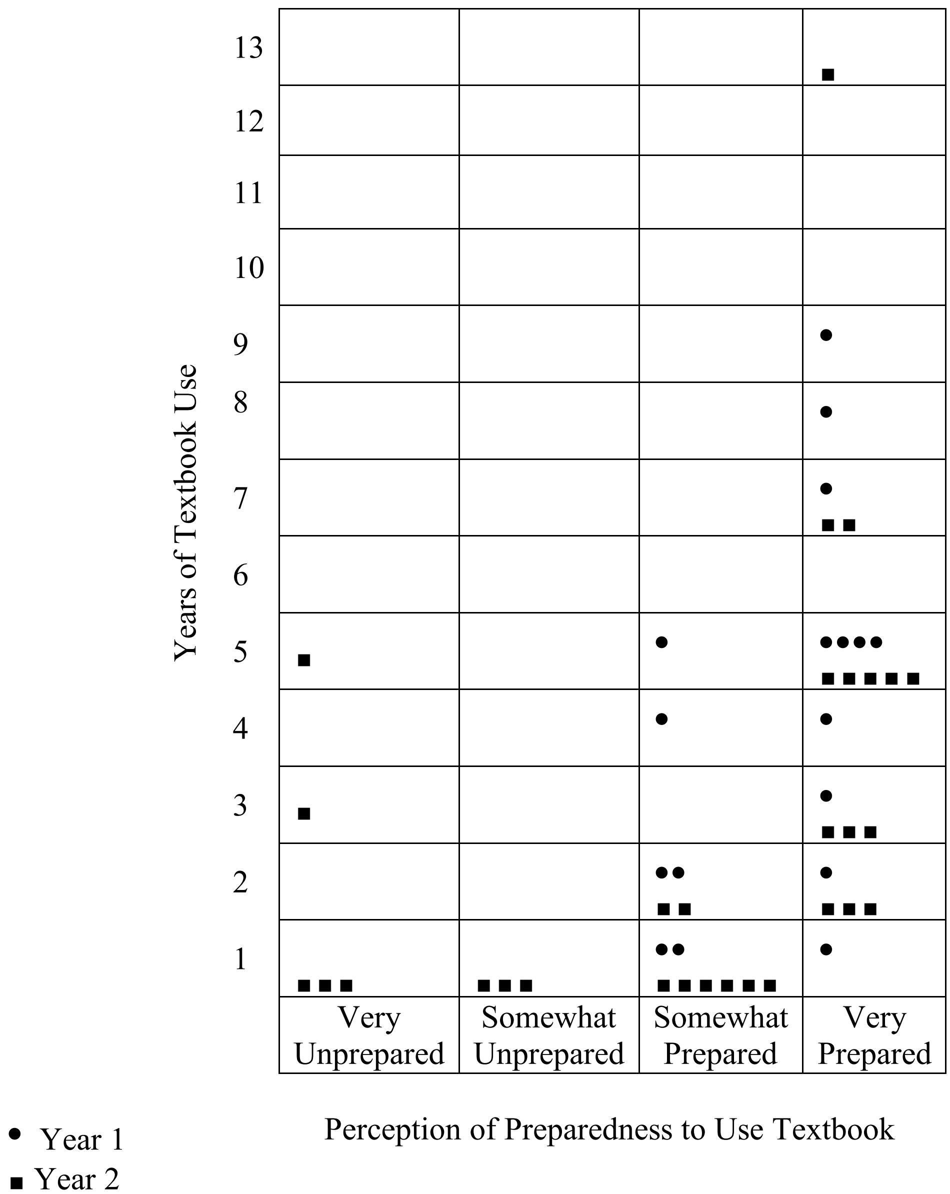


Figure 4: Relationship of teachers' years of textbook use and perceived preparation to use the textbook.

The final item in this series of questions asked teachers how they would rate the overall quality of the integrated textbook on a 5-point scale ranging from very poor to very good. Most teachers rated the integrated textbook from fair to very good (Figure 5).

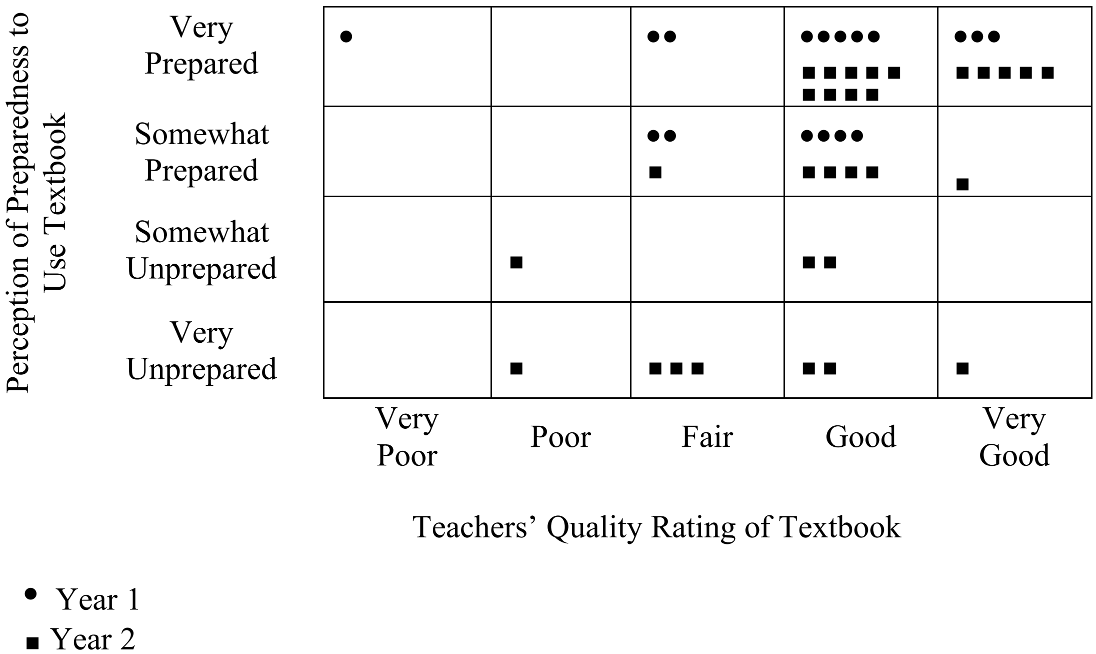


Figure 5: Relationship between teachers' preparation to use textbook and the quality rating of the integrated textbook.

In summary, teachers participating in this study were primarily female and had a wide range of experience, from 1 year to 28 years. Although not all teachers had a degree in mathematics or mathematics education, all were certified in mathematics teaching. In general, most teachers were familiar with the *Standards*, agreed with the ideas of the *Standards,* and felt they implemented the *Standards* in their classroom at least to some degree. Furthermore, most teachers felt prepared to use the integrated mathematics textbook and rated its quality in a positive manner.

Data Sources

Members of the COSMIC research team, including myself, developed several instruments used to measure classroom curriculum implementation from two perspectives, teacher and researcher. The teacher self-reported data were collected by asking each teacher-participant to complete (1) the two written surveys (described in previous section); (2) a Textbook Use Diary; and (3) a Table of Contents Record. For the researcher perspective, I, along with other members of the research team, gathered data utilizing classroom visit protocols.

Textbook Use Diaries

The purpose of the Textbook Use Diary (see Appendix C) was to gather specific information regarding textbook use during a common lesson. Recall a lesson in the *Core-Plus* textbook spans several days of classroom instruction. For example, teachers recorded what materials they used for each day of instruction for the identified lesson including information regarding what textbook tasks were used during class and what problems were assigned for homework. In Course 1, teachers completed Textbook Use Diaries for Unit 3 Lesson 2 [*Linear Graphs, Tables, and Rules*], and for Unit 2 Lesson 2 [*Coordinate Models of Transformations*] in Course 2. The information teachers reported was used to determine the extent to which teachers used their textbooks during their daily lessons and to help answer the research questions at the lesson level.

Table of Contents Record

On the Table of Contents [TOC] Record, the teacher provided information regarding every textbook lesson being used and whether the textbook lessons taught as presented in the textbook or were altered or adjusted. To obtain this information, each teacher was provided a TOC instrument that included a copy of the table of contents of the integrated textbook and s/he was asked to indicate the level of use for each section by choosing one of the following options: (1) content taught primarily from *Core-Plus* textbook; (2)

content taught from the *Core-Plus* textbook with some supplementation; (3) content taught primarily from an alternative source; and (4) content not taught (Figure 6).

Unit 1 **Matrix Models**		Taught primarily from *Core-Plus* textbook	Taught from *Core-Plus* textbook with some supplementation	Taught primarily from alternative(s) to *Core-Plus*	Did not teach content
Lesson 1 ***Building and Using Matrix Models***					
Inv 1	*There's No Business Like Shoe Business*	☐	☐	☐	☐
Inv 2	*Analyzing Matrices*	☐	☐	☐	☐
Inv 3	*Combining Matrices*	☐	☐	☐	☐

Figure 6: Excerpt from Table of Contents Record *Core-Plus* Course 1.

Updated TOC records were collected four times during the year corresponding approximately with the end of each quarter of the school year. This instrument provided an overall measure of textbook implementation as well as specific textbook implementation with respect to the four content strands: (1) Algebra and Functions; (2) Geometry and Trigonometry; (3) Statistics and Probability; and (4) Discrete Mathematics.

Classroom Visit Protocols

A classroom visit protocol (Tarr, McNaught, & Sutter, 2006) was developed after interviewing one of the *Core-Plus* textbook authors to determine what the curriculum developers expected of teachers in implementing their curricular materials. In interviewing the author, we asked questions regarding the key lesson components (e.g., Launch, Explore, Share and Summarize, and Apply) of the integrated textbook with particular attention to what constitutes a faithful implementation of each lesson component. The author’s responses to these interview questions were used to develop an observation visit protocol (see Appendix D) specific to the *Core-Plus* textbook.

Working with other members of the COSMIC research team, most teachers were observed at least three times during the school year; I observed teachers at all six sites in both year 1 and year 2. Classrooms visits were scheduled in advanced to ensure that the visit did not conflict with a test or another school activity. Data from more than 300 classroom visits were collected (3 visits for each teacher participant spread over the school year). During each classroom visit, the observer took notes to record anecdotal evidence of particular presentation features being implemented and completed a summary form that included recording information about the use of lesson components specific to the given curricula. Based on extensive field notes on how the written curriculum was implemented during class, the observer assigned an overall rating level of implementation for both *Content Fidelity* and *Presentation Fidelity* using a well-defined rubric (Table 5).

The Content Fidelity score was placed on a scale of 1 to 5, indicating the extent to which the textbook was the primary source of the lesson content. A lower rating indicated that the content of the enacted curriculum was largely inconsistent with the written curriculum. In other words, the textbook was not the primary source of the lesson content because of omissions, significant modifications, and/or supplementation. A higher rating indicated that the content of the enacted curriculum was consistent with the written curriculum and the textbook was the primary source of the lesson content with little or no deviation or supplementation. In a manner similar to rating Content Fidelity, observers determined whether the enacted curriculum was taught in a manner consistent with the expectations of the textbook authors, thus providing a Presentation Fidelity rating. A lower presentation rating indicated that during the lesson, the teacher implemented actions/activities that were not recommended and/or neglected to implement actions/activities that were advised or recommended. A higher rating indicated that the teacher refrained from actions/activities that were not advised or recommended. Each rating was independently made using a 1 to 5 scale allowing for the possibility of a high fidelity rating on one aspect of implementation and a lower rating on the other for any given lesson.

Table 5

Rubric for assigning Content and Presentation Fidelity Ratings

1 ***2***	***3*** ***4***	***5***
Lower Content Fidelity	***Moderate Content Fidelity***	***Higher Content Fidelity***
The content of the enacted curriculum was *largely inconsistent* with the written curriculum. The textbook was not the primary source of the lesson content because of omissions, significant modifications, and/or supplementation.	The content of the enacted curriculum was *moderately consistent* with the written curriculum. Although the textbook was a source of some of the lesson content, other portions of the lesson could not be attributed to the textbook.	The content of the enacted curriculum was *consistent* with the written curriculum. The textbook was the primary source of the lesson content with little or no deviation or supplementation.
Lower Presentation Fidelity	***Moderate Presentation Fidelity***	***Higher Presentation Fidelity***
The presentation of the enacted curriculum was *not consistent* with the expectations of the textbook authors. During the lesson, the teacher implemented actions/activities that were not recommended *and/or* neglected to implement actions/activities that were advised or recommended. The teacher placed disproportionate emphasis on particular lesson components at the expense of others.	The presentation of the enacted curriculum was *moderately consistent* with the expectations of the textbook authors. During the lesson, the teacher either implemented some actions/activities that were not recommended *or* neglected to implement actions/activities that were advised or recommended. The teacher generally placed appropriate emphasis on each lesson component.	The presentation of the enacted curriculum was *consistent* with the expectations of textbook authors. During the lesson, the teacher implemented recommended actions/activities *and* refrained from actions/activities that were not advised or recommended. The teacher placed appropriate emphasis on each lesson components.

The Content Fidelity and Presentation Fidelity Ratings from the Classroom Visit Protocol were used to triangulate data related to the lesson level research questions and to provide insight as to the consistency of pedagogical orientation with regard to textbook use. Recall, this question was also being examined using teacher-reported data from the

Textbook Use Diary, thus the data from these two sources allowed the questions to be examined vis-à-vis a researcher perspective and a teacher perspective.

Administrator Interviews

The interview protocol (see Appendix E) was designed to provide insight into the process of how teachers are assigned to teach particular mathematics courses. The intent was to gather information regarding the criteria used to determine teaching assignments and how much input teachers had in regard to determining their own teaching assignments. In order to assess the efficacy of the interview protocol, two pilot interviews were conducted and data analyzed, and the protocol was adjusted accordingly.

The interview questions solicited information at two levels: (a) across curriculum pathways and (b) within curriculum pathways. The questions targeting the first level were designed to gather information regarding how it is determined whether a mathematics teacher will teach courses in the subject-specific pathway (i.e., Algebra I, Geometry, or Algebra 2) or in the integrated pathway (i.e., *Core-Plus*). The second-level questions addressed how administrators determined what courses teachers were assigned to within each curriculum pathway. In other words, once it is decided a teacher will teach within the integrated pathway, what criteria are used to determine whether that teacher will teach Course 1, Course 2, or Course 3? In total, 12 interviews were conducted, averaging 15 minutes in length.

Data Analysis

Data analysis focused on determining the extent to which the integrated curriculum was being used within classrooms and on how decisions were made regarding teacher assignment to particular courses. More specifically, the data analysis unfolds in two sections. In the first section, I describe the analysis of the data with regard to documenting textbook implementation. In the second section, I describe the analysis of the data used to characterize teacher assignment to teach specific courses.

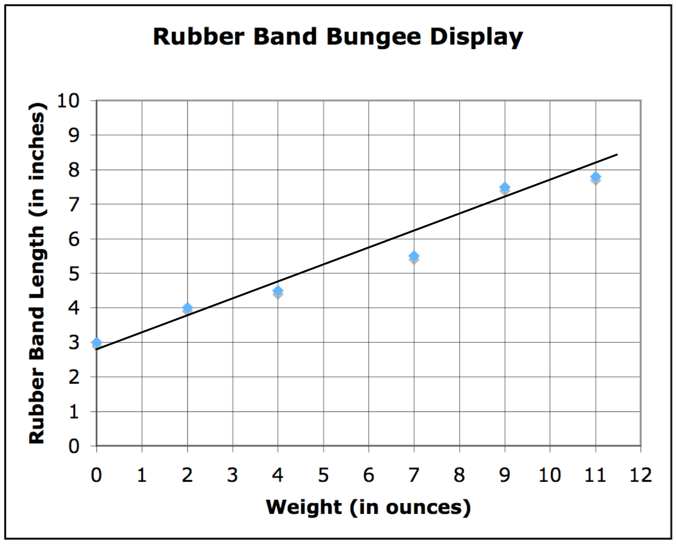
Documenting Textbook Implementation

Textbook Use Diaries. During year 1 and year 2 each teacher independently completed a Textbook Use Diary (see Appendix C). A total of 48 diaries were analyzed (21 from year 1 and 27 from year 2). Teachers teaching on a block schedule that completed an entire course during one semester, and teaching the same course the consecutive semester, filled out two diaries for the same course. For example, a teacher teaching Course 1 in semester 1 and Course 1 again to a new group of students in semester 2 completed two textbook diaries, one for each semester.

These diaries were first coded with respect to how many instructional days were used to cover the specified lesson. A *day* is defined as a class period on a 7-period day. In this study, these periods ranged from 47 to 60 minutes in length. For those teachers on a block schedule, the periods ranged from 85 to 90 minutes. Conventionally, a block period is considered as two 7-period class periods. Thus, the mean number of days allocated to a lesson is reported in terms of a 7-period day and data for those teachers who reported their days on a block schedule were doubled. The distributions of days allocated for year 1 and for year 2 are reported along with the means and standard deviations for each year.

The second analysis examined what elements of the textbook lessons were utilized. The use of the components of the lesson (Launch, Explore, Share & Summarize, and Apply) was reported by determining the percentage of teachers using each component *fully, partially,* or *not at all*. In order to be coded as used fully, the teacher needed to indicate that every item contained within that component was used. For example, Figure 7 shows the *Think About This Situation* activity comprising the Launch component of Unit 3 Lesson 2.

Think About This Situation



The graph shows the overall pattern relating *weight* and rubber band *length*.

a. Based on the linear model (not the data points themselves), what pattern would you expect in a table of (*weight, length*) data pairs for weights that range from 0 to 10 ounces?

b. How long is the rubber band with no weight attached, and how is that fact shown on the graph?

c. How much does the rubber band stretch for each ounce of weight added, and how is that shown on the graph?

Figure 7: Think About This Situation activity from *Core-Plus* Course 1 (p. 181).

If the teacher reported using items a, b, and c, then the code assigned was *full.* If the teacher reported using some of these items, but not all, the resulting code was *partial.* If none of the items was used, the code assigned was *none.* Also, the types of problems

(Modeling, Organizing, Reflecting, or Extending [MORE]) assigned were examined by determining the frequency each type of problem assigned by teachers in comparison to the recommended number identified by the authors. By requesting data on a common lesson across the sites, these analyses shed light on the variability among teachers within and across schools in regard to the pace at which the curriculum unfolds for a particular lesson.

A third examination of the Textbook Use Diaries was completed by attending to the degree of supplementation employed and the regularity with which the textbook was used by the teacher to teach the content contained within the identified lesson. The number of days a teacher used the textbook was determined by including days the teacher reported any problems being used from the textbook. This includes those days in which a teacher may have reported using both the textbook and some supplements. Each entry that did not indicate any sort of textbook use (e.g., using only a teacher-made worksheet) was coded as *no textbook use*. For each teacher, the total days the textbook was used to teach the content was divided by the total days of instruction to provide a *frequency of use* percentage. The degree of supplementation is reported by providing the percentages with regard to three categories: (1) use of textbook only; (2) use of supplements only; and (3) a mix of textbooks and supplements.

Table of Content Records. Although units of each course are integrated around multiple content strands, the authors have identified each unit has having a *primary strand* within which connections are made across other strands (Tables 6 and 7). As a check on the authors' identification of a primary strand, a confirmatory unit classification check was conducted. A colleague not associated with the COSMIC project reviewed several units chosen from each course. After reading through the lesson objectives and classroom activities, the primary strand(s) were chosen. In all cases (17 Lessons in Course 1 and 21 Lessons in Course 2), his choice confirmed what the authors had identified. In the cases where the authors identified a split focus in Course 2, I made a choice between the two strands based on my review of the material. The strand for which I chose the unit has been included in the analysis is shown in Table 7 with an asterisk.

Table 6

Primary content strand for each unit of the Course 1 integrated program

Course 1	Algebra & Functions	Statistics & Probability	Geometry & Trigonometry	Discrete Mathematics
Unit 1 Patterns in Data		X		
Unit 2 Patterns of Change	X			
Unit 3 Linear Models	X			
Unit 4 Graph Models				X
Unit 5 Patterns in Space & Visualization			X	
Unit 6 Exponential Models	X			
Unit 7 Simulation Models		X		
Capstone Planning a Benefits Carnival	X	X	X	X

Table 7

Primary content strand for each unit of Course 2 integrated program

Course 2	Algebra & Functions	Statistics & Probability	Geometry & Trigonometry	Discrete Mathematics
Unit 1 Matrix Models	X*			X
Unit 2 Patterns of Location, Shape & Size	X		X*	
Unit 3 Patterns of Association		X		
Unit 4 Power Models	X			
Unit 5 Network Optimization				X
Unit 6 Geometric Form & Its Function			X	
Unit 7 Patterns in Chance		X		
Capstone Forests, the Environment, and Mathematics	X	X	X	X

The extent to which the textbook was used during instruction and the manner in which it was used is reported utilizing three indices developed from teacher-reported data on the Table of Contents Records: (1) Opportunity to Learn; (2) Extent of Textbook

Implementation; and (3) Textbook Content Taught. These three indices were calculated for all lessons contained within each course and for each of the four content strands in the *Core-Plus* textbook: (1) Algebra and Functions; (2) Statistics and Probability; (3) Geometry and Trigonometry; and (4) Discrete Mathematics.

