CHALLENGING THE GRIDLOCK:

A STUDY OF HIGH SCHOOLS USING RESEARCHED-BASED CURRICULA TO IMPROVE MATHEMATICS

Based on a multi-year study conducted by
Inverness Research Associates

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Acknowledgements

This book is about real people doing the real work of implementing research-based mathematics curricula at the high school level. The names and places have *not* been changed to protect the innocent. Such a project would never have been possible were it not for the dozens of teachers and administrators who so generously and graciously welcomed us into their districts, schools, and classrooms. Some are named in the pages of this project – others are not. Named and unnamed, we heartily thank each and every one!

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ABSTRACT

Despite the success of integrated secondary mathematics programs in other industrialized countries – Japan and Germany, for example – a topic-focused, sequential curriculum has dominated mathematics courses in US high schools for decades and continues to do so. American students begin with Algebra, followed by Geometry, then Algebra II and Trigonometry, and if they meet with success, then Pre-Calculus. Only a select few actually reach the mathematics course that drives this curriculum sequence – Calculus. In other countries, high school students complete math courses that combine ideas from many areas of mathematics, rather than spending an entire year focused on a single subject, like Algebra or Geometry. During the 1990s, mounting evidence suggested that the lack of topic integration in mathematics and an instructional emphasis on procedure in US high school classrooms was putting American students at a distinct disadvantage in the international marketplace. However, the challenge of such a major restructuring at any level – classroom, school, or district – remained daunting.

Towards the end of the decade, a collection of five integrated curricula, all developed with funding the National Science Foundation, appeared on the textbook scene. Over the next few years, a number of schools and districts across the US began to pilot, adopt, and implement these researched-driven, standards-based programs. The early implementers of the five NSF-funded secondary mathematics curricula faced numerous challenges as they attempted to break new ground in high school mathematics education. In the course of their work, they encountered the various and multiple forces that hold the current high school mathematics sequence so firmly in place. As they worked to overcome barriers and to gain the benefits embedded in the new programs, they learned many valuable lessons for the field – lessons that have remained largely unstudied and unreported. This study, commissioned by the COMPASS Implementation Center in Ithaca, NY and conducted by Inverness Research Associates, is a qualitative research project aimed at better understanding and systematically documenting what actually happens to schools and districts that embark on such a path of innovation in mathematics at the secondary level.

INTRODUCTION

> *Were all instructors to realize that the quality of mental process, not the production of correct answers, is the measure of educative growth, something hardly less than a revolution in teaching would be worked.*
>
> *John Dewey*

Walk into any high school mathematics classroom in the United States and, chances are, what transpires will resonate with one's own high school experience: students seated in rows, the teacher at the front of the room, familiar problems on the board, homework to correct, and more homework to be assigned. Despite decades of research on how young people learn best, coupled with centuries of educational philosophy espousing the notion that learning comes from participating rather than spectating, the American secondary mathematics classroom has remained remarkably static since the early nineteenth century. Of course, some elements have changed. For example, students study topics outside of the direct path to calculus, such as probability and statistics; and advances in technology make handheld calculators a commonplace tool. However, on a more fundamental level, the curriculum in most classrooms, schools, and districts remains structured so that students study isolated topics and practice individual techniques, rather than learning mathematics as a holistic discipline and experiencing its value as a tool for interpreting a variety of real-world phenomena. This is the status quo, but there are exceptions – places that have cultivated fundamentally different visions of secondary mathematics education. And over the past decade, their numbers have grown.

Since the 1960s, evidence for the need to change business as usual in American secondary mathematics classrooms has mounted steadily. From international studies of student achievement in mathematics (Husen, 1967; Schmidt, et. al., 1997), to research in cognitive science, a growing body of knowledge indicates that *how* students learn affects *what* they learn and the extent to which they learn it. By the end of the 1980s, a series of mathematics education publications, such the National Research Council's (NRC) *Everybody Counts* and the National Council of Teachers of Mathematics' (NCTM) *Curriculum and Evaluation Standards for School Mathematics*, had articulated a similar message – namely, that the teaching of mathematics in American schools needed to change at all grade levels in order to provide the best possible learning opportunities for all students and that the need for a mathematically literate citizenry had never been greater. These publications reflected a growing national recognition that the status quo of high school mathematics had led to widespread discouragement and failure. The details differed across documents, but they shared the notion that mathematics instruction should emphasize less practicing of finite procedures and more solving of complex problems involving multiple mathematical ideas. Even more revolutionary was the goal of making mathematics "a pump rather than a filter" – a vehicle for fueling the pipeline of prospective mathematicians, scientists, and engineers with able and interested students, rather than a gate for keeping young people from pursuing such professions.