Opportunity to Learn (OTL) index. The OTL index indicates whether the textbook content is being taught or not taught. Content here refers to the content objectives contained in the textbook lessons and includes content taught primarily from the textbook or from alternative sources. The OTL index was computed by summing the frequency of occurrence of the first three options reported across all textbook lessons on a Table of Contents Record (see Figure 8) divided by the total number of lessons included in the particular textbook.

$$\text{OTL} = \frac{\text{[Frequency of Option 1] + Frequency of Option 2]+[Frequency of Option 3]}}{\text{Total Number of Lessons}} * 100$$

Figure 8: General formula for calculating the OTL index.

The OTL index essentially represents the percentage of the content in the textbook that students were provided the opportunity to learn aggregated by content strand and academic year. The formula below provides a specific example of how the OTL index was calculated:

$$OTL = \frac{6+6+29}{75} * 100 = 54.67$$

For this example, across the 75 investigations in Course 1, the teacher chose option 1 (content taught primarily from textbook) on the Table of Contents Record 6 times, option 2 (content taught from the textbook with some supplementation) 6 times, and option 3 (content taught primarily from an alternative source) 29 times. The remaining 34 investigations were marked as option 4 (content not taught) and represents content not taught. The mean and standard deviation for year 1 and for year 2 were computed separately. The OTL index was also calculated within content strands with means and standard deviations reported by strand.

Extent of Textbook Implementation Index (ETI). The ETI index was determined by weighting each of the first three options provided to the teachers on the Table of Contents Records. The largest weight was given when the first option was identified for a section, that is, content was taught primarily from the textbook. This was given a weight of 1. The lowest weight was given to the third option, content taught primarily from an alternative source and it was given a weight of $\frac{1}{3}$. The second option, taught with supplementation, was given a weight of $\frac{2}{3}$ and omitted sections were assigned a value of 0. The index was then calculated by summing the weights across textbook lessons and then dividing by the number of lessons contained in each respective textbook (Figure 9).

$$\text{ETI} = \frac{1*[\text{Freq of Option 1}] + \frac{2}{3}*[\text{Freq of Option 2}] + \frac{1}{3}\,[\text{Freq of Option 3}]}{\text{Total Number of Lessons}} *100$$

Figure 9: General formula for calculating the ETI index.

The formula below uses the data from the previous OTL example to calculate the ETI:

$$ETI = \frac{1(6) + \frac{2}{3}(6) + \frac{1}{3}(29)}{75} * 100 = 26.22$$

For this example, the same information for the OTL is now weighted to provide a better representation of OTL relative to *how* the textbook was used. The quotient was multiplied by 100 in order to give an ETI index on a scale ranging from 0 to 100 for ease of interpretation. An index of 100 would indicate that every lesson contained in the textbook was taught directly from the textbook and done so without supplementation or use of alternate sources. An index of 0 would indicate that no lessons from the textbook were taught. The mean and standard deviation for year 1 and again for year 2 were calculated. The ETI index was also calculated with respect to each of the four content strands with means and standard deviations reported by strand.

Textbook Content Taught Index (TCT). The TCT index differs from the ETI index by considering only those lessons whose content was taught in some manner and ignores content students were not given the opportunity to learn. The lessons were weighted in the same manner as the ETI but the index was calculated by dividing by the number of sections reported as content being taught in any manner and again multiplied by 100 (see Figure 10).

$$\text{TCT} = \frac{1*[\text{Freq of Option 1}] + \frac{2}{3}*[\text{Freq of Option 2}] + \frac{1}{3}\,[\text{Freq of Option 3}]}{\text{Total Number of Lessons Taught}} *100$$

Figure 10: General formula for calculating the TCT index.

The formula below uses the data from the previous OTL and ETI examples to calculate the TCT:

$$TCT = \frac{1(6) + \frac{2}{3}(6) + \frac{1}{3}(29)}{75 - 34} * 100 = 47.97$$

Again, this index was reported as a scale ranging from 0 to 100. An index of 100 would represent that every lesson taught was taught without supplementation and not from alternative sources. In contrast, an index of 0 would represent that every lesson taught was taught utilizing alternative resources, that is, taught with similar content substituted for that in the textbook. All indices in between would roughly indicate the extent to which lessons were supplemented or replaced. Ultimately, this index reports the extent to which teachers, *when teaching textbook content*, followed their textbook, supplemented their textbook lessons, or used altogether alternative curricular materials. The mean and standard deviation for year 1 and again for year 2 are reported. The TCT index was also calculated with respect to each of the four content strands with means and standard deviations reported by strand.

In summary, the results of the Table of Contents Records were analyzed by calculating an OTL, ETI, and TCT for each teacher across all lessons and for each teacher across lessons associated with each of the four individual strands. The results of the indices are summarized by calculating the means and standard deviations overall and the means and standard deviations associated with each content strand. Analysis of variance (ANOVA) is used to determine the differences among the content strands with respect to the opportunity to learn indices. The results provide evidence of the extent of textbook use and how that use varies across teachers and across content strands. These analyses are complemented by examining the amount of emphasis teachers place on each strand within the textbook in relation to the amount of content that is taught over the course of the year. An overall emphasis index (adapted from Tarr et al., 2006) was calculated for each strand by comparing the percentage of lessons taught within that strand to the percent of lessons contained in the textbook devoted to each strand:

$$\text{Emphasis Index}_{\text{Content Strand}} = \frac{\text{Percent of lessons taught}_{\text{Content Strand}}}{\text{Percent of lessons in textbook}_{\text{Textbook}}}$$

Although all school districts in the sample used the same integrated textbook, there were unique circumstances regarding its implementation. Districts B and T implemented the integrated series at two different paces, regular and accelerated. In District B, the accelerated pace was designed such that during year 1, students would use all units of Course 1 and Units 1-4 of Course 2. In year 2, these students would use Unit 6 out of Course 2 and Units 1-6 out of Course 3. In year 3 the students would begin with the books designed for Course 4. In this study, for teachers in District B, the year 1 textbook was considered to include all the material in Course 1 and units 1-4 in Course 2. Thus when the indices were calculated in respect to this accelerated course, the total number of sections used in the denominator was larger (117) rather than the 77 used for the regular classes, reflecting the differentiated pacing. Similarly, during year 2, the number of sections included the remaining units in Course 2 and all of the units in Course 3 for a total of 117 rather than the 75 used for the regular-paced classes.

A similar situation existed in District T, however, some Course 3 units were actually used in year 3. Year 1 was designed the same as in District B but year 2 was designed to finish Course 2 and use only units 1-5 in Course 3. Thus, for the purposes of this analysis, the total number of sections used in year 2 was 94 instead of 75.

An unusual situation existed in District C. During year 1, the teacher only covered units 1-4 in Course 1. Thus, when students moved to the next year, the next teacher started with unit 5 in Course 1, and then used the remainder of the school year to finish the textbook and did not move into the Course 2 textbook. Thus, the one teacher participating in District C during year 2 was deleted from the analyses for year 2.

Classroom Visit Protocols. For each teacher, the individual ratings for the overall Content Fidelity and Presentation Fidelity ratings were aggregated across visits to provide a mean Content Fidelity and Presentation Fidelity rating for each teacher. Means and standard deviations across all teachers were computed.

Characterizing Teacher Assignment to Courses

Interviews. Semi-structured interviews with school administrators were conducted and recorded. Analytic notes and general interpretations were made from these data and organized for all interviews. I developed an original list of codes for each interview and continued to refine the list in search of themes or patterns among responses (LeCompte & Schensul, 1999). In the second stage of coding, I compared data across interviews and identified the most salient categories. During this process, I noticed the responses were centered on two perspectives: *the teaching unit* and *the teacher*. Thus, these two perspectives became my interview coding categories (Bogdan & Biklen, 1998). I then reread the interview notes with a focus on these two categories and identified working relationships between administrators and the teaching unit and relationships between administrators and teachers. Ultimately, I used these two categories to develop a framework for describing administrators' decision-making when assigning teachers to teach particular courses.

Reliability

In an effort to maintain a high degree of consistency in the coding of Classroom Visit Protocols (CVP), extensive training of observers was conducted and continued until project directors felt comfortable that Content Fidelity and Presentation Fidelity would be rated reliably. Furthermore, during the first year a confirmatory reliability test was conducted by double coding 15 lessons during data collection. These lessons were neither randomly selected nor purposefully selected but instead chosen based on feasible observation schedules. That is, two researchers attended the same lesson only when their individual schedules permitted such an opportunity. Ideally, we sought to double code at least one lesson for every school in each year of data collection. Individual researchers took field notes and immediately following each lesson each researcher working in isolation completed the protocol including the content and presentation judgments. When all coding was completed, researchers compared codes, negotiating disagreements until they were resolved. Consensus codes were used in subsequent analysis of implementation data but the set of original assigned codes were used to gauge the ongoing reliability of the CVP coding.

Overall, the coding of Content Fidelity and Presentation Fidelity was quite high. With regard to Content Fidelity, 14 of the 15 rating pairs from the two observers were identical. Although in one instance the two observers disagreed, their individual ratings were within one unit of each other. The results for Presentation Fidelity revealed 10 of the 15 rating pairs were identical. Similar to Content Fidelity, the remaining 5 pairs were all within one unit of each other.

Summary

The design of this study necessitated the collection of data using multiple sources and utilized both quantitative and qualitative analyses. The teacher participants were 44 teachers from six school districts, all of which offer a dual curricular option program (an integrated approach and subject-specific approach). The instruments used were two written teacher surveys, Textbook Use Diaries, Table of Contents Records, classroom observations and interviews with administrators at each participating district. Textbook Use Diaries were coded with respect to the number of instructional days to teach a lesson common among teachers and with respect to the elements of the textbook lesson utilized. The diaries were also examined by attending to the degree of supplementation employed and the regularity with which the teacher used the textbook. In analyzing the Table of Contents data, three indices were developed: Opportunity to Learn (OTL) index, Extent of Textbook Implemented (ETI) index, and Textbook Content Taught (TCT). These indices were computed across all lessons and also across lessons aggregated by four content strands: (1) Algebra and Functions; (2) Geometry and Trigonometry; (3) Statistics and Probability; and (4) Discrete Mathematics. In addition, Content Fidelity Ratings and Presentation Fidelity Ratings were developed from the classroom observation protocols. Finally, semi-structured interviews were conducted and analyzed to determine the perspectives of administration when assigning teachers to courses. The results of the data analysis are presented in the next chapter.

CHAPTER IV: RESULTS

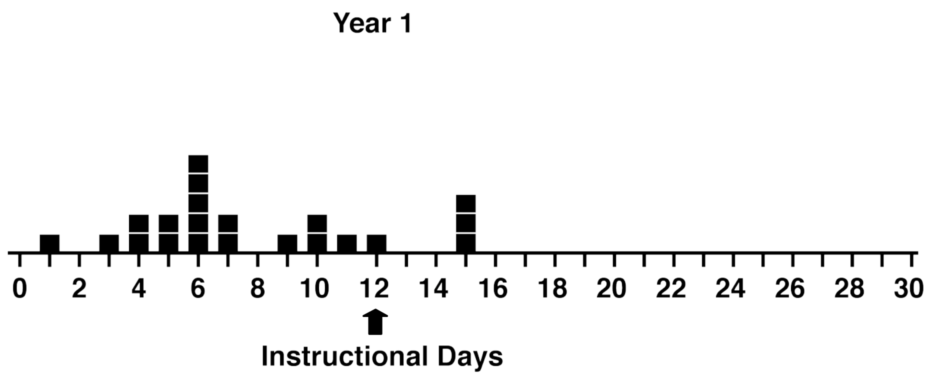
This chapter summarizes how secondary school teachers used integrated mathematics textbooks and the decisions administrators made regarding assignment of teachers to courses utilizing the integrated curriculum within schools. The results presented are organized into three sections. In the first two sections, I report textbook implementation data from the lesson-level analyses and the course-level analyses, respectively. In the final section, I provide the results of administrator interviews conducted to determine criteria used to assign teachers to mathematics courses.

Lesson-Level Results

Textbook Use Diaries were analyzed to describe the extent and nature of teachers' use of the integrated textbook materials during a common lesson. In this diary, teachers notated what textbook pages and problems were used during the instructional period and what problems were assigned as homework for the specified lesson, or for the first 15 consecutive days devoted to the lesson, whichever came first. In addition, teachers noted what and when supplementary materials were used. Furthermore, observational data from the Classroom Visit Protocols were used to gauge textbook use from the perspective of the researcher. During classroom observations, judgments regarding the degree to which the textbook influenced the content taught and the manner of presentation of the mathematics lessons were coded.

Instructional days given to lesson

The first analysis of the diaries examined how many days each teacher spent on the multi-day lesson. The mean number of instructional days is reported in terms of a 7-period day; for those teachers who reported their days on a block schedule, the number of instructional days has been doubled. For year 1, teachers spent an average of approximately 8 days (M = 7.76, SD = 4.04) on the common lesson [Unit 3 Lesson 2, Linear Graphs, Tables and Rules]. In year 2 they spent an average of 14 days (M = 14.33, SD = 6.40) on the common lesson [Unit 2 Lesson 2, Coordinate Models of Transformations]. The distribution of days allocated for year 1 and for year 2 are represented in Figure 11.



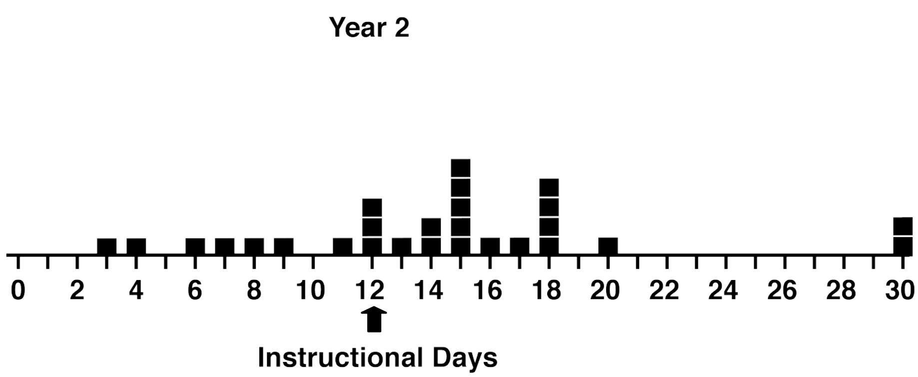


Figure 11: The number of instructional days spent on a common textbook lesson.

In each year, the textbook authors recommended 12 days as the number of days that would typically be spent on these lessons. As the diagrams reveal, in year 1, most teachers devoted far less than the recommended time on the lesson. For example, 17 of 21 teachers spent fewer instructional days than was recommended by the authors; 3 of 21 teachers devoted more instructional time than was recommended; and only 1 teacher spent the recommended amount of time on the lesson. On average, year 1 teachers spent 35% fewer days than the recommended number of instructional days. In year 2, the situation was reversed with 17 of the 27 teachers spending more days than recommended, while 10 of 27 spent fewer, and no teacher spent the recommended number of days on the lesson. On average, year 2 teachers spent almost 20% more instructional days than was recommended.

Elements of textbook lessons utilized

The examination of the number of instructional days provides a general overview of the time spent on the particular content of a lesson but more specific information is revealed from an analysis of the teacher use of the instructional components of textbook lessons. The particular lessons chosen for both year 1 and year 2 contains three investigations. Table 8 displays the percentage of teachers who attended to each lesson component embedded within each investigation across the year 1 lesson and the year 2 lesson. Data are summarized into three categories: (1) Full attention to the component; (2) Partial attention to the component; and (3) No attention to the component (None).

The percentage of teachers skipping an investigation or using none of the lesson components within an investigation increased as teachers moved forward through the investigations comprising the lesson. For example, during year 1, only 9.5% of teachers omitted Investigation 1 while 61.9% of teachers did not use Investigation 3. It is worth nothing that those teachers who did not complete the lesson within the 15 allotted days for the diary may inflate the latter number. Recognizing these caveats, the *Explore* component was skipped least often while the *Share/Summarize* and *Apply* components were most often omitted. For example, on average during year 2, 19.8 % of the teachers did not use the *Explore* component, but 38.3% and 34.6% of teachers omitted the *Share/Summarize* and *Apply* components, respectively. In some cases, although investigations were completed, the *Share/Summarize* and *Apply* components are nonetheless omitted.

Table 8

The percentage of teachers implementing lesson components across a common lesson

Instructional Component	Year 1			Year 2		
	Full	Partial	None	Full	Partial	None
Launch	76.2%	0.0%	23.8%	51.9%	3.7%	44.4%
Investigation 1						
Explore	76.2%	14.3%	9.5%	14.8%	81.5%	3.7%
Share/Summarize	66.7%	0.0%	33.3%	63.0%	11.1%	25.9%
Apply	57.1%	0.0%	42.9%	85.2%	7.4%	7.4%
Investigation 2						
Explore	52.4%	19.0%	28.6%	7.4%	81.5%	11.1%
Share/Summarize	33.3%	0.0%	66.7%	51.9%	11.1%	37.0%
Apply	52.4%	0.0%	47.6%	29.6%	33.3%	37.0%
Investigation 3						
Explore	28.6%	9.5%	61.9%	22.2%	33.3%	44.4%
Share/Summarize	33.3%	0.0%	66.7%	29.6%	18.5%	51.9%
Apply	38.1%	0.0%	61.9%	22.2%	18.5%	59.3%
Across the 3 Investigations						
Explore	52.4%	14.3%	33.3%	14.8%	65.4%	19.8%
Share/Summarize	44.4%	0.0%	55.6%	48.1%	13.6%	38.3%
Apply	49.2%	0.0%	50.8%	45.7%	19.8%	34.6%

The *Apply* component used in the instructional component cycle is not to be confused with the homework component. The *Apply* component contains the *On Your Own* section, a series of questions intended to be used by teachers during class to assess students' level of understanding. In addition to the classroom activities, the *Core-Plus* textbook provides MORE (Modeling, Organizing, Reflecting, Extending) problems that are intended to be *out-of-class exercises* to help students reinforce and extend the knowledge they acquired during the lesson.

Although the authors recommend the MORE problems as a means for assessing the level of understanding of each individual student, the results of this study indicate that teachers did not closely abide by this recommendation. Figures 12 and 13 display the use of the MORE problems by teachers during each year disaggregated by MORE problem type. The dark line represents the author-recommended number of each particular problem type to be assigned. The dotted lines represent an interval of within ±1 about the author recommended number.

As these data reveal, most teachers assigned far fewer problems than the number recommended in the teacher's editions. During year 1, 18 of 21 teachers assigned fewer Modeling problems and 17 teachers assigned fewer Organizing problems than were advised. Among the four types of problems, the Reflecting and Extending tasks were the least assigned problems with 12 teachers not assigning any Reflecting problems and 15 teachers not assigning any Extending problems.

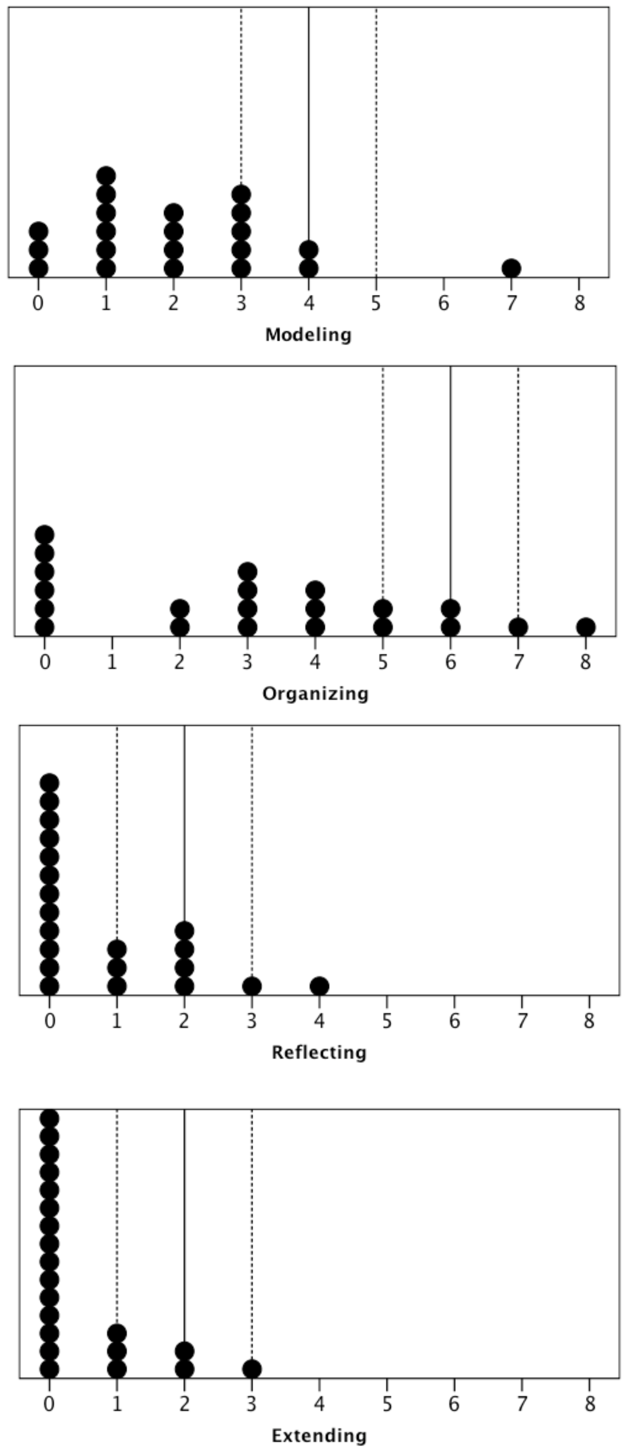


Figure 12: Frequency of the number of MORE problems assigned by teacher during a common lesson, year 1.

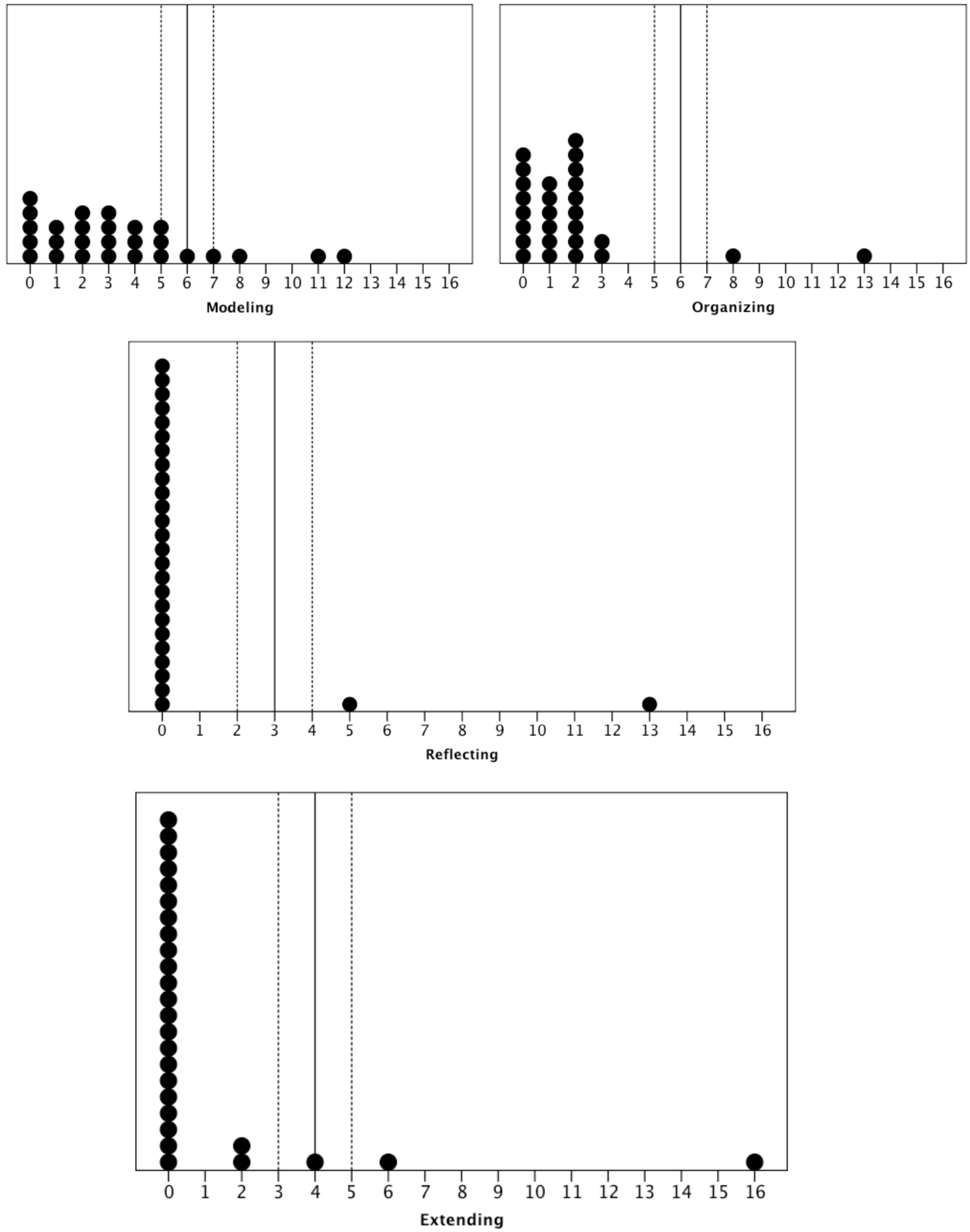


Figure 13: Frequency of the number of MORE problems assigned by teacher during a common lesson, year 2.

This trend is even more pronounced during year 2 in that 22 teachers assigned fewer Modeling problems than recommended and 25 teachers assigned fewer Organizing problems. Again, the Reflecting and Extending problems were rarely utilized with only 2 teachers reporting any use of the Reflecting problems and only 5 teachers reporting use of Extending problems. Moreover, when considering the ± 1 interval across the two years, teachers consistently fall on the lower side of the interval. By a ratio of 4 to 1, teachers were more likely to assign one fewer problem than one more than the number of problems recommended. Furthermore, although MORE problems were designed as outside of class activities, classroom observations revealed several teachers using them as in-class activities. Surprisingly, the diaries also revealed that three teachers during the first year and four teachers during the second year did not utilize *any* of the MORE problems contained within the identified lesson.

Degree of supplementation

The degree of supplementation considers both how often teachers supplemented textbook lessons and how often they substituted material in place of using a textbook lesson. The frequency of textbook use is taken into account in the analysis. First, Figure 14 summarizes the frequency of textbook use as determined from the textbook diaries for a common lesson. In each year, fewer than one-half of the teachers used the textbook more than 90% of the time. In fact, 9.5% of year 1 teachers and 14.8% of year 2 teachers reported using the textbook fewer than one-half of their instructional days. In cases when the textbook was not used, the most popular choice of supplementation was the use of teacher-made worksheets to teach the content. In some cases, teachers reported using videos or skill practice worksheets to prepare for standardized testing.

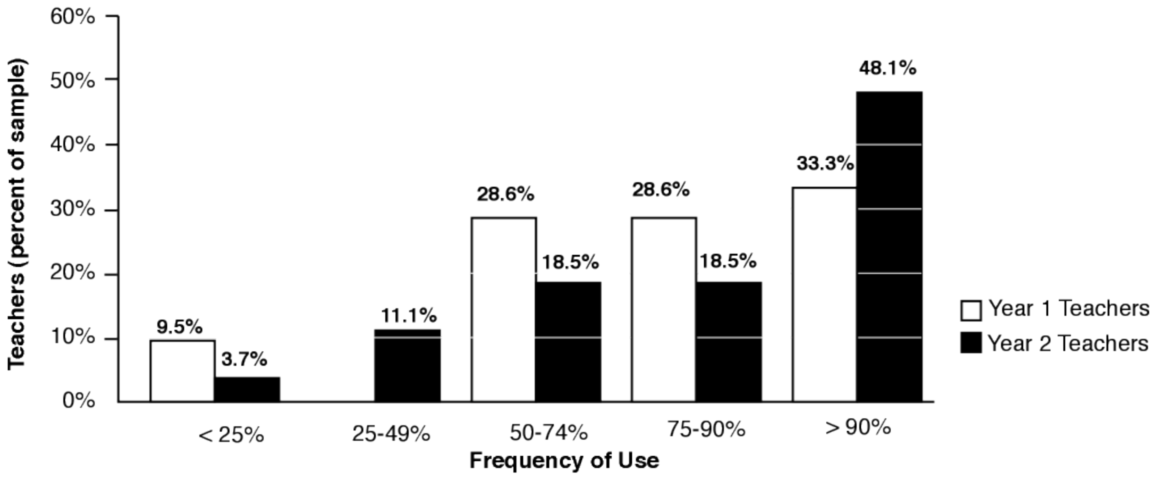


Figure 14: Frequency of textbook use of a common lesson across teachers for year 1 and year 2.

To provide more insight into the use of supplements in relation to textbook use, Figure 15 displays information from textbook use diaries for a common lesson with respect to three categories: (a) the percentage of days *only* the textbook was used; (b) the percentage of days *only* supplements were used; and (c) the percentage of days the textbook was used in conjunction with supplemental materials. These data reveal that during both years the textbook was used exclusively without supplementation more often than the use of the textbook in conjunction with supplemental materials, 62% compared to 23% during year 1 and 73% compared to 11% during year 2. During year 1, teachers more freely used supplements along with the textbook than in year 2. However, the exclusive use of supplementation was similar in both years, 15% in year 1 and 16% in year 2.

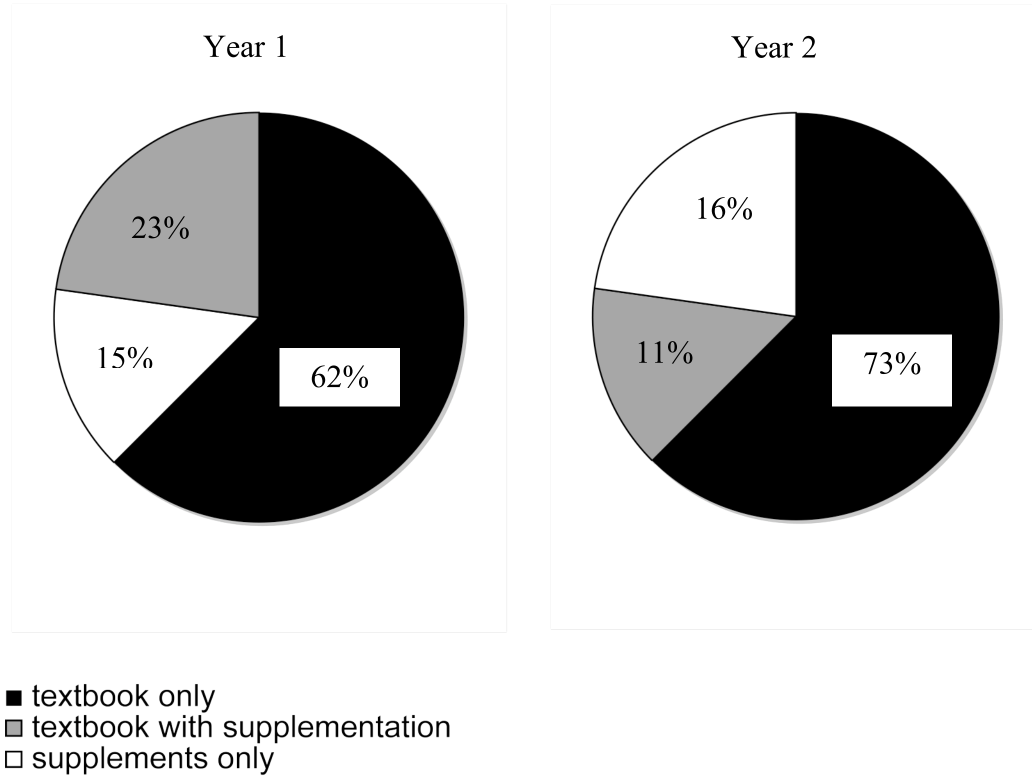


Figure 15: Degree of supplementation of a common lesson.

When examining textbook use via the Classroom Visit Protocols, analyses of Content Fidelity ratings showed that the content used during the observation was primarily attributable to the textbook (see Table 9). For year 1 teachers, the mean Content Fidelity rating was 4.04 (SD = 0.98) on a 5-point scale across 60 observations. For year 2 teachers, the mean Content Fidelity rating was 3.73 (SD = 1.14) across 78 observations. Substantial variation was present within these ratings. For example, during year 2, one teacher was rated consistently with a rating of 5 across three lessons, whereas another teachers received ratings of 1, 3, and 2. In general, lower ratings were given when teachers skipped ideas contained within the lesson or added unrelated content.

Table 9

Teacher Content Fidelity Ratings

Content Fidelity		1	2	3	4	5
		Low		Medium		High
Mean (SD)	**Year 1** (n=21)	4.04 (0.98)				
	Year 2 (n=26)	3.73 (1.14)				

Although the content of the enacted lesson can be attributed to the textbook, consideration was also given to the manner in which the textbook content was utilized in the classroom by coding a measure of Presentation Fidelity. With regard to Presentation Fidelity, the overall ratings were significantly lower than the Content Fidelity Ratings in both school years (Year 1: $t = 6.01$, $p < 0.001$; Year 2: $t = 4.07$, $p < 0.001$). The mean overall Presentation Fidelity (see Table 10) rating was 2.90 (SD = 1.01) across year 1 teachers and 2.88 (SD = 1.21) across year 2 teachers suggesting the *manner* in which the lessons were taught was less consistent with the authors' expectations than was the *content* of lessons taught.

Table 10

Teacher Presentation Fidelity Ratings

Presentation Fidelity		1	2	3	4	5
		Low		Medium		High
Mean (SD)	**Year 1** (n=21)	2.90 (1.01)				
	Year 2 (n=26)	2.88 (1.21)				

Although there was substantial variation across teachers, there was less variation across observations of a single teacher. For example, one teacher was rated consistently with a Presentation Fidelity score of 5 in each of her three observed lessons.

Course-Level Results

Using the Table of Content Records, three opportunity-to-learn indices, OTL, ETI, and TCT were computed for each teacher, each year, across the entire textbook and then in respect to four content strands.

Opportunity to Learn Indices

Overall. The overall mean opportunity to learn (OTL) index across the 21 teachers participating in year 1 was 66.60 with standard deviation of 13.23 as represented in Figure 16. That is, on average in year 1 approximately two-thirds of the content embedded in the integrated textbook was taught. Across the 26 teachers participating during year 2, the mean OTL index was 57.44 with a standard deviation of 8.57 as represented in Figure 16. These indices indicate the percent of content taught to students, *as defined by the textbook;* that is, the percentage of content students were provided the opportunity to learn during each year. Interestingly, although the year 1 mean OTL is greater than the mean in year 2, there was substantially more variation among teachers in year 1. For example, during year 1 the lowest OTL index for a teacher was 42.86 while the highest OTL index for a teacher was 90.91, and during year 2 the lowest OTL index was 41.88 while the highest was 76.00.

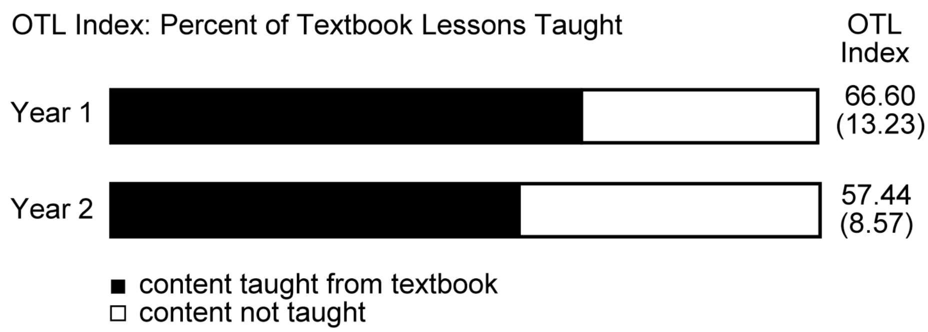


Figure 16: Percentage of textbook lessons taught disaggregated by school year.

Although OTL indices provide one measure of the content from the textbook that is covered, the ETI provides a more refined picture by considering to what degree the textbook is used to teach the content. Figure 17 displays the overall *Extent of Textbook Implementation* index by year. As the data show, across year 1 teachers, slightly less than half of the content (45%) was taught primarily from the textbook, while about 16% of the content was taught with some supplementation, and 6% was taught from alternative resources. Across year 2 teachers, the content taught primarily from the textbook is considerably less than in year 1, but the content taught with some supplementation and from alternative resources is about the same.

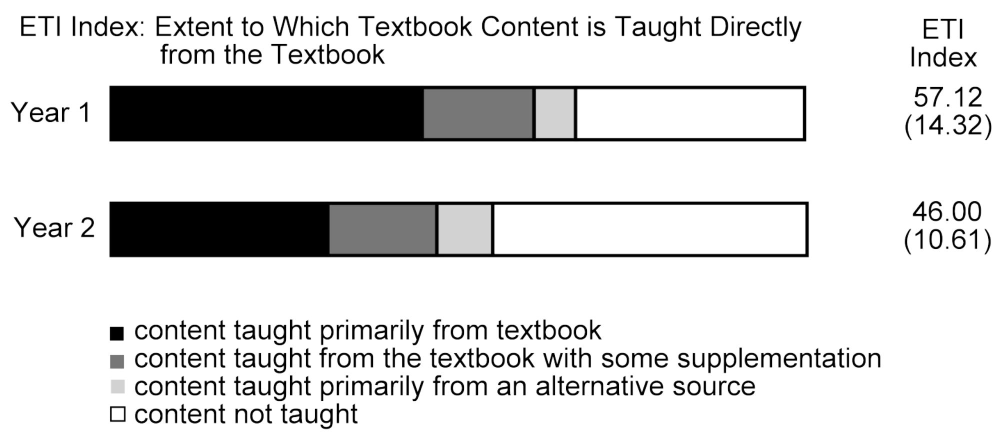


Figure 17: Extent to which textbook content is taught directly from the textbook.

Whereas the ETI indices provide information regarding the use of the entire textbook, the Textbook Content Taught indices narrow the focus to the content embodied in the textbook that was actually taught. Figure 18 displays the TCT indices. As depicted in Figure 18, the results show that for the content taught across year 1 teachers approximately 65% of that content is taught directly from the textbook. During year 2, less content is taught directly from the textbook (56%) as compared to year 1. With regard to content supplementation, the difference is smaller with teachers during year 2 supplementing 29% of the content as compared to 25% during year 1. In general, little content is taught from alternative sources, 9% during year 1, and 15% during year 2.

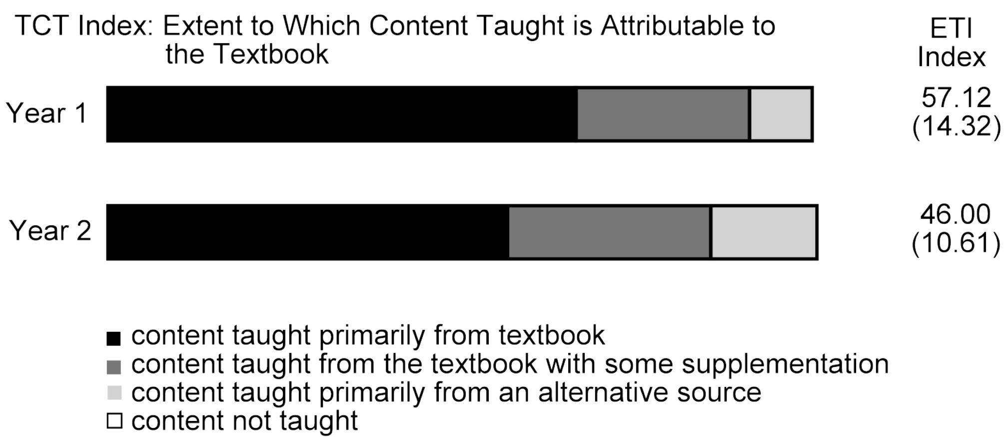


Figure 18: Extent to which content taught is attributable to the textbook.

As the overall indices indicate, year 1 teachers using Course 1 materials on average covered approximately 67% of the content contained within the textbook, whether utilizing the *Core-Plus* textbook to do so or not; year 2 teachers using Course 2 materials covered approximately 57% of the content. Given these results, teachers are clearly making decisions regarding what content to teach and what to omit. Using the same Table of Content Records, the OTL index was computed with respect to each content strand contained within the *Core-Plus* integrated textbook.

Content Strand Indices

The OTL, ETI, and TCT indices reported previously provide information regarding teachers' use of the *Core-Plus* textbook in shaping students' opportunity to learn mathematics. The overall indices do not, however, reveal teachers' tendencies to select particular *strands* of mathematics to teach within the textbook. This issue is addressed in the following sections.