In the years that followed, numerous private and public foundations funded efforts that focused on moving mathematics teaching and learning in this direction. The NCTM *Standards*, a collaboratively written document that called for creating a nation of mathematically powerful young people, played a pivotal role in these reform initiatives. The *Standards* offered a new vision for K-12 mathematics education – one that called for *all* students to learn rigorous mathematics, relevant to the 21st century – demanding significant changes in pedagogy as well as content. Not everyone embraced this vision. However, among those who did, a cultural shift began to take place in mathematics education circles across the United States.

As part of this trend, the National Science Foundation funded a series of curriculum development efforts during the 1990s aimed at designing high-quality mathematics programs for all grades K-12. The goal was to provide teachers with the resources needed to actualize the vision laid out in the NCTM standards. These curricula were to provide teachers with tools that could help them move beyond traditional practice, imbuing their teaching with new methods and topics that would make mathematics education more relevant and meaningful to young people of the 21st century. At the high school level, where the challenge to break with tradition seemed most foreboding, NSF funded five different curriculum development projects. All were designed to be "break the mold" efforts that challenged high school mathematics departments to re-conceptualize their programs, clarify their beliefs, and change their course offerings. The call to completely rework math at the high school level came amidst a growing perception that the discipline had remained steadfastly unchanged for too long. Many math educators agreed that starting over was the only way to move beyond the gridlock.

Five Innovative High School Mathematics Programs

Each of the grants for the five high school mathematics curriculum development projects ran for a period of approximately five years, roughly from 1992 to 1997. The grants represented opportunities for the five development teams to fundamentally reconsider all assumptions about secondary mathematics education, to essentially start over and redefine the high school mathematics experience. Each team was comprised of individuals representing various constituencies: teachers, staff developers, math professors, members of the private sector, etc. Their initial work was centered in five different states – California, Montana, Michigan, Massachusetts, and Connecticut – although they piloted and field tested their materials in schools and districts across the country. Not surprisingly, the five programs that resulted each have their own individual character. However, they bear a strong resemblance as a family of curricula, sharing many common attributes: all are integrated curricula that place an emphasis on higher-order thinking, on contextualized problem solving, on mathematical modeling, and on the appropriate use of technology. They are cumulative with respect to both mathematics content and math-related skills. All take a similar pedagogical stance – for example, using technology as a tool for mathematical exploration, providing opportunities for students to experience mathematical inquiry, and placing emphasis on the multi-

representational communication of ideas. Most notably, they have been designed to be readily accessible to all 9th grade students, with the goal of eliminating the need for remedial offerings. The idea is that schools implementing these programs can offer the same curriculum to all students. Pacing might vary across courses to accommodate differences in student ability or experience, but ultimately, all students have access to the same mathematics.

All five curricula are highly ambitious programs that involve much more than incremental change within current offerings. Full implementation of any one of the five means replacing the familiar Algebra, Geometry, Algebra II & Trigonometry, Pre-Calculus sequence with a coherent program of three or four integrated courses that are cumulative and comprehensive. This in and of itself remains a radical, if not revolutionary, notion at the high school level, especially in mathematics, where any change tends to occur in a much more incremental fashion. Instead of emphasizing the mastery of finite techniques, these programs attempt to develop mathematical thinking grounded in deep conceptual understanding. It is a vision of mathematics and mathematics teaching that most teachers find somewhat unfamiliar. Had the developers produced something with which teachers were immediately comfortable, they most likely would have missed their mark. Still, by recasting high school mathematics as a multi-year program rather than a sequence of topic-based courses, all five of the NSF secondary mathematics curricula ask teachers not only to teach math in a different way, but also to teach a *different* mathematics. For example, all of the programs include more statistics, discrete mathematical modeling, and contemporary topics than a standard textbook series. The expectation is also that the five curricula would be accessible and appealing to all students. In theory, schools should have far less need for the heterogeneous grouping and complex tracking systems associates with most high schools – posing new challenges for teachers and administrators, as well as for the students themselves.

The five curriculum development projects and the textbooks that resulted from their NSF grants are as follows:[1]

PROJECT:	Application Reform in Secondary Education (ARISE)
TEXT:	*Mathematics: Modeling Our World* (W.H. Freeman and Co.)
PROJECT:	*Core-Plus* Mathematics Project (CPMP)
TEXT:	*Contemporary Mathematics in Context* (Glencoe/McGraw-Hill)
PROJECT:	Interactive Mathematics Project (IMP)
TEXT:	*Interactive Mathematics Program* (Key Curriculum Press)
PROJECT:	MATH Connections Project
TEXT:	*MATH Connections: A Secondary Mathematics Core Curriculum* (It's About Time Publishing)
PROJECT:	Systemic Initiative for Montana Mathematics and Science Project (SIMMS)
TEXT:	*SIMMS Integrated Mathematics: A Modeling Approach Using Technology* (Kendall/Hunt Publishing)

[1] For more details about each of these projects, see Appendix A.