Opportunity to Learn index. As displayed in Figure 19, the results indicate that during year 1, the Algebra and Functions (A & F), Geometry and Trigonometry (G & T) strands, and Statistics and Probability (S & P), received similar attention, while Discrete Mathematics (DM) received somewhat less attention. Students were provided the opportunity to learn approximately three-fourths of the content contained within the textbook for each of these three content strands. However, within these three content strands, the greatest variance existed within the Geometry and Trigonometry strand. For example, four teachers completed every lesson in the Geometry and Trigonometry strand whereas two teachers omitted every geometry lesson contained in *Course 1*. Not only did the Discrete Mathematics strand receive the least amount of attention of the four content strands, with only 60% of the material contained in the textbook being utilized, it was also the strand with the greatest variation across teachers. For example, 3 out of 21 teachers omitted all units pertaining to discrete mathematics whereas only two teachers completed every Discrete Mathematics lesson.

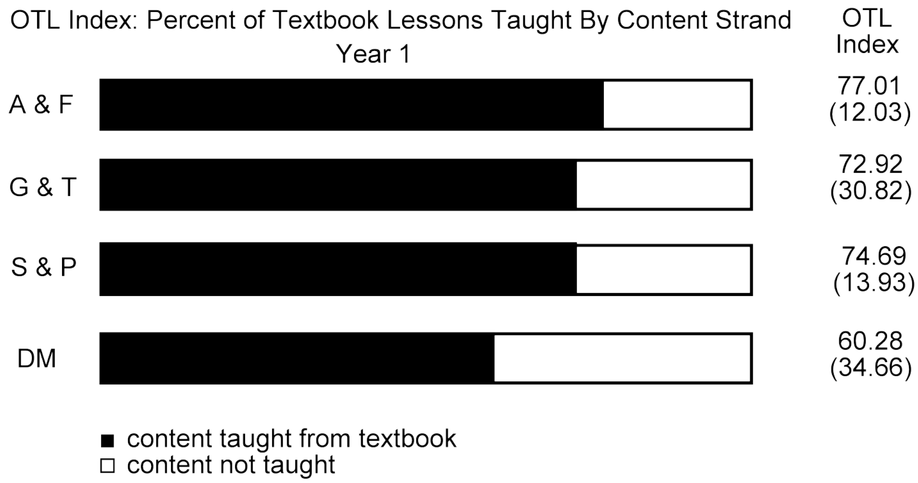


Figure 19: Percentage of textbook lessons taught during year 1 disaggregated by content strand.

Despite the relatively uniform attention given to the various strands by year 1 teachers, the picture is strikingly different in year 2 (Figure 20). In particular, the Algebra and Functions strand not only received the greatest emphasis but it also was implemented the most consistently. Over 90% of the Algebra and Functions content was utilized. In comparison, the remaining three strands received much less attention. Only 27% of the Statistics and Probability content was utilized. Furthermore, the remaining three strands were implemented with considerably more variation than the Algebra and Functions strand. Similar to year 1, the Discrete Mathematics strand also contained extensive variation.

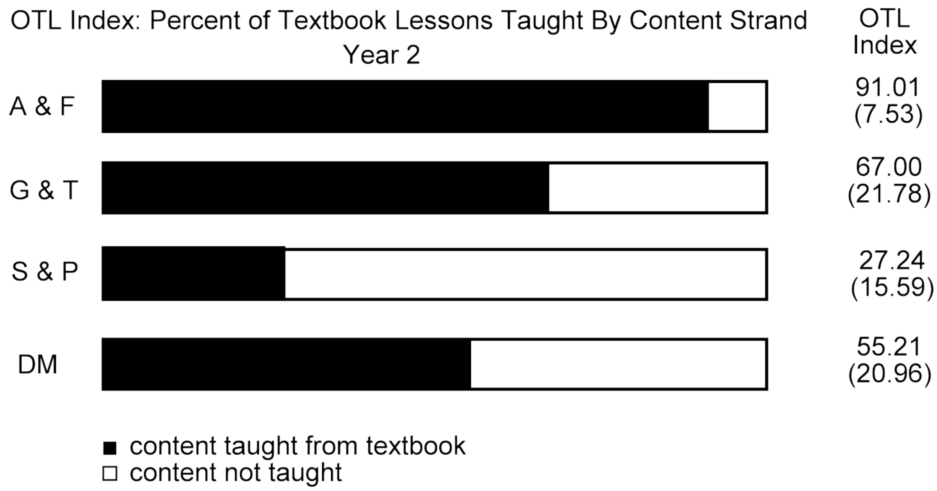


Figure 20: Percentage of textbook lessons taught during year 2 disaggregated by content strand.

Extent of Textbook Implementation index. Figure 21 displays the ETI index for year 1 disaggregated by content strand. As the data show, among the strands, teachers relied more on the textbook when teaching content from the Discrete Mathematics and Statistics and Probability strands. For these two strands, slightly more than half of the content, 51% for Statistics and 58% for Discrete Mathematics, was taught primarily from the textbook. However, teachers supplemented more frequently with the Statistics strand with 20% of the content being taught with some supplementation whereas only 6% of the Discrete Mathematics content was taught with supplementation. In both cases very little of the content was taught from alternative sources, 3% for Statistics and 1% for Discrete Mathematics.

Teachers' greatest use of supplementation emerged in the Geometry and Trigonometry strand with only 38% of the Geometry content being taught primarily from the book, 21% being taught with some supplementation, 15% being taught from alternative materials and 26% not taught. Teachers' textbook use when considering the

Algebra and Functions strand was similar to that of the Statistics and Probability strand but with slightly less variation: 49% of the Algebra content was taught primarily from the book, 20% of the content was taught with some supplementation, and 7% of the content was taught from alternative materials, and 24% of the content was not taught.

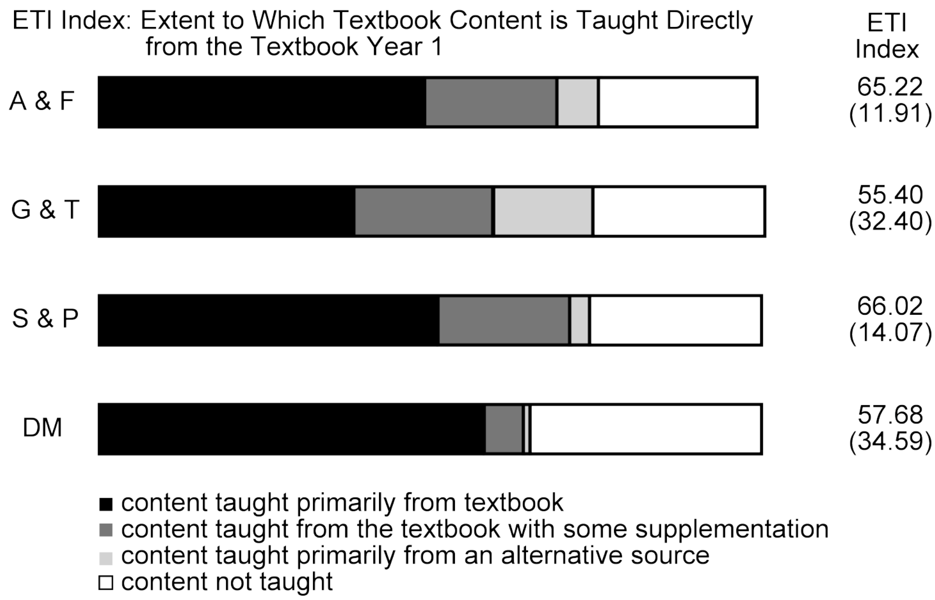


Figure 21: Extent to which textbook content is taught directly from the textbook disaggregated by content strand, year 1.

During year 2, teachers taught content primarily from the textbook most often within the Algebra and Functions strand; 50% of the content compared to 27% for Geometry, 20% for Statistics and 41% for Discrete (Figure 22). Teachers' attention to the content contained in the Algebra and Functions and the Geometry and Trigonometry strands was similar in their extent of supplementation, 26% for Algebra and 23% for Geometry, and use of alternative materials, 13% for Algebra and 18% for Geometry. Little use of alternative materials occurred within the Statistics and Probability strand and the Discrete Mathematics strand, 2% and 1%, respectively.

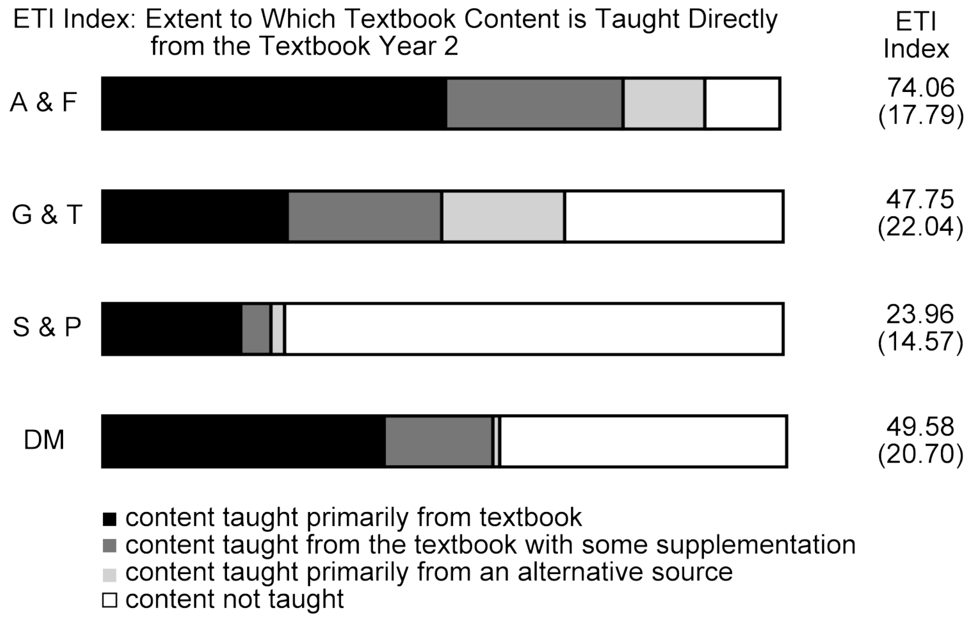


Figure 22: Extent to which textbook content is taught directly from the textbook disaggregated by content strand, year 2.

Textbook Content Taught index. Figure 23 displays the TCT indices for year 1 participants. The results show that when teaching content contained in the textbook, teachers relied primarily on the textbook most often when teaching the Discrete Mathematics content, 90% when compared to 64% for Algebra and Functions, 51% for Geometry and Trigonometry and 69% for Statistics and Probability. The use of supplementation was similar across the first three strands, 26%, 29%, and 27%, respectively, although it was greatest within the Geometry and Trigonometry strand. Moreover, teachers' use of alternative materials was also greatest when teaching Geometry and Trigonometry content (20%) when compared to the other three strands, 10% for Algebra and Functions, 4% for Statistics and Probability, and 2% for Discrete Mathematics.

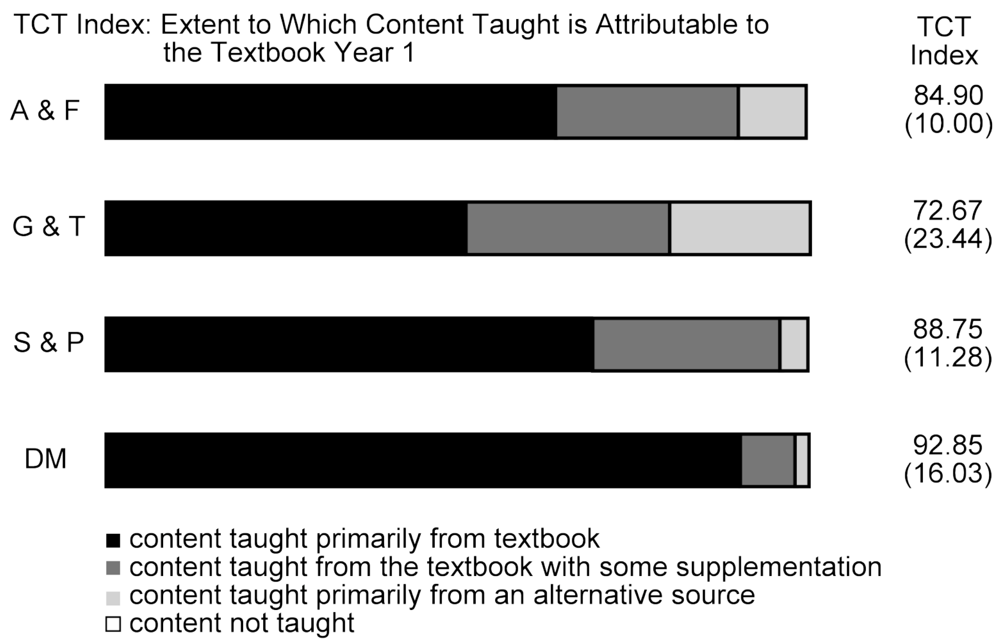


Figure 23: Extent to which content taught is attributable to the textbook disaggregated by content strand, year 1.

During year 2 (Figure 24), the results show that when teaching content contained in the textbook, teachers again relied heavily on the textbook when teaching the Discrete Mathematics content (71%) and seldom on alternative resources (2%) and the trend was similar for the Statistics and Probability content. However, the Discrete Mathematics content was implemented more consistently than the Statistics and Probability content. The pattern of supplementation among all the strands was similar but it was the greatest for the Geometry and Trigonometry strand at 34% when compared to 30% for Algebra and Functions, 21% for Statistics and Probability, and 27% for Discrete Mathematics. The greatest use of alternative materials occurred when teachers were teaching Geometry and Trigonometry content and this was repeated during year 2, 26% as compared to 14% for Algebra and Functions, 7% for Statistics and Probability, and 2% for Discrete Mathematics.

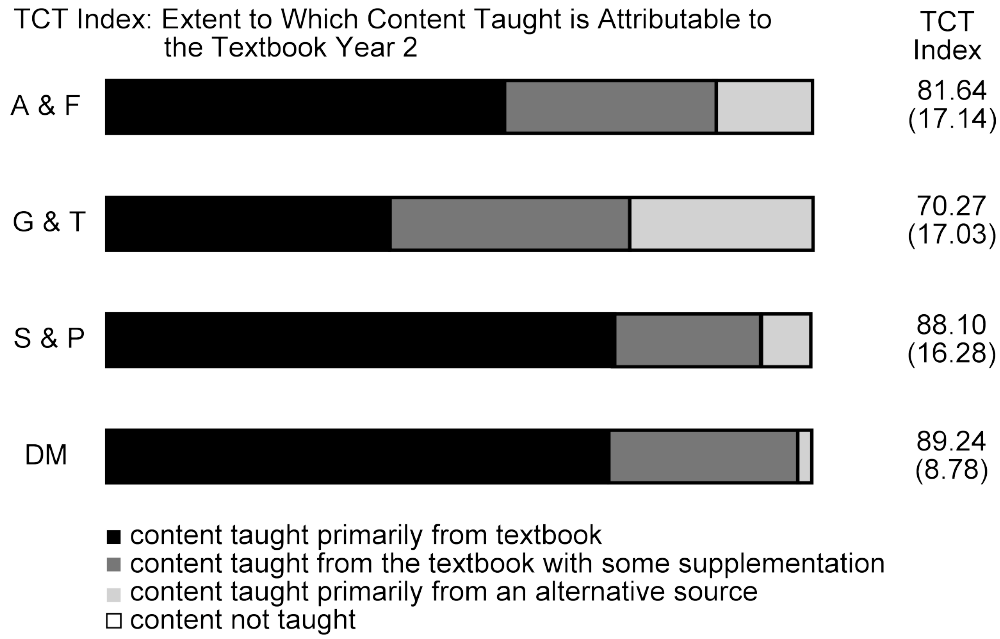


Figure 24: Extent to which content taught is attributable to the textbook disaggregated by content strand, year 2.

Relationship among indices. One-way analysis of variance (ANOVA) was used to examine differences in teacher OTL indices (dependent measures) across the four content strands using alpha = .05 as the predetermined level for the significance tests. The ANOVAs were done separately for year 1 and for year 2 since different teachers were involved in each year of the study. The results of these six ANOVAs (3 OTL indices x 2 study years) are displayed in Table 11.

For year 1, no statistically significant differences were found with respect to students' opportunity to learn across the four content strands when considering the OTL and ETI indices as the dependent measures. However, comparing the TCT indices in year 1, a significant mean difference was detected. In year 2, statistically significant differences among the content strands were found using all three indices.

Table 11

Analysis of variance among content strands

	Year 1		Year 2	
Measure	F	*p*	F	*p*
OTL	1.86	0.144	69.44	<.001*
ETI	0.96	0.417	34.83	<.001*
TCT	5.45	0.002*	9.15	<.001*

**p* < 0.05

In order to determine which content strand means differ significantly from one another, pair-wise comparisons were conducted using Tukey's post hoc comparison test. In year 1, using the TCT index, the results indicated a significant difference ($p < 0.05$) between the Geometry and Trigonometry strand ($\bar{x} = 72.67$) and the Statistics and Probability Strand ($\bar{x} = 88.75$); teachers provided students more opportunity to learn Statistics and Probability content than Geometry and Trigonometry. Another significant difference was found between the Geometry Strand ($\bar{x} = 72.67$) and the Discrete Mathematics Strand ($\bar{x} = 92.85$) with teachers providing students more opportunity to learn Discrete Mathematics content.

During year 2, when comparing strands using the OTL measure as the dependent measure, a significant difference was found between every pair of strands. The OTL means were 91.01 for Algebra and Functions, 67.00 for Geometry and Trigonometry, 27.24 for Statistics and Probability, and 55.21 for Discrete Mathematics. When using the ETI measure as the dependent measure, significant differences were found between the same pairs of content strands as with the OTL measure, with the exception of the pairing of the Geometry and Trigonometry strand ($\bar{x} = 47.75$) with the Discrete Mathematics strand ($\bar{x} = 49.58$) where no significant difference was detected. Finally, when using the TCT measure, significant differences were found only between three pairs of strands.

When pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Algebra and Functions ($\bar{x} = 81.64$), the results were favorable toward the Algebra and Functions Strand. When pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Statistics and Probability ($\bar{x} = 88.10$) the results were favorable toward Statistics and Probability. Lastly, when pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Discrete Mathematics ($\bar{x} = 89.24$), the mean was greater for the Discrete Mathematics strand.

Emphases on strands. Although teachers attended to each content strand, teachers' decisions about what to teach and what to omit resulted in a different emphasis on each strand than is represented in the composition of the written curriculum. Figures 25 and 26 display the emphasis placed on each strand by the authors when designing the Course 1 and Course 2 materials, and the figures also provide a comparison of this information to how much emphasis teachers placed on the respective strands in each course.

In general, the enacted curriculum was similar to the authors' composition of the written curriculum during year 1. The percentage allocation to each strand differed by at most 1%. However, the picture was considerably different during year 2. The enacted percentage allocation to each content strand differed by as much as 17% from what the textbook authors intended. In particular, much more emphasis was placed on Algebra and Functions by the teachers during year 2 than would be expected given the composition of the written curriculum, 40% of the enacted curriculum was Algebra and Functions content as compared to the 23% expected by the textbook authors. This emphasis placed by the teachers came at the expense of the Statistics and Probability and Discrete Mathematics strands. Specifically, the Statistics and Probability content occupied 11% of the enacted curriculum, less than one-half of what curriculum authors expected given the composition of the written curriculum.

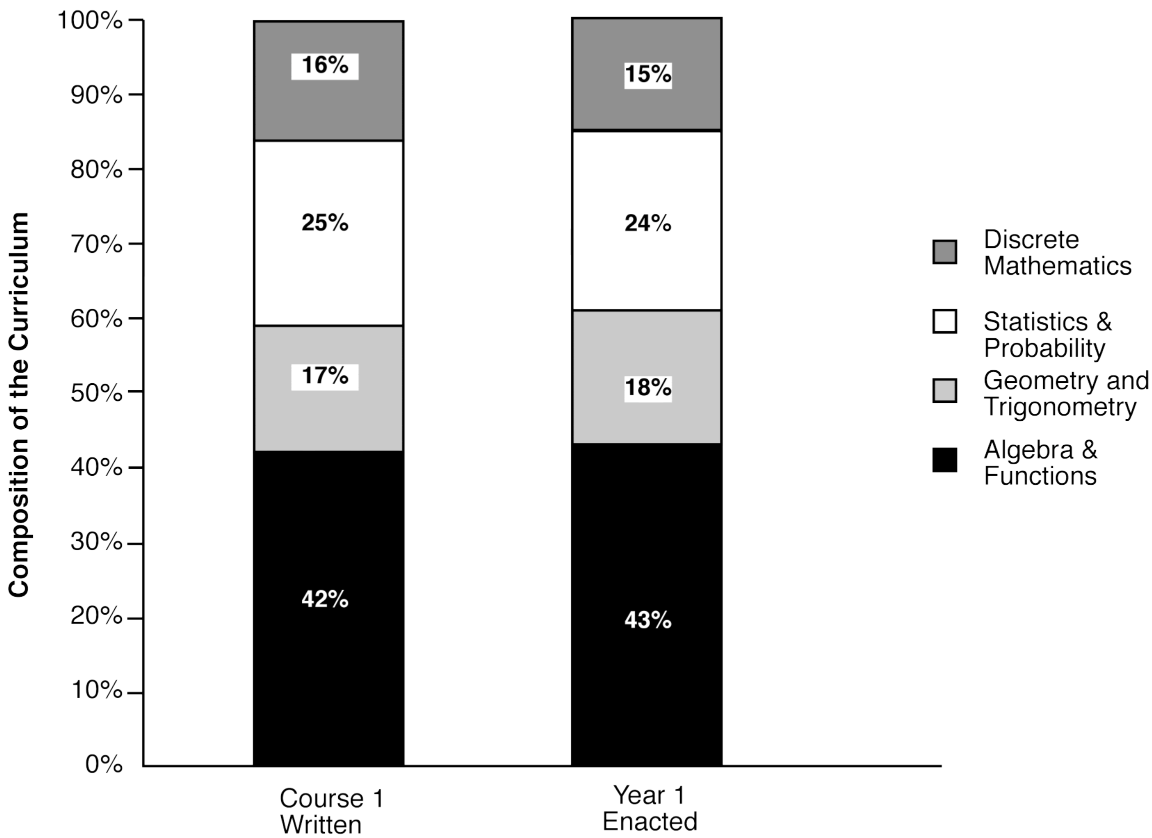


Figure 25: Emphasis placed on content strands in *Core-Plus* Course 1 by textbook authors and by participating teachers in year 1.

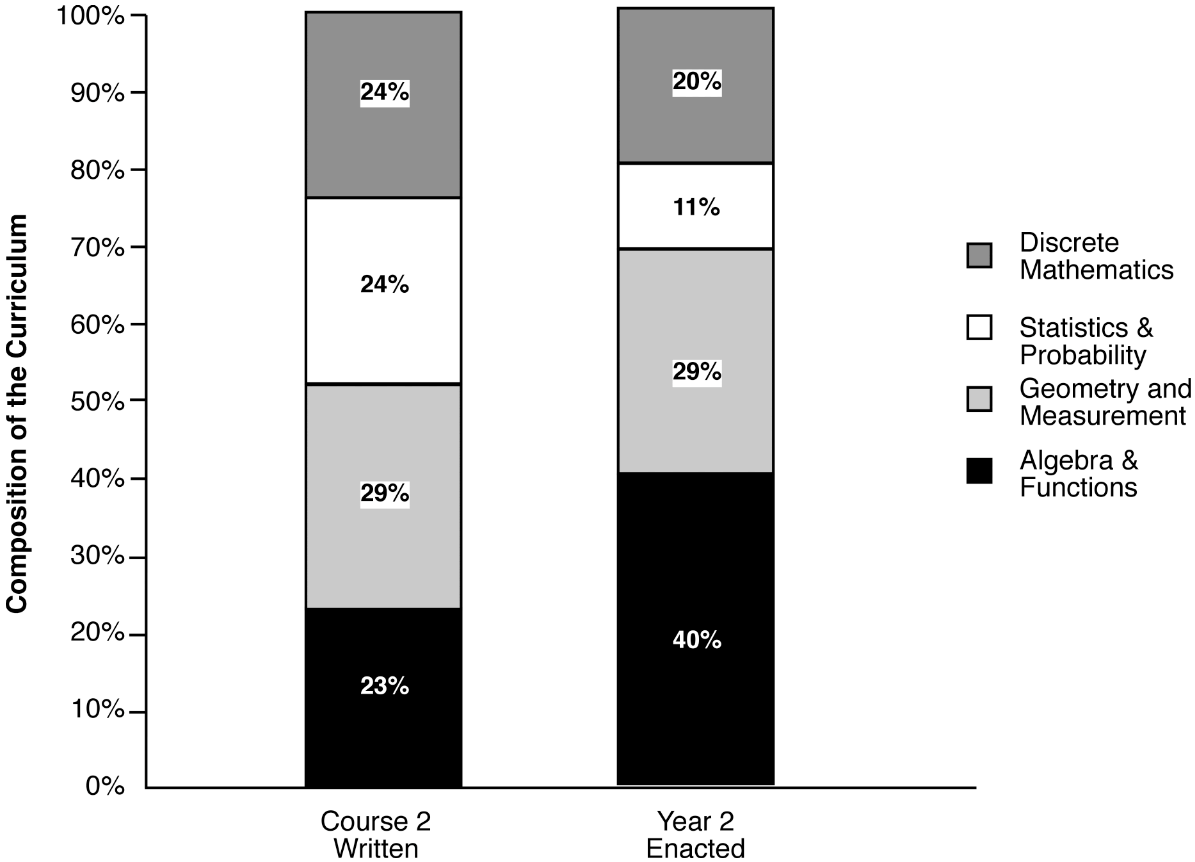


Figure 26: Emphasis placed on content strands in *Core-Plus* Course 1 by textbook authors and by participating teachers in year 2.

For ease of comparison, to measure the overall relative emphasis placed on each content strand by the teachers and the textbook authors, an emphasis index (Tarr et al., 2006) was calculated for each strand. Recall the index is computed by dividing the percent of lessons taught by the percent of lessons contained in the textbook. For example, in Course 1, the composition of the Algebra and Functions strand in the enacted curriculum is 43% but only 42% in the written curriculum is devoted to this content strand in the textbook. So the overall emphasis placed on this strand is 1.02 ($0.43 \div 0.42$). This index indicates that teachers placed slightly more emphasis on the Algebra and Functions strand than would be expected given the composition of the Course 1 textbook (see Figure 27). By way of contrast, during year 2, teachers placed much more emphasis on the Algebra and Functions strand (index = 1.73) than would be expected given the composition of the Course 2 textbook.

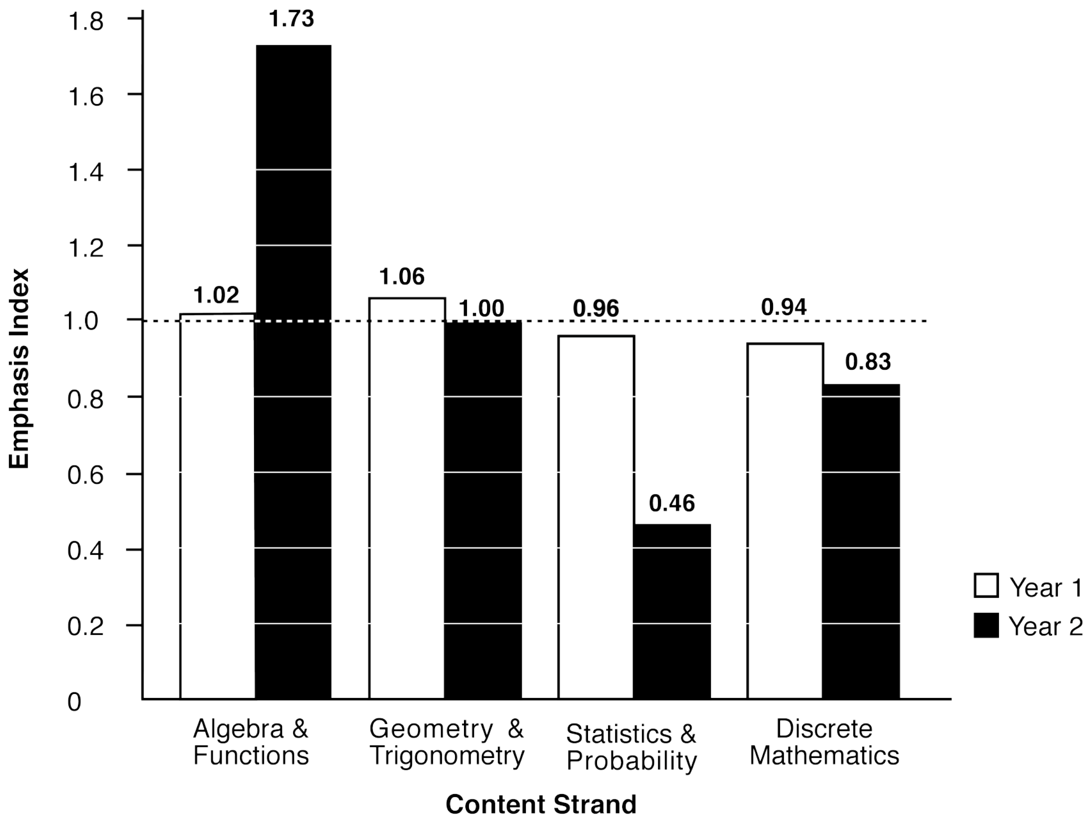


Figure 27: Relative emphasis placed on content strands by teachers as compared to the composition of the *Core-Plus* integrated textbook.

Teacher Assignment to Courses

As these results indicate, teachers relied heavily on the textbook when teaching the content but they did not use the textbook in its entirety or exclusively. Thus, teachers were making decisions regarding what content to teach and what materials to use in order to teach content to students. Teachers' decisions affected OTL, which in turn may influence student achievement. However, any study of the influence of curriculum on student learning should also consider how teachers are placed into classrooms and whether deliberate decisions are made when considering which teachers will teach with an integrated curriculum. In this study, administrative representatives (principal, department chair, or curriculum coordinator) were interviewed at each site to garner information concerning how it is determined which teachers will teach which courses.

The interview questions solicited information at two levels. The questions targeting the first level were designed to gather information regarding how it is determined whether a mathematics teacher will teach courses in the subject-specific pathway or in the integrated pathway. The second-level questions addressed how administrators determined what courses teachers were assigned to teach within each curriculum pathway. Although this was the original intent of the interview, the interviewees largely did not distinguish between different criteria being used at the two levels. Each interviewee noted that scheduling is done within a context of practicality. In other words, before any decisions can be made concerning scheduling or teacher assignment, the number of students requesting a particular course, the number of sections needed to accommodate those requests, and the number of teachers available must be known. Given this information, two levels of consideration emerged that guided administrators' final scheduling decisions in preparing a master schedule: (1) the teaching unit; and (2) the individual teacher. Furthermore, analyses of the interview data revealed the presence of an *informant* at work between the administrator and each of the levels that provided important information when making the final teacher assignment decisions.

Figure 28 depicts the administrators' levels of consideration that influence decisions regarding teacher assignment to mathematics course. The considerations are done within the two levels, teaching unit and teacher, with informants at work between the administration and the respective level. The ovals represent factors that possibly influence the administrators' teacher assignment decisions with respect to that level. The description contained in this section addresses each level individually with the realization that the interplay among these perspectives within the context of practicality is as important as each perspective individually.

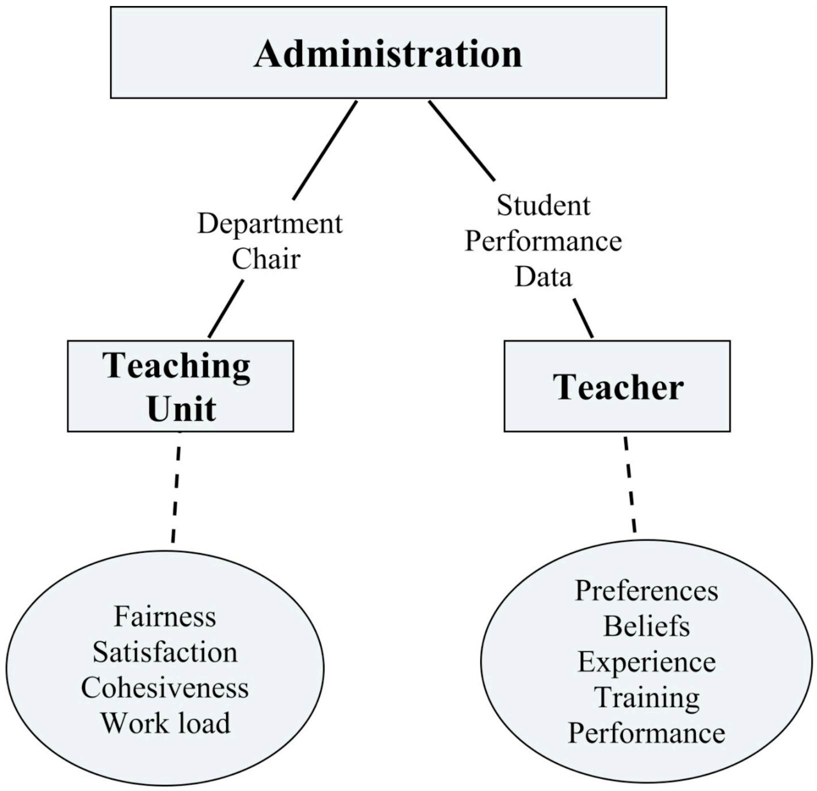


Figure 28: Depiction of administrators' levels of consideration that influence decisions regarding teacher assignment to courses.

Teaching Unit. The teaching unit refers to the group of teachers that comprise a mathematics department within an individual school site. The teaching unit is comprised of two subsets within each site. One subset contains those teachers who are currently teaching in the district and planning to stay. The other subset contains the teachers employed to fill vacancies or new positions. As administrators considered the applicants for teaching positions, they had the opportunity to impact the teaching unit and thus possibly change the dynamics within the teaching unit with regard to willingness to teach or experience with teaching classes utilizing integrated curricula. Through their hiring practices, principals were looking to build a teaching unit that contains individuals who were *willing* to teach with the integrated curriculum. As is evident in the following quotes, principals influence these dynamics in the manner in which they hire teachers.

> Here, I try to hire all math teachers who will teach integrated … so then I have a much larger pool that are reform math oriented. (Principal, School 35)

> People historically do not like to teach integrated, consequently, when I am interviewing math teachers that is one criteria as to will you be interested? If you are not, I may not be interested in you. (Principal, School 60)

Although hiring practices were not an explicit focus of the interviews, analysis nonetheless revealed that it is an important consideration when examining decisions administrators make with regard to the assignment of teachers to courses.

Concomitant with hiring new teachers, administrators expressed a concern for teachers already within the unit. Two common concerns were *teachers' workload* and *job satisfaction*. Concern for workload was managed by limiting the number of preparations for any one teacher to a maximum of two or three courses when possible.

> I try to limit preps to no more than three a day (Assistant Principal, School 70)

> What we try to do, but are not always successful, is try to limit the number of preparations to two…It does not always work out that way (Principal, School 75)

When considering job satisfaction, analyses revealed a pattern of explicating the importance of listening to teachers' input and considering their level of comfort to teach certain courses. These excerpts from two principals were typical of the concerns they expressed:

> I think they [teachers] need to be happy and comfortable (Principal, School 45)
>
> I'm a strong believer that teachers want to teach what they feel most confident in teaching and most competent in teaching. And I'm also a strong believer that if they are empowered to make decisions about what they are going to teach, they are going to be happier and they are going to do a better job. (Principal, School 15)

When it was not possible or feasible to grant each teacher's preferences, administrators spoke of the need to compromise. As one principal (School 15) phrased it, "everyone shares in the wealth and everyone shares in the challenges." In other words, there is a concern that teachers should be assigned to teach both the upper-level courses (e.g., Calculus or Course 4) and at least one lower-level course (e.g., Algebra I or Course 1). When pressed to clarify the importance of this decision, the responses revealed a pattern of perception that discipline problems were more likely to occur in lower-level courses than in upper-level courses and this was true in both curriculum pathways. This concern for perceived fairness across teaching schedules was also evident in analysis of comments by department chairs. One particular department chair (School 80) shared that "sometimes people are not happy [with this year's schedule] so they get first pick the next year." Thus, this process of reaching a compromise could continue over consecutive academic years. Through these negotiation processes, the desired product was a group of teachers within the teaching unit who are more satisfied and ultimately more productive.

Analysis of interviews revealed that the department chair serves as the primary informant who relays teachers' preferences and desires between the teaching unit and the principal. Most principals spoke of a collaborative effort between the department chair and principal to build a master schedule. Typically, the department chair works with the teachers and expresses their desires and preferences across pathways and within pathways. However, an often-used caveat with this collaboration was that the principal had the final say, as the follow quotes exhibit.

> I make the decision as to what people are going to teach. (Principal, School 75)
>
> I am smart enough to know that you hire quality people and you give them autonomy to make decisions about what they do… but I have the final veto. (Principal, School 15)

When asked about possible scenarios for vetoing teachers' wishes, administrators were more specific to a particular situation rather than the teaching unit, as demonstrated in the following quote:

> I didn't feel as though we had enough kids who were getting into calculus and precalculus is a prerequisite. In talking to my calculus teacher, kids were being eliminated who really shouldn't have been eliminated from calculus. They were scared off by precalculus and so I switched around the precal teachers and… I just did some flip-flopping…The charge was let's get more kids into calculus. (Principal, School 75)

Scenarios such as this described by administrators led to another perspectives that must be considered, the individual teacher.

Teacher. Although during each interview consideration of teacher preferences was disclosed, other criteria considered when assigning teachers were more specific teacher characteristics. For example, in order for a teacher to be assigned to teach an integrated course, most administrators expressed a requirement that teachers had gone through some sort of training. This training may be provided by outside professional developers or within a school district by teachers currently using the integrated materials. However, several department chairs made it clear that, despite this requirement, not all teachers of an integrated curriculum had in fact completed any training. On some occasions, this training had consisted of sharing materials within the teaching unit.

The primary criterion for the assignment of teachers to integrated courses was ultimately an expression of their desire to do so. In addition to this criterion, a factor unique to district W was administrators' expression of the need to examine teacher performance, primarily measured with test scores of students on the state test. One principal shared a situation in which a teacher reported being unhappy with her teaching assignment because he removed her from the class she had been teaching. In this case, the principal noted that test results of her students in that particular course were unsatisfactory in his judgment and therefore he felt such a move was necessary. The influence of tests scores was evident in analysis of interviews of other principals within the same district.

> I do look at scores…I do try to take that into consideration when placing teachers (Principal, School 45)
>
> If a teacher has had a couple years of struggling with test scores…Well, I am old enough to know that numbers alone do not tell a story – there's attitudes, attendance, discipline, all types of factors – But if there is a consistent pattern, then I think you do at least have to pay attention to it. Whether we like it or not that's the real world we live in and test scores are plastered all over the state. (Principal, 15)

In general, administrators from district W revealed pressure from a common perception among the public that good teaching and having a good school is somewhat based on test scores. However, this influence was revealed only in reference to this district and therefore appears to be a local phenomenon,

Summary. The primary criteria revealed for assigning teachers to teach courses utilizing integrated curricular materials was a willingness of each individual teacher to do so. In general, administrators relied heavily on teacher preferences and recommendations from the department chair with regard to the schedule of courses for the teaching unit. However, principals reserved the right to veto recommendation based on factors such as classroom management skills of an individual teacher and the success of students on state tests.

In the next chapter, an overview of the entire study is provided. The findings of this study are discussed in relation to the theoretical framework and relevant research and implications of this study are offered. Finally, the limitations of this research are summarized and recommendations for future research are proposed.

CHAPTER V: SUMMARY, DISCUSSION AND RECOMMENDATIONS

Research has established that students learn what they are given the opportunity to learn (Floden, 2002; Hiebert, 1999; Hiebert & Grouws, 2007). In classrooms, teachers are the final decision-makers with regard to the specific mathematics content taught and how it is taught, and they rely heavily on curricular materials to inform such decisions (Grouws & Smith, 2000; Weiss et al., 2001; Weiss et al., 2003). As part of curricular reform, new content has been added to textbooks that bring topics such as statistics, probability, and discrete mathematics to a more central position in the school mathematics curriculum. Moreover, content such as algebra and geometry is presented in a more integrated fashion than embodied in predecessors to standards-based textbooks. However, we know little about the relative emphasis teachers place on content embodied in these standards-based textbooks. In order to understand how mathematics textbooks impact student learning one must also understand how teachers use textbooks in the classroom. Furthermore, when considering curriculum implementation, it is worth knowing how administrators assign teachers to teach mathematics courses using integrated textbooks because teacher beliefs about and disposition toward the courses they are assigned to teach likely affect how the curriculum is enacted. Interestedly, there is a notable lack of empirical research about how such administrative decisions are made.

Student achievement in secondary school mathematics is significantly influenced by the manner in which a textbook is used, the mathematics content students are given the opportunity to learn, and the manner in which the mathematical learning is facilitated; however, our knowledge of the effects of different approaches to mathematical content in textbooks is limited. Furthermore, it is impossible to judge the effectiveness of textbooks and draw inferences regarding student learning from them without knowledge about how textbooks are being used in the classroom (National Research Council, 2004). Studies of teachers' use of mathematics textbooks are needed in order for school personnel, curriculum developers, and policy makers to make informed decisions regarding curriculum adoption. Consequently, this study was designed to gain in-depth understanding behind students' opportunity to learn mathematics from an integrated textbook with respect to the content strands contained within an integrated textbook and to explore how teachers come to teach classes using integrated materials. Specifically, the following research questions were investigated:

Lesson Level

1. To what extent do secondary school mathematics teachers use integrated mathematics textbooks during lessons?
    a. How many instructional days are devoted to the teaching of lessons as compared to the textbook authors' recommendations for the number of class periods to be allocated to the teaching of lessons?
    b. What elements of textbook lessons are utilized during classroom instruction and what problems from the textbook lesson are assigned for homework? How do these teacher decisions compare to author recommendations concerning the use of the elements?
    c. To what degree do teachers supplement the textbook content associated with lessons?

Course Level

2. To what extent do secondary school mathematics teachers provide students the opportunity to learn the *mathematics content embodied* in integrated mathematics textbooks?
    a. What opportunities are provided for students to learn the mathematics associated with the Algebra and Functions strand of integrated textbooks?
    b. What opportunities are provided for students to learn the mathematics associated with the Geometry and Trigonometry strand of integrated textbooks?
    c. What opportunities are provided for students to learn the mathematics associated with the Statistics and Probability strand of integrated textbooks?
    d. What opportunities are provided for students to learn the mathematics associated with the Discrete Mathematics strand of integrated textbooks?
    e. Do students' opportunities to learn vary across the content strands embedded in integrated textbooks?

Department Level

3. How are secondary school mathematics teachers assigned to the courses they teach in schools that offer both a subject-specific curricular path and an integrated curricular path?
    a. How are teachers assigned to courses across curricular paths?
    b. How are teachers assigned to courses within an integrated curricular path?

Summary of Methodology

Using data from the *Comparing Options in Secondary Mathematics: Investigating Curriculum* (COSMIC) project, a descriptive study was conducted to document the nature and extent of textbook use by 44 high school mathematics teachers. Six school districts in five states are participating in the COSMIC study, all of which employ a dual curricular option program (an integrated approach and subject-specific approach) allowing students to choose freely between the two curricular options each school year rather than be assigned to a particular curriculum path based on their past mathematics achievement. The most widely used of the integrated programs in secondary schools, the *Core-Plus* integrated textbook, *Contemporary Mathematics in Context* (Coxford et al., 1998a), was chosen to represent the integrated curriculum option. Twelve school administrators from the participating schools were selected for an individual interview to gather information about the assignment of teachers to the integrated curricular path.

The design of this study necessitated the collection of data using multiple sources and utilized both quantitative and qualitative analyses. The instruments used were two written teacher surveys, Textbook Use Diaries, Table of Contents Records, classroom observations, and interviews with administrators at each participating district. Textbook Use Diaries were coded to determine the number of instructional days devoted to teaching a common lesson across teachers and to ascertain the elements of the textbook lesson utilized by each teacher while teaching the lesson. The diaries were also examined to determine the degree of supplementation teachers employed and the regularity with which they used the textbook. In analyzing the Table of Contents data, three indices were developed: Opportunity to Learn (OTL) index, Extent of Textbook Implemented (ETI) index, and Textbook Content Taught (TCT). These indices were computed first across all lessons contained within the textbook and then within the lessons aggregated by four content strands: (1) Algebra and Functions; (2) Geometry and Trigonometry; (3) Statistics and Probability; and (4) Discrete Mathematics. In addition, Content Fidelity Ratings and Presentation Fidelity Ratings were developed from the classroom observation protocols. Finally, semi-structured administrative interviews were conducted and analyzed to determine the perspectives of administrators with regard to assigning teachers to courses.

Results

Study results are organized and reported via three ascending levels: lesson level, course level, and department level. At the *lesson level*, the focus is on textbook use in relation to a specific lesson. The *course level* is aimed at how teachers use their integrated textbook across the school year. At the *department level,* the focus is on the decision making process that determines which teachers will be assigned to teach classes utilizing integrated textbooks.

Lesson Level

Textbook Use Diaries were analyzed to describe the extent and nature of the use of the integrated materials during a lesson. These diaries were examined in relation to the instructional days given to the lesson, the elements of textbook lessons utilized, homework problems assigned, and the degree of supplementation used during the lesson. Furthermore, observational data were used to gauge textbook use from the perspective of the researcher.

Instructional days. Despite the fact that textbook authors recommended teachers spend 12 instructional days on the particular lessons upon which the Textbook Use Diaries were based each year, 40 of the 44 teachers did not abide by this recommendation. In year 1, most teachers devoted far less than the recommended time on the lesson *Linear Graphs, Tables, and Rules*, while in year 2 most teachers spent more than the recommended number of days on the lesson *Coordinate Models of Transformations*.

Elements of lesson utilized. Each lesson in the *Core-Plus* textbook is designed around a Launch-Explore-Share/Summarize-Apply cycle. The percentage of teachers skipping an investigation (*Explore*) or using none of the lesson components within an investigation increased as teachers moved forward through the investigations comprising the lesson. For example, during year 1 in the lesson that included three investigations, 9.5% omitted Investigation 1 while 61.9% of teachers did not use Investigation 3. There were three teachers who did not complete the lesson within the 15 allotted days for the diary, and as a consequence the latter number may be somewhat of an overestimate. Recognizing the previous caveat, the teachers skipped the *Explore* component least often while skipping the *Share/Summarize* and *Apply* components most often.

With respect to the assignment of homework, the *Core-Plus* textbook provides MORE (Modeling, Organizing, Reflecting, Extending) problems that are intended to be *out-of-class exercises* to help students reinforce and extend the knowledge they acquired during the classroom portion of the lesson. Although the authors recommend the MORE problems as a means for assessing student learning, the results of this study indicate that teachers did not closely abide by these recommendations. Few teachers assigned the number of problems recommended by the textbook authors and the Reflecting and

Extending problems were least likely to be assigned by teachers. In fact, by a ratio of 4 to 1, teachers were more likely to assign one fewer problem than one more than the number of problems recommended. The diaries also revealed that three teachers during the first year and four teachers during the second year utilized none of the MORE problems contained within the identified lesson. Furthermore, although MORE problems were designed as outside of class activities, classroom observations revealed several teachers using them as in-class activities

Degree of supplementation. Fewer than one-half of the teachers reported using their textbook during class periods more than 90% of the time. During both years the textbook was used exclusively without supplementation more often than the textbook was used in conjunction with supplemental materials during a class period, 62% compared to 23% during year 1 and 73% compared to 11% during year 2. Thus, in year 1, teachers more freely used supplements along with the textbook than in year 2. The exclusive use of supplementation was similar in both years, 15% in year 1 and 16% in year 2. In cases when the textbook was not used, the predominant choice of replacement materials was using teacher-made worksheets to teach the content. In some cases, teachers reported using videos or skill practice worksheets to prepare for standardized testing.

Classroom Observations. Analyses of Content Fidelity ratings from the Classroom Observation Protocol indicated that the content of the lessons taught was primarily attributable to the integrated textbook. During year 1, the mean Content Fidelity rating was 4.04 (SD = 0.98) on a 5-point scale and the mean was 3.73 (SD = 1.14) across teachers in year 2.

Although the mathematics content of lessons can be attributed to the textbook, consideration was also given to the manner in which the textbook content was taught through the provision of the Presentation Fidelity measure. The mean overall Presentation Fidelity rating was 2.90 (SD = 1.01) on a 5-point scale across the year 1 teachers and 2.88 (SD = 1.21) across the year 2 teachers. This indicates that the *manner* in which the lessons were taught was considerably less consistent with the authors' expectations than was the *content* of lessons taught. With regard to Presentation Fidelity, teachers' overall ratings were significantly lower than the ratings for Content Fidelity across the two years (year 1: $t = 6.01$, $p < 0.001$; year 2: $t = 4.07$, $p < 0.001$)

Course Level

Overall. The analysis of the Table of Content records showed that on average year 1 teachers taught approximately 67% of the content embodied in the integrated textbook to students during the school year whereas in year 2 the percentage decreased to 57%. These results clearly show that a substantial portion of the integrated textbook was not taught in year 1, and an even smaller portion was taught from Course 2 the following school year.

A more refined measurement of curriculum implementation, the *Extent of Textbook Implementation* (ETI) index showed that on average in year 1, slightly less than one-half of the content (45%) was taught primarily from the textbook, about 16% of the content was taught with some supplementation, a small portion (6%) was taught from alternative resources, and about 33% was not taught. Across year 2 teachers teaching Course 2, the content taught primarily from the textbook was considerably less than in year 1 (32%) but the content taught with some supplementation and from alternative resources was approximately the same, 16% and 9% respectively.

When considering only the textbook lessons taught, the *Textbook Content Taught* (TCT) index showed that across year 1 teachers, approximately 65% of the content was taught directly from the textbook, however, during year 2, less content was taught directly from the textbook (56%). The content supplementation difference was smaller between years with teachers during year 2 supplementing 29% of the content, compared to 25% during year 1. In general, little content was taught from alternative sources (9% during year 1, and 15% during year 2).

Algebra and Functions. During year 1, teachers provided students the opportunity to learn approximately 77% of the Algebra and Functions content contained within the textbook, while teachers in year 2 covered 91% of the Algebra and Functions content. In both years, teachers displayed less reliance on the textbook when teaching the Algebra and Functions content in comparison to the Statistics and Probability and Discrete Mathematics strands.

Geometry and Trigonometry. During year 1, teachers taught approximately 73% of the Geometry and Trigonometry content contained within the textbook while teachers in year 2 covered 67% of this content. When considering only textbook lessons taught, teachers in both years exhibited the least reliance on the textbook and the greatest use of alternative materials when teaching the Geometry and Trigonometry content in comparison to the other three content strands.

Statistics and Probability. In contrast to other content strands, teachers were not consistent in providing students with opportunities to learn Statistics and Probability across the years. On the one hand during year 1, students were provided the opportunity to learn approximately 75% of the Statistics and Probability content contained within the textbook, but during year 2 this opportunity decreased drastically to 27% of the Statistics and Probability content. In both years, teachers displayed a great reliance on the textbook and little use of alternative materials when teaching the Statistics and Probability content. The only other strand in which more reliance on the textbook was displayed was the Discrete Mathematics strand.

Discrete Mathematics. Teachers' use of the content contained within the Discrete Mathematics strand was similar across the two school years. Although during year 1, this strand received the least attention, students were still provided the opportunity to learn approximately 60% of the Discrete Mathematics content. During year 2 this opportunity decreased slightly to 55% covered but still received more attention than the Statistics and Probability strand. Teachers displayed the greatest reliance on the textbook and very little use of alternative materials when teaching the Discrete Mathematics content contained within the integrated textbook.

Relationships among strands. One-way analysis of variance (ANOVA) was used to examine differences in teacher opportunity to learn indices (dependent measures) across the four content strands using alpha = .05 as the predetermined level for the significance tests. The ANOVAs were computed separately for years 1 and 2 because different teachers were involved in each year of the study. For year 1, no statistically significant differences were found with respect to students' opportunity to learn across the four content strands when considering the OTL and ETI indices as the dependent measure, but when comparing the TCT indices a significant mean difference was detected. For year 2, statistically significant differences among the content strands were found using all three indices.

In order to determine which content strand means differ significantly from one another, pair-wise comparisons were conducted using Tukey's post hoc comparison test. In year 1, using the TCT index, the results indicated a significant difference ($p < 0.05$) between the Discrete Mathematics strand ($\bar{x} = 92.85$) and the Geometry strand ($\bar{x} = 72.67$) with teachers providing students more opportunity to learn Discrete Mathematics content. Another significant difference was detected between the Statistics and Probability Strand ($\bar{x} = 88.75$) and the Geometry and Trigonometry strand ($\bar{x} = 72.67$) with teachers providing students more opportunity to learn Statistics and Probability content than Geometry and Trigonometry.

During year 2, when comparing strands using the OTL measure as the dependent measure, a significant difference was found between every pair of strands. The OTL means were 91.01 for Algebra and Functions, 67.00 for Geometry and Trigonometry, 27.24 for Statistics and Probability, and 55.21 for Discrete Mathematics. When using the ETI measure as the dependent measure, significant differences were found between the same pairs of content strands as with the OTL measure, with the exception of the pairing of the Geometry and Trigonometry strand ($\bar{x} = 47.75$) with the Discrete Mathematics strand ($\bar{x} = 49.58$) where no significant difference was detected. Finally, when using the TCT measure, significant differences were found between three pairs of strands. When pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Algebra and Functions ($\bar{x} = 81.64$), the mean was greater for the Algebra and Functions strand. When pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Statistics and Probability ($\bar{x} = 88.10$) the mean was greater for the Statistics and Probability strand. Lastly, when pairing Geometry and Trigonometry ($\bar{x} = 70.27$) with Discrete Mathematics ($\bar{x} = 89.24$), the Discrete Mathematics strand had the greater mean.

Emphases among strands. Although teachers were attending to each content strand, teachers' decisions about what to include and what to omit result in a different emphasis on each strand than is represented in the composition of the written curriculum. In general, during year 1, the composition of the enacted curriculum is similar to the authors' content composition of the written curriculum. However, the picture was considerably different in year 2 with teachers placing much more emphasis on Algebra and Functions than would be expected, given the composition of their textbook. This emphasis on Algebra and Functions came at great expense to the Statistics and Probability strand and, to a lesser extent, at the expense of the Discrete Mathematics strand.

Department Level

Ultimately the primary criterion for the assignment of teachers to teach integrated courses was simply an expression of teachers' desire to do so. During interviews conducted at each site, administrators regularly described scenarios in which teachers volunteered to teach integrated courses and were happy to do so. In addition, within the integrated pathway, teacher preference and recommendations from the department chair were heavily considered. The department chair played the role of *informant* by relaying each teacher's preference to the school principal and often provided a recommended schedule for the teaching unit. According to administrators, teachers were expected to be able to teach both upper level and lower courses, but each teacher's classroom management skills also impacted this course assignment decision. Thus, the ability of a teacher to manage their classroom provided one possible reason a principal could veto a teacher's course preferences.

Discussion of Key Findings

The variance across these teachers revealed in these results reinforces previous research findings that curriculum implementation is an uneven process (Chval, Chávez, Reys, & Tarr, 2009; Grouws & Smith, 2000; Kilpatrick, 2003; National Research Council, 2004). Thus, when examining what students are learning when interacting with specific mathematics curricula, results of this study lend credence to the notion that we cannot assume these curricula are being implemented in any specific way (Scott, 1994) nor that the enacted curriculum matches the curriculum embodied in the textbook. In order to document and describe teachers' use of an integrated curriculum, textbook implementation was examined in this study using a textbook implementation framework (adapted from Chval et al., 2009) comprised of three essential components: regular use of the textbook, use of a significant portion of the textbook, and the consistency with pedagogical orientation.

Regular use of the textbook

The Textbook Use Diaries revealed that all teachers used the textbook and other supplementary materials to teach the content of the common lesson studied. Although teachers sometimes opted to supplement with other materials such as teacher-made worksheets or alternative curricular materials, approximately two-thirds of the teachers used the textbook more than 75% of the time during that lesson. This is consistent with previous research, which has noted that the textbook is the primary resource used to teach mathematics (Ball & Cohen, 1996; Grouws & Smith, 2000; Robitaille & Travers, 1992; Weiss, Pasley, Smith, Banilower, & Heck, 2003).

Although teachers use the textbook as the primary resource for content, further analysis regarding the number of instructional days spent on the content revealed that teachers vary considerably from the authors' recommendations outlined in the integrated textbook. The results for teachers who spend fewer days than recommended may suggest that these teachers are sensitive to their students' needs when deciding how long to spend on the particular content. The results for teachers spending more days using supplementation may suggest that teachers are unaware of how the curriculum program is designed and may believe important mathematics content is missing from their curricular materials. Alternatively, these teachers may believe that their textbook does not adequately address important content that they believe is critical to success on state-mandated tests. Or it is possible that these teachers simply have a desire to use their own ideas in place of those in the textbook or are continuing to use ideas from previous curricular materials that they found to be beneficial. The reasons for teachers' deviation from textbook recommendations were not established in this study, but they merit further research.

Use of a significant portion of the textbook

The Table of Contents Records provided the information for the second component of textbook implementation, use of a significant portion of the textbook. Given that during the course of two years, as much as one-third of the content taught includes some use of supplementary materials, the impact of this particular curriculum on student learning can be called into question, if this supplementation is not accounted in the design of research studies concerning curricular effectiveness.

In light of the overall results of content coverage, a closer examination of the content utilized from the textbook is warranted. Teachers are making decisions regarding what content to teach and what to omit and these decisions clearly impact students' opportunity to learn particular content. For example, if teachers were using an algebra textbook, the content omitted would most likely be algebraic content. However, when teachers are using an integrated textbook, the source of the content omitted might have originated from any of the four strands contained within the textbook. The results from this study during year 1 revealed that, on average, the Algebra and Functions strand, Geometry and Trigonometry strand, and the Statistics and Probability strand received similar attention. However, during year 2, the Algebra and Functions strand received considerably more attention at the expense of other three content strands. This is consistent with the results of the Tarr et al. (2006) study examining middle school teachers' enacted lessons by content strand. In particular, they found that teachers of NSF-funded textbooks emphasized Number and Operation and Algebra significantly more than Geometry and Measurement and Data Analysis and Probability. Thus, the distribution of enacted material differed significantly from the distribution of content within the written material. Given that two studies of NSF-funded curricula, albeit at different grades levels, resulted in similar findings, questions emerge as to why this is the case.

Plausible reasons for teachers' differential attention to content strands may be attributable to the timing of this particular course within a student's mathematical education. In other words, the year 2 integrated course is the second in a series of four courses and would most likely be taken during a student's 10^{th} grade year, a targeted testing grade within the requirements of mathematics testing outlined in No Child Left Behind. In her study, Bowzer (2008) reported the influence of state testing programs on the composition of district curriculum guides in order to ensure students' opportunity to learn key mathematical content. If district guides are not available, teachers may decide to focus on Algebra and Functions content because they perceive it to be the content mostly likely to be included on the test (Stecher & Barron, 2001). Other reasons for a heavy emphasis on Algebra and Functions might include teachers' lack of content knowledge with regard to Statistics and Probability or Discrete Mathematics. Furthermore, teachers may give preference to those content strands that they perceive students will need for college.

Another possible conjecture may be that some adaptations were made in order to achieve greater resemblance between the mathematical content in the integrated and subject-specific pathways. However plausible, this conjecture was not ultimately supported by the data in this study. Results indicated that in year 1 the teachers of the integrated curriculum did not emphasize algebra dramatically more than would be expected given the composition of their textbook, and in year 2 the emphasis index for Geometry and Trigonometry was exactly 1.00. Regardless, the cause of wide range of differential attention to content strands across two years suggests that additional research is warranted.

Other interesting research questions arise from the result that teachers relied heavily on the textbook for teaching Discrete Mathematics content and less so for content within the Algebra and Functions strand. One possible reason might be that worksheets for Algebra and Functions are more prevalent and therefore more readily located by teachers. Likewise, teachers can open a high school Algebra textbook and draw upon its content for use with students in classrooms studying from integrated curriculum, but they do not have this possibility with regard to a high school Discrete Mathematics textbook. Finding supplemental materials for Discrete Mathematics content is simply more difficult than for other content strands. Teachers may also feel less comfortable with teaching Discrete Mathematics content and thus, when teaching the content, use the integrated materials as their primary guide for teaching. Perhaps, as Smith (1996) purported, implementing standards-based textbooks has the potential to threaten a teacher's self-efficacy and so teachers may be retreating to more familiar, comfortable methods or materials they have previously used in order to preserve their self-efficacy. Although these questions provide fodder for future research, they were beyond the scope of this study.

Consistency of pedagogical orientation

The frequency of textbook use, emphasis on content strands, and covering a significant portion of the textbook do not depict the entire story with regard to textbook implementation because further complexities become evident when one looks *within* an a textbook lesson. The consistency with pedagogical orientation of the textbook was examined in terms of the components constituting the textbook's instructional cycle (Launch-Explore-Share&Summarize-Apply) contained within the lesson as reported on the Textbook Use Diary. This analysis revealed that teachers consistently used the *Explore* component while often skipping the *Share & Summarize* and the *Apply* components. Thus, even though teachers use the textbook on a regular basis to teach the content, results of this study suggest that they are not using the complete instructional cycle to do so. The omission of certain elements of the instructional cycle may suggest that teachers have a lack of understanding of the purpose of each part of the cycle.

Further disruption of the instructional cycle was evident in the analyses of the MORE exercises that showed few teachers assigned the Reflecting and Extending tasks, which are used to encourage students self-evaluate their understanding and to delve deeper on a particular mathematical topic. Although reasons for not assigning these exercises were not explicitly investigated in this study, teachers may fail to see the purpose of assigning such problems or feel that they do not serve to bolster mathematical learning. Another possible scenario is teachers may feel that these problems are too difficult for their students. Moreover, these problems often ask students to describe how they would solve a particular problem or explain why a particular situation does not make sense. Mathematics teachers may feel unprepared to grade problems that will yield a wide variety of responses or may feel overburdened to grade such problems while balancing other teaching responsibilities.

Pedagogical consistency was also examined using the ratings of Presentation Fidelity from the Classroom Visit Protocols. In general, teachers tend to be more faithful in terms of *Content Fidelity* than *Presentation Fidelity* of the lesson. The lower ratings on the Presentation Fidelity support the contention of Ball and Cohen (1996) that teachers transform the textbook as they prepare and teach lessons. Many new curricular programs include presentation strategies that are not well developed as part of many teacher education programs (e.g., an investigative approach to instruction, use of small cooperative groups). Furthermore, teachers may find it difficult to use a curriculum that conflicts with their beliefs about how mathematics should be taught (Stein et al., 2007). These reasons may help to explain the wide range in Presentation Fidelity ratings observed across teachers.

Taken together, these three components describe the variation in textbook implementation of an integrated textbook across teachers and across schools. These findings are consistent with relevant literature regarding teachers' reliance on textbooks (Grouws & Smith, 2000; Robitaille & Travers, 1992; Tyson-Bernstein & Woodward, 1991; Weiss et al., 2003); however, this study is unique in the fact that all the teachers were using an integrated textbook. The Presentation Fidelity ratings that are lower than the Content Fidelity ratings provide evidence that adopting a particular curriculum does not ostensibly yield changes in instructional practices (Ball & Cohen, 1996).

Discussion regarding teacher assignment

When examining the components of textbook implementation, it must be recognized that each teacher brings a unique perspective to textbook implementation. Although we know from previous research that teachers may modify curricula based on their personal beliefs, knowledge, and experience within the mathematics classroom (Chávez, 2003; Remillard, 2005; Stein, Remillard, & Smith, 2007), we know very little about how teachers are assigned to use specific textbooks, especially within schools incorporating dual paths. These two paths will provide different opportunities and experiences for the students. Within this study, a majority of the teachers reported that they were familiar with the *Standards*, agreed with the vision portrayed in the *Standards,* and felt at least somewhat prepared to use the integrated textbook. This may explain administrator comments about the overall willingness of teachers to teach the courses within the integrated curriculum. Nevertheless, administrators referred to teacher input as only one recommendation taken into account in assigning teachers to courses. They also considered the student perspective when making the final decision.

Implications of the Study

Two primary arenas for implications of this study are worthy of attention, one with respect to research and the other with respect to practice.

Research Implications

Given that during the course of two successive school years, as much as one-third of the content taught includes the use of supplementary materials, any measures of the impact of this particular curriculum on student learning should be re-examined, if this supplementation was not accounted for during data analysis. Measures of opportunity to learn in the past have been simple dichotomies, but these do not provide an adequate picture of the degree to which the textbook is used to teach content. Using the three indices computed in this study, OTL, ETI, and TCT, provides a much more robust documentation of textbook use. While the OTL index provides information on whether students are learning a topic, the ETI and TCT indices provide a more refined measure of the extent to which the textbook is used in teaching mathematics content.

Although the data to compute these indices is gathered through teachers' self-report, the information is useful when it is not feasible to visit a classroom on a daily basis. The Table of Contents Records and the Textbook Use Diaries ask teachers to record information at the end of each day of instruction, which reduces the problem of teacher recall and thus increases the chances of a more accurate report (Rowan & Correnti, 2009). Effective yet simple, instruments can yield robust information to educational researchers as well as school administrators who assess and monitor reform efforts. However, these types of instruments should not preclude conducting classroom observations. Visits to a teachers' classroom add important information about *how* teachers use curricular materials.

School districts have their choice of a large number of textbooks from which to make their textbook adoption and these textbooks differ in substantive ways from one another. High quality studies of how teachers use certain types of curriculum are needed in order for curriculum developers to make informed decisions about how to increase students' mathematics learning. Understanding how teachers use textbooks assists researchers when building theory concerning the impact of curriculum on student achievement.

Practical Implications

Within school districts, if textbooks are selected on the basis of content included and emphasized within the textbooks, then those concerned with what mathematics students learn (e.g., principals, department chairs, curriculum coordinators) need to be aware that teacher decision-making may not be consistent with the intentions associated with the textbook selection. Teachers make decisions regarding what content to teach and what to emphasize and these decisions impact students' opportunity to learn mathematical content. Furthermore, administrators need to be aware of the inequity of students' opportunity to learn content within their own school. Often departments chairs or district curriculum coordinators formulate pacing guides to provide uniformity in the content students are provided the opportunity to learn, however without some enforcement or monitoring, teachers may not adhere to the guides. Albeit teachers need flexibility and some professional discretion in order to respond to their students' needs, but given that some teachers spend 15 times as many instructional days on a lesson as other teachers, there is a need for increasing equity in students' opportunities to learn. Consequently, pacing guides whose use is monitored provide one avenue for narrowing such disparities.

One of the goals of this study was to explore how teachers are assigned to classes utilizing integrated textbooks. This study demonstrated that a teachers' expression of a desire to teach with an integrated curricular program was the primary criteria used to determine teacher assignments. However, an expression of the desire to teach may not be a sufficient criterion for assigning teachers to teach with a *standards-based* program in place. The development of the *Core-Plus* curricular program was guided by philosophical and design principles (Fey & Hirsch, 2007) that should be well understood by teachers implementing the program. Teachers need to understand how integrated curricula are organized and why there is an instructional cycle within each lesson. Teachers need to aware of the purpose of each component of the instructional cycle, since disruption of the instructional cycle may result in the lack of students making connections across lessons and content strands. Moreover, administrators need to be aware of the nature of integrated curriculum so they make informed decisions with respect to assigning teachers to classrooms using integrated curriculum.

Limitations of the Study

Specific to the conduction of this study, limitations originate from two sources: (1) the data collection instruments and (2) the examination of only one integrated program.

Several methods of data collection are employed in this study although a substantial part of the data originates from teacher self-reported data. For example, regarding the documents teachers are requested to complete, it is difficult to know whether the self-reported data accurately reflect the extent to which teachers are making use of their textbook and thus, self-reported data must always be interpreted with some degree of caution (Porter, 2002) . Fortunately, the data were triangulated with classroom visits, but teachers were observed at most three times.

The data collected from the administrator interviews were limited to one interview session and did not yield particularly robust information. Although interviewees were willing to share information, they seemed to have difficulty moving beyond the practical constraints within which they prepared teaching schedules in order to discuss more profoundly the decisions made when assigning teachers to courses. Furthermore, the interviewees who were employed as a principal of a school seemed particularly apprehensive in discussing teachers' knowledge and backgrounds.

The second study limitation stems from the sole focus on the *Core-Plus* program, *Contemporary Mathematics in Context* (Coxford et al., 1998a) adopted as the integrated approach to be investigated in this study. Although this particular curriculum is worthy of study and is a reasonable representative of integrated mathematics textbooks, other *standards-based* secondary mathematics programs exist and thus the generalizability of study results must take this limitation into account.

Recommendations for Future Research

One study is clearly not sufficient to adequately describe the complexity of teacher-curriculum interactions. Through the course of this dissertation, the extent to which the textbook is implemented in each classroom was carefully documented as was the differential treatment teachers placed on various mathematical content strands (i.e., Algebra and Functions, Geometry and Trigonometry, Statistics and Probability, and

Discrete Mathematics), but this study limited the choice of integrated textbooks to *Core-Plus.* However, not all integrated textbooks are designed similarly. For example, the design of the *Interactive Mathematics Program* (Fendel, Resek, Alper, & Fraser, 1997) is problem-centered. In other words, each unit is designed around a central problem whose solution requires concepts from various strands of mathematics and students explore to solve the problem over the course of the unit (Fendel, Resek, Alper, & Fraser, 1998). *Mathematics: Modeling Our World* (Consortium for Mathematics and Its Applications, 1998) is application based in that it arranges units around contexts and applications rather than mathematical topics. With these differences in design, it would be worthwhile to examine how other integrated textbooks are implemented in classrooms and the differential treatment teachers place on various mathematical content strands.

Among the important topics left unaddressed by this study is examining *why* teachers make specific decisions regarding their use of curricular materials. Teachers' decisions regarding what to teach and what to omit might very well have been purposeful and further analysis could yield insight into this matter. Teacher beliefs might offer at least some explanation about these decisions. Another interesting possibility is the examination of whether a relationship exists between the student demographics within the teachers' classrooms and the teachers' decisions regarding the omission of certain mathematical topics. For instance, do teachers of high achieving students skip certain content because they feel their students already know it? On the other hand, do teachers of low achieving students skip certain content because they feel it is too hard for their students? Another potential relationship to examine is the omission of particular content in relation to the consequences associated with state testing. For example, do teachers in states that require students to pass the test in order to earn a high school diploma make different decisions with regard to content than teachers in states where no such requirement for graduation exist? These particular questions, although worthy of study, were beyond the scope of this study.

Future studies should be designed around the relationships among curriculum standards, curricular materials, and student learning with attention to how teachers understand and make sense of the various forms of mathematics curriculum available to them as they make instructional decisions and enact mathematics curriculum in their classrooms. For example, is there a relationship between teachers' pedagogical content knowledge and their respective use of the instructional design components (i.e., Launch, Explore, Share and Summarize, Apply)? What are teachers' views of the importance or significance of learning the mathematics contained within the content strands and how does that guide their use of the mathematics curriculum?

When considering teachers' assignment to courses, school administrators need to be knowledgeable about the integrated mathematics programs and what is expected of teachers who implement them. Further research is needed to establish whether more deliberate consideration needs to be made in the preparation of a master schedule. More complete characterizations of the assignment of teachers to courses need to be developed so that administrators can begin to understand what characteristics foster or hinder teachers' use of integrated textbooks.

Closing Remarks

Teachers in the U.S. rely heavily on their mathematics textbook and, in particular, the mathematical content that becomes part of the lesson is heavily influenced by the textbook (Grouws & Smith, 2000; Robitaille & Travers, 1992; Tyson-Bernstein & Woodward, 1991). Moreover, prior research suggests that different teachers implement the same curriculum in different ways (Bowzer, 2008; Chávez, 2003; Tarr, Chávez et al., 2006). The way teachers implement a curriculum affects both what and how students learn mathematics. That is, students' opportunity to learn (OTL) will often change based on the choices a teacher makes when planning and teaching a lesson (Floden, 2002).

This study examined mathematics teachers' use of integrated curriculum materials in secondary school classrooms. Its findings are consistent with previous research in that teachers rely on curricular materials when making instructional decisions. However, this study is unique in the fact that all the teachers are using an integrated textbook. Whereas teachers did attend to each major content strand included in secondary school textbooks where the mathematics is organized in an integrated manner, their daily decisions result in student opportunity to learn being different than that intended in the textbook design.

Although we know that textbooks are the centerpiece of mathematics instruction in U.S. schools (Grouws & Smith, 2000), we know very little about the relationship between implementation levels, specific textbooks, and content specific student learning. The research adds to previous research examining teachers' use of textbook materials, however our knowledge of the effects of different approaches to mathematical content in textbooks is still limited. Much research work remains to be done in order to understand the effectiveness of integrated mathematics materials.

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APPENDIX A: INITIAL TEACHER SURVEY

INITIAL TEACHER SURVEY

Please complete all of the questions. Answer the questions to the best of your ability, keeping in mind that there are no “right” or “wrong” answers.

Estimated time of completion of the survey is 30 minutes or less.

If you have questions about the study or any items in the survey, please ask the COSMIC personnel present at the orientation meeting.

Section A: Demographic Information

1. Your Name:

First: __________________________ M.I. _____Last:_________________________

2. School:

District: __________________________ Building: ___________________________

3. Email Address: ____

4. What grade levels are contained in your school (mark all that apply)?

☐ 6th ☐ 7th ☐ 8th ☐ 9th ☐ 10th ☐ 11th ☐ 12th ☐ Others _______

5. Indicate your gender: ☐ Male ☐ Female

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

7. How many years have you taught middle or high school mathematics prior to this school year? _______________

8. When did you complete this questionnaire? ____ /____ / ____
month day year

9. What is the calendar duration/ structure of your mathematics classes?

☐ Full Year
☐ Semester
☐ Block Schedule
☐ Semester Block
☐ Year-long Block

10. In minutes, how long is each class period you teach? _______

11. For each class period you are currently teaching, enter the course title, the course type (remedial, regular, or honors), the textbook title, and the number of students from the choices given – you may use the abbreviations given. If you do not teach during a class period, enter "None" for the course title and leave the fields pertaining to that class period blank. For courses you teach other than those listed, enter the name of the course and use "other" for the textbook title.

Course Title Choices:	Textbook Title Choices:
Algebra I (A1)	*Core-Plus* Course 1 (CP1)
Geometry (Geo)	*Core-Plus* Course 2 (CP2)
Algebra II (A2)	*Core-Plus* Course 3 (CP3)
Integrated I (Int1)	Glencoe Geometry (Glen)
Integrated II (Int2)	Prentice Hall Geometry (PH)
Integrated III (Int3)	McDougal Littell Geometry(McD L)

Course Type Choices:

Modified/Remedial (M/R)
Regular (Reg)
Honors/Advanced (H/A)
N/A

	Room #	Course Title	Course Type	Textbook Title	# of Students
1st Class					
2nd Class					
3rd Class					
4th Class					
5th Class					
6th Class					
7th Class					
8th Class					

Lunch Period

Begin: ____________ End:___________

Section B: Teacher Opinions

12. Please provide your belief/opinion about each of the following statements:

	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
Students learn mathematics best in classes with students of similar abilities.	☐	☐	☐	☐	☐
The testing program in my state/district dictates what mathematics content I teach.	☐	☐	☐	☐	☐
I enjoy teaching mathematics.	☐	☐	☐	☐	☐
Students should share their thinking and approaches to solving mathematics problems with other students.	☐	☐	☐	☐	☐
Learning mathematics concepts is more important than learning mathematics skills and procedures.	☐	☐	☐	☐	☐
Students learn mathematics best when the teacher demonstrates concepts and methods, and then provides students opportunities for practice and reinforcement.	☐	☐	☐	☐	☐
Calculators help high school students explore mathematical ideas and solve problems.	☐	☐	☐	☐	☐
Learning mathematics requires that students actively engage in thinking, exploring and talking about their ideas.	☐	☐	☐	☐	☐
Mathematics is a subject in which natural ability matters more than effort.	☐	☐	☐	☐	☐
Mathematics teachers should make sure that students see lots of different ways to look at the same question or problem.	☐	☐	☐	☐	☐
Much of secondary mathematics can be learned through exploration and discovery.	☐	☐	☐	☐	☐
Most mathematics problems can be solved in only one way.	☐	☐	☐	☐	☐
To solve most mathematics problems you have to be taught the correct procedure.	☐	☐	☐	☐	☐
When students can't solve problems, it's usually because they can't remember the right formula or rule.	☐	☐	☐	☐	☐
I like to teach using mathematics problems that can be solved in many different ways.	☐	☐	☐	☐	☐
When two students solve the same mathematics problem correctly using two different strategies I usually have them share their solutions with the class or with each other.	☐	☐	☐	☐	☐

13. Please provide your belief/opinion about each of the following statements:

	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
I tend to integrate multiple strands of mathematics within a single unit or chapter.	☐	☐	☐	☐	☐
I often learn from my students during mathematics class because my students come up with ingenious ways of solving problems that I have never considered.	☐	☐	☐	☐	☐
It is not very productive for students to work together during mathematics class.	☐	☐	☐	☐	☐
Every student in my room should feel that mathematics is something he/she can do.	☐	☐	☐	☐	☐
Whenever possible, I try to integrate assessment into mathematics activities.	☐	☐	☐	☐	☐
In my classes, students learn mathematics best when they can work together to discover mathematical ideas.	☐	☐	☐	☐	☐
I encourage students to use manipulatives to explain their mathematical ideas to the class or other students.	☐	☐	☐	☐	☐
When students are working on mathematics problems, I put more emphasis on getting the correct answer than on the process followed.	☐	☐	☐	☐	☐
Creating scoring rubrics for mathematics problems is a worthwhile assessment strategy.	☐	☐	☐	☐	☐
I don't necessarily answer students' mathematics questions directly but rather let them figure things out for themselves.	☐	☐	☐	☐	☐
A lot of things in mathematics must simply be accepted as true and remembered.	☐	☐	☐	☐	☐
I like my students to master basic mathematical skills before they tackle complex problems.	☐	☐	☐	☐	☐
I encourage students to explain their mathematical ideas in class.	☐	☐	☐	☐	☐
Using computers to solve mathematics problems often distracts students from learning basic mathematical skills and procedures.	☐	☐	☐	☐	☐
If students use graphing calculators, then it is likely they won't master the basic mathematical skills and procedures they need to know.	☐	☐	☐	☐	☐
You have to study mathematics for a long time before you see how useful it is.	☐	☐	☐	☐	☐

14. How familiar are you with *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000)?

- ☐ Not Familiar*
- ☐ Somewhat Familiar
- ☐ Fairly Familiar
- ☐ Very Familiar

*If you answered "Not familiar" to Question 16, skip to Question 17.

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

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ No Opinion
- ☐ Agree
- ☐ Strongly Agree
- ☐ Not Applicable

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

- ☐ Not At All
- ☐ Minimal Extent
- ☐ Moderate Extent
- ☐ Great Extent
- ☐ Not Applicable

Section C: Teacher Background

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

	Not Adequately Prepared	Somewhat Prepared	Fairly Well Prepared	Very Well Prepared
Take students' prior understanding into account when planning instruction.	☐	☐	☐	☐
Develop students' conceptual understanding of mathematics.	☐	☐	☐	☐
Lead a class of students using investigative strategies.	☐	☐	☐	☐
Serve as facilitator as students work in collaborative learning groups.	☐	☐	☐	☐
Use the textbook as a resource rather than the primary instructional tool.	☐	☐	☐	☐
Teach groups that are heterogeneous in ability.	☐	☐	☐	☐
Have students work in cooperative learning groups.	☐	☐	☐	☐
Use calculators/computers for drill and practice.	☐	☐	☐	☐
Use calculators/computers to explore concepts.	☐	☐	☐	☐
Use calculators/computers to collect and/or analyze data.	☐	☐	☐	☐

18. Do you have the following degrees?

	Yes	No	Working on It
Bachelor's	☐	☐	☐
Master's	☐	☐	☐
Doctorate	☐	☐	☐

19. Indicate the area of study for each degree obtained or working towards:

Bachelor's: ___________________________

Master's: ____________________________

Doctorate: ___________________________

20. Indicate all areas of study, including grade levels, in which you have teaching certification (e.g. Mathematics grades 4-8):

21. Is this your first year teaching any subject? ☐ Yes ☐ No

*Answer "yes" to Question 21 if this is your first year teaching. Do not answer "yes" if this is your first year teaching Geometry or *Core-Plus*.

*If you answered "yes" to Question 21, you do not need to continue completing the survey. If you answered "no" to Question 21, please continue.

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

	None	Less than 6 hours	6-15 hours	16-35 hours	More than 35 hours
Last 12 months	☐	☐	☐	☐	☐
Last 3 years	☐	☐	☐	☐	☐

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

	Yes	No
Taken a formal college/university mathematics course. (Please do not include courses taken as part of your undergraduate degree.)	☐	☐
Taken a formal college/university course in the teaching of mathematics. (Please do not include courses taken as a part of your undergraduate degree.)	☐	☐
Met with a local group of teachers to study/discuss mathematics teaching issues on a regular basis.	☐	☐
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.)	☐	☐
Attended a workshop on mathematics teaching.	☐	☐
Attended a national or state mathematics teachers association meeting.	☐	☐
Taught an in-service workshop in mathematics or mathematics teaching.	☐	☐
Served on a school or district mathematics textbook selection committee.	☐	☐

Questions 24-25 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.

24. Considering all the professional development you have participated in during the last 3 years, how much was each of the following EMPHASIZED?

	Not At All	Slightly	Some-what	Quite a bit	To A Great Extent
Deepening my mathematics content knowledge.	☐	☐	☐	☐	☐
Understanding students' thinking in mathematics.	☐	☐	☐	☐	☐
Learning how to use inquiry/ investigation oriented strategies.	☐	☐	☐	☐	☐
Learning how to use technology in mathematics instruction.	☐	☐	☐	☐	☐
Learning how to assess student learning in mathematics.	☐	☐	☐	☐	☐
Learning how to use the district-adopted mathematics textbook.	☐	☐	☐	☐	☐

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

	Little or No Impact	Confirmed what I was already doing	Caused me to change my teaching practices
Deepening my mathematics content knowledge.	☐	☐	☐
Understanding students' thinking in mathematics.	☐	☐	☐
Learning how to use inquiry/ investigation oriented strategies.	☐	☐	☐
Learning how to use technology in mathematics instruction.	☐	☐	☐
Learning how to assess student learning in mathematics.	☐	☐	☐
Learning how to use the district-adopted mathematics textbook.	☐	☐	☐

APPENDIX B: MIDCOURSE TEACHER SURVEY

MIDCOURSE TEACHER SURVEY

Please complete all of the questions. Answer the questions to the best of your ability, keeping in mind that there are no "right" or "wrong" answers.

Estimated time of completion of this survey is 20 minutes.

If you have questions about the study or any items in the survey, please email cosmic@missouri.edu.

Your Information

Name: ____
First M.I. Last

School:

District: __________________________ Building: ____________________________

Email address: ____

Your Mathematics Teaching in *Core-Plus* Classes

Please answer the following with respect to the *Core-Plus,* Course 1 class(es) you teach. Give your best estimate of the times and amounts that are requested.

1. Are students assigned to this class by level of ability? ☐ Yes ☐ No

2. Which of the following best describes the ability of the students in your *Core-Plus* classes 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

3. Indicate the approximate percentage of students in your *Core-Plus* classes who are formally classified as each of the following:

   a) Limited English Proficiency __________ b) Learning Disabled ___________

4. How many years (including this year) have you taught from a *Core-Plus* textbook? _______

5. How well prepared do you feel you are to teach from the *Core-Plus* textbook?

   ☐ Very Unprepared
   ☐ Somewhat Unprepared
   ☐ Somewhat Prepared
   ☐ Very Prepared

6. What role do the *Core-Plus* textbook materials play in your teaching? (check all that apply)

   ☐ Help me plan daily instruction.
   ☐ Help determine the sequence of topics
   ☐ Provide activities to explore math topics
   ☐ Help parents know what their child is studying
   ☐ Serve as source of example problems.
   ☐ Serve as a source of homework problems.
   ☐ Serve as a source of assessment items.
   ☐ Serve as a resource for individual student work
   ☐ Other (please specify)____

7. How would you rate the overall quality of the *Core-Plus* textbook?

- ☐ Very Poor
- ☐ Poor
- ☐ Fair
- ☐ Very Good

8. What percentage of instructional days do you primarily use the *Core-Plus* textbook during class to teach mathematics?

- ☐ < 25%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-90%
- ☐ > 90%

9. Estimate the percentage of the *Core-Plus* textbook you will "cover" in your course(s) this year?

- ☐ < 25%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-90%
- ☐ > 90%

10. List 2 strengths and 2 weaknesses of the *Core-Plus,* Course 2 textbook.

Strength: ______________________________

Strength: ______________________________

Weakness: ______________________________

Weakness: ______________________________

11a. Do you supplement the *Core-Plus* instructional materials? ☐ Yes ☐ No

11b. If Yes, indicate each type of supplementary material that you have used.

- ☐ Materials presenting special topic(s) not in the *Core-Plus* textbook
- ☐ Worksheets for review
- ☐ Worksheets for skill practice
- ☐ Materials to prepare for out-of-course assessments (e.g., mandatory state exam)
- ☐ Other commercial textbooks
- ☐ Other curriculum materials (e.g., NCTM *Navigations* book)
- ☐ Teacher-developed materials
- ☐ Other (please specify) ______________________________

11c. If you chose “Other textbooks” or “Other commercial curriculum materials,” list the publishers of the textbooks and commercial curricula that you use to supplement.______________________________

12. Think about the *Core-Plus* class(es) you teach. How much emphasis do you place on each of the following student objectives?

	None	Minimal Emphasis	Moderate Emphasis	Heavy Emphasis
Increase students' interest in mathematics.	☐	☐	☐	☐
Learn mathematical concepts.	☐	☐	☐	☐
Learn to perform algorithms with speed and accuracy.	☐	☐	☐	☐
Learn how to solve problems.	☐	☐	☐	☐
Learn to reason mathematically.	☐	☐	☐	☐
Learn how mathematical ideas connect with one another.	☐	☐	☐	☐
Understand the logical structure of mathematics.	☐	☐	☐	☐
Learn about the history and nature of mathematics.	☐	☐	☐	☐
Learn to explain ideas in mathematics effectively.	☐	☐	☐	☐
Learn how to apply mathematics in business and industry.	☐	☐	☐	☐
Prepare students for standardized tests.	☐	☐	☐	☐

13. About how often do you do each of the following when you teach your *Core-Plus* class(es)?

	Never	Rarely	Some-times	Often	All the Time
Introduce content through formal presentations.	☐	☐	☐	☐	☐
Pose open-ended questions.	☐	☐	☐	☐	☐
Engage in whole-class discussions.	☐	☐	☐	☐	☐
Require students to explain their reasoning when giving an answer.	☐	☐	☐	☐	☐
Ask students to explain concepts to one another.	☐	☐	☐	☐	☐
Ask students to offer alternative methods for solutions.	☐	☐	☐	☐	☐
Ask students to use multiple representations (e.g., numeric, graphic, verbal, tabular, symbolic, etc.).	☐	☐	☐	☐	☐
Help students see connections between mathematics and other disciplines.	☐	☐	☐	☐	☐
Assign mathematics homework.	☐	☐	☐	☐	☐
Read and comment on the reflections students have written (e.g., in their journals).	☐	☐	☐	☐	☐

14. About how often do students in your *Core-Plus* class(es) take part in the following types of activities?

	Never	Rarely	Some-times	Often	All the Time
Listen and take notes during a presentation by the teacher.	☐	☐	☐	☐	☐
Work in groups or pairs.	☐	☐	☐	☐	☐
Engage in mathematical activities using concrete materials.	☐	☐	☐	☐	☐
Practice routine computations/algorithms.	☐	☐	☐	☐	☐
Review homework/worksheet assignments.	☐	☐	☐	☐	☐
Follow specific instructions in an activity or investigation.	☐	☐	☐	☐	☐
Use mathematical concepts to interpret and solve applied problems.	☐	☐	☐	☐	☐
Answer textbook or worksheet questions.	☐	☐	☐	☐	☐
Collect, record, represent, and/or analyze data.	☐	☐	☐	☐	☐
Write reflections (e.g., in a journal).	☐	☐	☐	☐	☐
Make formal presentations to the rest of the class.	☐	☐	☐	☐	☐
Use calculators or computers for learning or practicing skills.	☐	☐	☐	☐	☐
Use calculators or computers to develop conceptual understanding.	☐	☐	☐	☐	☐
Use calculators or computers as a tool (e.g. spreadsheets, data analysis).	☐	☐	☐	☐	☐

15. Consider a typical Unit of *Core-Plus*. In any given day, you will not likely utilize every feature of the curriculum. Over the course of an entire unit, estimate the average percent of class time spent on each of the following *Core-Plus* features. The numbers should total 100%.

_________ *Think About This Situation*
_________ Investigations
_________ *Checkpoint*
_________ *On Your Own*
_________ Students working on/class discussion of MORE problems
_________ Quizzes and tests
_________ Project work/reports
_________ Other (Please describe)____

16. About how often do students in your *Core-Plus* class(es) use calculators/computers to:

	Never	Rarely	Some-times	Often	All the Time
Practice skills	☐	☐	☐	☐	☐
Perform simulations	☐	☐	☐	☐	☐
Collect data using sensors or probes	☐	☐	☐	☐	☐
Perform data analysis	☐	☐	☐	☐	☐
Create data displays	☐	☐	☐	☐	☐
Assist in taking a test or quiz	☐	☐	☐	☐	☐

17. How many days a week do you assign homework from the *Core-Plus* textbook?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

18. How many days a week do you assign homework from a source other than the *Core-Plus* textbook (e.g., teacher-developed worksheet)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19. How much mathematics homework do you assign to your *Core-Plus* students in a typical week?

☐ 0-30 min ☐ 31-60 min ☐ 61-90 min ☐ 91-120 min

☐ 2-3 hours ☐ More than 3 hours

20. Choose the level of graphing calculator availability for homework that best describes your *Core-Plus* class(es):

☐ Students are not allowed to use graphing calculators on homework problems.

☐ Students are allowed to use graphing calculators on homework problems but most do not have access to one outside of class.

☐ Students are allowed to use graphing calculators on homework problems and most have access to one outside of class.

☐ Students are required to use graphing calculators on homework problems and so all students are expected to have access to one outside of class.

21. How often do you assess your *Core-Plus* students' progress in mathematics in each of the following ways?

	Never	Rarely	Some-times	Often	All the Time
Conduct a pre-assessment to determine what students already know.	☐	☐	☐	☐	☐
Observe students and ask questions as they work individually.	☐	☐	☐	☐	☐
Observe students and ask questions as they work in small groups or pairs.	☐	☐	☐	☐	☐
Ask students questions during large group discussions.	☐	☐	☐	☐	☐
Use assessments embedded in class activities to see if students are learning "it."	☐	☐	☐	☐	☐
Review student homework.	☐	☐	☐	☐	☐
Review student notebooks/journals.	☐	☐	☐	☐	☐
Have students present their work to the class.	☐	☐	☐	☐	☐
Give short-answer tests (e.g., multiple choice, true/false, fill in the blank).	☐	☐	☐	☐	☐
Give tests requiring open-ended responses (e.g. descriptions, explanations).	☐	☐	☐	☐	☐

22. Choose the option that best describes your use of the assessment material provided with the *Core-Plus* materials.

	Always	Frequently	Rarely	Never
One form only of the Lesson Quizzes	☐	☐	☐	☐
Both forms of the Lesson Quizzes	☐	☐	☐	☐
One form only of the In-class Unit Exams	☐	☐	☐	☐
Both forms of the In-class Unit Exams	☐	☐	☐	☐
Unit Take-home problems	☐	☐	☐	☐
Unit Projects	☐	☐	☐	☐
In-class Semester Exam	☐	☐	☐	☐

23. Choose the typical number of times a quiz or test from the *Core-Plus* materials is given each semester.

Quiz: ☐ 0 ☐ 1-2 ☐ 3-4 ☐ > 5

Test: ☐ 0 ☐ 1-2 ☐ 3-4 ☐ > 5

APPENDIX C: TEXTBOOK USE DIARY

Core-Plus Course 1 Textbook-Use Diary

Instructions: For the *first Core-Plus* class you teach, record the instructional activities that correspond to **Unit 3, Lesson 2.** Log activities for the first 15 days only. A sample entry is provided below.

Unit 3, Lesson 2: Linear Graphs, Tables, and Rules

Date	**Inv**	**Problems worked *in class* (include page numbers)**		**Homework Assignment (include page numbers)**	
10/7/08	*1*	*Pages 225-228*	*TATS: a,b* *Investigation: 1-6* *Checkpoint: a-c*	*Pages 234-236*	*OYO:a-c* *M:1; O:3; R:1*

APPENDIX D: CLASSROOM VISIT PROTOCOL

comparing options in secondary mathematics:

COSMIC

investigating curriculum

Core-Plus Classroom Visit Protocol

James E. Tarr
Melissa D. McNaught
Angela D. Sutter

University of Missouri
Columbia, MO

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Part I: Lesson Tape Recording Sheet

Visitor: ______________________________ Date of Visitation: ____________________

Teacher: ______________________________ School:_______________________________

As you observe the lesson, record in Column 3 the activities of the teacher and the students. Provide a time stamp in Column 2 to correspond with the events (record a time stamp at least every 4 minutes). When possible, identify and record the following activities:

- Interactions between the teacher and students
- Interactions between students
- Use of any instructional materials (by teacher or students)
- Exercises/examples being worked/discussed in class
- How students are grouped
- Out-of-class assignments (include problem numbers where possible).

After the lesson, assign relevant codes of the Classroom Learning Environment (e.g., ST3, R2, SM1) in Column 4.

Line	Time	Event	Selected Elements
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

Part II: Lesson Summary Form

Visitor: ______________________ Time Lesson Begins/Ends: ________ / ________

Teacher: ______________________ School: ______________________

Textbook pages: ______________________ Course (circle one): 1 2

Date of Visitation: ______________________ Class Period: ______________________

Number of students present: ____________ Seated: Individually Pairs Groups of ___ (indicate #)

DURING THE LESSON

Use your notes from the Lesson Tape to summarize the classroom visit and complete the remainder of this form. For each observable activity during the lesson, identify the corresponding line from the "lesson tape" on the blank following the activity.

HOMEWORK REVIEW (If the teacher did not spend time reviewing homework, check here ____ and proceed to **LAUNCH**.)

1. What was the primary focus of homework review (mark the descriptor that best applies):

√	Activity	Lesson Tape Line
_____	Focus on answers	________
_____	Focus on procedures	________
_____	Focus on understanding	________

LAUNCH (If this class period did not contain a **LAUNCH**, check here ____ and proceed to **EXPLORE**.)

2. Which of the following were observed during the **LAUNCH**? (mark all that apply):

√	Activity	Lesson Tape Line
	The Teacher:	
_____	drew connections to a previous lesson or other knowledge that is prerequisite to the instruction at hand (beyond reviewing homework problems)	________
_____	made reference to the learning objectives for the class period	________
_____	utilized the *Think About This Situation* for the lesson from the textbook	________
_____	did not diminish the problematic nature of the content prematurely by providing unnecessary scaffolding	________

EXPLORE (If this class period did not contain an **EXPLORE**, check here ____ and proceed to **SHARE & SUMMARIZE**.)

3. Was today's instruction a continuation of a previous day's Investigation? Yes No

   If yes, did the teacher draw connections between the previous day's content and today's? Yes No

4. Which of the following were observed during the **EXPLORE**? (mark one):

√	Activity	Lesson Tape Line
	The Teacher (mark the best descriptor):	
_____	did not circulate around the classroom for a significant portion of the EXPLORE	__________
_____	moved around the classroom primarily interacting with individual students	__________
_____	moved around the classroom primarily interacting with groups	__________

SHARE & SUMMARIZE

(If this class period did not contain a formal **SHARE & SUMMARIZE**, check here ____ and proceed to **APPLY**.)

5. Which of the following were observed during the **SHARE & SUMMARIZE**? (mark all that apply):

√	Activity	Lesson Tape Line
	The Teacher:	
_____	had students work individually on questions from the *Checkpoint*	__________
_____	had students discuss in groups questions from the *Checkpoint*	__________
_____	had students discuss as a class questions from the *Checkpoint*	__________
_____	did not directly provide the students answers to questions from the *Checkpoint*	__________

APPLY (If the teacher did not assign the students problems, check here _____ and proceed to **ASSESSMENT**.)

6a. If *On Your Own* problems were not assigned, check here ____ and proceed to Question 7.

b. Problems were to be worked (circle one): in class outside of class both

c. If in class, the assignment was to be completed (circle one):

individually in groups unsure

7a. The teacher assigned problems from (circle all that apply):

MORE *Core-Plus* resource materials

teacher-developed assignment source other than the *Core-Plus* materials

b. Problems were to be worked (circle one): in class outside of class both

c. If in class, the assignment was to be completed (circle one): individually in groups unsure

ASSESSMENT (If no summative assessment was given, check here _____ and proceed to **GENERAL CLASSROOM CHARACTERISTICS**.)

8. A written summative assessment was given from (circle one): *Core-Plus* auxiliary materials   alternate source

GENERAL CLASSROOM CHARACTERISTICS

9. The teacher brought closure to the lesson (circle one): Yes No

10. Indicate the overall level of student engagement during the class period (mark the descriptor that best applies):

√	Activity
_____	Relatively few students appeared to be off task
_____	About one-half of the students appeared to be off task
_____	The majority of the students appeared to be off task

11. Indicate the technology used during the class period (mark all that apply):

√	Activity	
	Use of graphing calculator:	
_____	by most students	
_____	by the teacher	
	Use of interactive computer software:	
_____	by most students	Software utilized:
_____	by the teacher	Software utilized:

12. Indicate the dominant level of student collaboration for the class period (mark only one):

√	Activity
_____	Most students worked individually
_____	Some students worked collaboratively while others worked individually
_____	Most students worked collaboratively

AFTER THE LESSON

After the lesson is finished, please review your notes on the lesson tape recording sheet and then respond to each of the following sections.

1. Describe the <u>main activities</u> that occurred during the class period and the <u>amount of time</u> devoted to each activity. For example:

Non-instructional activities (e.g., announcements, attendance)	LAUNCH
Warm-up activities	EXPLORE
Homework review	SHARE & SUMMARIZE
Closure	APPLY

Activity	**Time**

2. Were curricular materials other than the *Core-Plus* textbook used during the lesson? Yes No

   If yes, please describe these materials:

   ____

Overall Ratings

These indicators measure the extent to which the instruction during the class period of your visit aligns with the recommendations and content of the *Core-Plus* textbook. For each rating, choose the indicator that best describes what you observed.

1. Overall rating of *content fidelity*:

1 ***2*** ***3*** ***4*** ***5***

Lower Fidelity	***Moderate Fidelity***	***Higher Fidelity***
The content of the enacted curriculum was *largely inconsistent* with the written curriculum. The textbook was not the primary source of the lesson content because of omissions, significant modifications, and/or supplementation.	The content of the enacted curriculum was *moderately consistent* with the written curriculum. Although the textbook was a source of some of the lesson content, other portions of the lesson could not be attributed to the textbook.	The content of the enacted curriculum was *consistent* with the written curriculum. The textbook was the primary source of the lesson content with little or no deviation or supplementation.

2. Overall rating of the *presentation fidelity*:

1 ***2*** ***3*** ***4*** ***5***

Lower Fidelity	***Moderate Fidelity***	***Higher Fidelity***
The presentation of the enacted curriculum was *not consistent* with the expectations of the textbook authors. During the lesson, the teacher implemented actions/activities that were not recommended *and/or* neglected to implement actions/activities that were advised or recommended. The teacher placed disproportionate emphasis on particular lesson components at the expense of others.	The presentation of the enacted curriculum was *moderately consistent* with the expectations of the textbook authors. During the lesson, the teacher either implemented some actions/activities that were not recommended *or* neglected to implement actions/activities that were advised or recommended. The teacher generally placed appropriate emphasis on each lesson component.	The presentation of the enacted curriculum was *consistent* with the expectations of textbook authors. During the lesson, the teacher implemented recommended actions/activities *and* refrained from actions/activities that were not advised or recommended. The teacher placed appropriate emphasis on each lesson components.

Part III: Selected Elements of the Classroom Learning Environment (*use rubric)*

		Weak⇔Strong
REASONING ABOUT MATHEMATICS		
R1	Students were afforded opportunities to make conjectures about mathematical ideas Supporting examples	1 2 3 4 5
R2	Students' mathematical arguments or justifications were challenged by others. Supporting examples	1 2 3 4 5
R3	Mathematical authority rested with *students*, not with the teacher or textbook Supporting examples	1 2 3 4 5
STUDENTS' THINKING IN INSTRUCTION		
ST1	Formative assessment techniques were used to guide instructional decision-making Supporting examples	1 2 3 4 5
ST2	Students' statements about mathematics were used to build a shared understanding Supporting examples	1 2 3 4 5
ST 3	Student misconceptions or mistakes were used as a learning site for others. Supporting examples	1 2 3 4 5
FOCUS ON SENSE-MAKING		
SM1	Multiple (alternative) solution strategies were encouraged Supporting examples	1 2 3 4 5
SM2	The enacted lesson developed procedural knowledge in meaningful ways Supporting examples	1 2 3 4 5
SM3	The enacted lesson developed conceptual understanding of mathematics Supporting examples	1 2 3 4 5
SM4	Connections within mathematics were explored in the lesson Supporting examples	1 2 3 4 5

APPENDIX E: INTERVIEW PROTOCOL

Interview Protocol

Determining teacher assignments across pathways

1. What criteria do you consider when determining whether a mathematics teacher will teach courses in the subject-specific path (i.e., Algebra 1, Geometry, Algebra 2) or in the integrated (*Core-Plus* Course 1, Course 2, Course 3)?

2. Do you have a preference regarding whether teachers teach courses in one pathway exclusively or some courses in each pathway?

Determining teacher assignments within pathways

3. What criteria do you consider when determining what courses a mathematics teacher will teach within each pathway?

Sources of input

4. How much input do other school personnel have in regard to determining the master teaching schedule?

5. How much input do teachers have in regard to their own teaching assignments?

6. Is there anyone else I should talk to in your school to get a perspective on the kinds of things that we have talked about today?

VITA

Melissa Dawn McNaught was born on May 23, 1972 in Fayetteville, Arkansas, the son of Jimmy and Lucille Weston of Stella, Missouri. She attended public schools in Granby, graduating as the valedictorian of the East Newton High School Class of 1990. She has earned the following degrees: B.A. in Mathematics from University of Arkansas (1995); B.S.E. in Secondary Mathematics from Missouri Southern State University (1997); M.S. in Mathematics from the Pittsburg State University (2005) and Ph.D. in Curriculum and Instruction from the University of Missouri, Columbia (2009).

Prior to her doctoral studies, she was a secondary school mathematics teacher for seven years. While on staff, she taught various mathematics courses including Algebra I, Geometry, Algebra II, College Algebra, and Course 1 of the *Core-Plus* Mathematics Project. Working with the principal, she played a key role in initiating changes in the mathematics curriculum employed at the district and took an active role in perusing and analyzing high school standards-based curriculum during the process of deciding which program to adopt.

Melissa is currently a member of the Teaching and Learning Department at the University of Iowa, Iowa City.