While the specifics varied from one program to the next, any school or district that committed to implementing one of these programs in the early years of publication could count on receiving additional supports from the curriculum developers as well as the publishers. These generally included on-site professional development during the summer and school year, regular email and/or phone contact with someone from the curriculum project office, and at least some complimentary materials.

The COMPASS Implementation Center

As the five high school math projects readied for publication, NSF recognized the need to do more than simply fund the development of the curriculua. The COMPASS (Curricular Options in Mathematics Programs for All Secondary Students) Center was created and funded to provide a coordinated dissemination effort for the five projects. Because no prior mechanism or structure existed to connect schools and districts with these five innovative secondary math projects, COMPASS became that interface.

The funding for COMPASS has supported six different sites. In addition to the central site at Ithaca College, which is the home of COMPASS, each of the five curriculum projects houses their own dissemination and implementation effort – commonly referred to as a COMPASS "satellite site." There are a number of common activities and structures for which all six sites pool resources – for example, maintaining a website, publishing brochures, and making presentations at regional and national conferences. Funding for the central COMPASS site creates a national effort that connects and promotes the dissemination work of the five curriculum projects. The central office serves as a first point of contact for many schools and districts interested in any one of the five math curricula, although many also contact the individual projects directly. The COMPASS work across all six sites falls into four major categories: creating awareness of the curricula on a national scale, building knowledge about the implementation of innovative programs for the field at large, facilitating curriculum selection among clients, and providing support at a national level for those schools and districts that choose to implement one of the five COMPASS curricula.

This Study

In the summer of 2000, the directors of the COMPASS central office and its satellites approached Inverness Research Associates with an idea for a study. The question they hoped to answer was: *What actually happens over the course of implementation to the schools and districts that choose to adopt these programs?* While they understood many of the challenges that early implementers faced, they wanted deeper knowledge of the complexities that result when schools and districts take on this degree of innovation in high school mathematics programs. All of the COMPASS satellites had worked closely with a collection of pilot sites during the curriculum development process, but once the programs went to publication, the develop teams knew far less about the people and places that chose to use and implement them.

Inverness Research Associates agreed to conduct an exploratory study. Our goal was to find five implementation stories to portray – one for each of the five NSF-funded secondary mathematics programs. We did not want the stories to reflect "best" cases. Instead, we sought stories that would be illuminative and that would teach valuable lessons about the real work of implementation. We chose to take a journalistic approach – using the names of real people and real places – obtaining permission to do so from the outset. Once the stories had been written down, reviewed, and double-checked for accuracy, we began to study our collection of cases in fine detail, carefully distilling lessons learned that practitioners as well as policy makers would find of value in their efforts to improve secondary mathematics education. To date, we know of no other similar long-term study of curriculum implementation. While there are many studies that examine mathematics teaching and learning (Weiss, et. al., 2003), and even the impact of innovative mathematics curricula (ARC, 2002), few focus centrally on processes of curricular decision making and implementation, especially at the secondary level. Ours takes a purely qualitative approach, providing rich descriptive data about the phenomenon of high school mathematics curriculum implementation.

Purpose

Because Inverness Research Associates has served as the external evaluators of the National Science Foundation grant that funds COMPASS, we want to be quite clear about what the study that we describe here is not. First and foremost, it is not an evaluative study. It is also not a comparative study of the five curricula; nor is it a study of the success or failure of implementation centers and their strategies. Instead, the current study is a piece of exploratory research, conducted under the auspices of COMPASS. It seeks to document what happened at each site over multiple years, and to understand the factors that most influenced the degree and nature of implementation – at the district level, at the school level, and at the classroom level. While there is currently much attention given to research that focuses on student achievement, on teachers and teacher knowledge, and on instructional "best practices," there is far less research conducted on the process of curriculum improvement. We believe it is equally critical to know the dynamics and factors that shape the processes by which districts and schools improve their mathematics programs, curricula, and instructional materials. Therefore, we have focused our cases on the realities of implementation, and our team from Inverness Research chose to immerse ourselves in the real work of the five sites we selected. We spent a number of days at each site– meeting with various constituents in the implementation process; observing classrooms; and interviewing students, teachers, principals, and district administrators. We also conducted a series of follow-up interviews and asked key site leaders to review our case study drafts – all in an effort to let them teach us about the real world of innovative curriculum implementation.

The curricula involved in our study reflect a distinct theory of action and growing body of research. The logic goes something like this: students who use challenging curricula in rich mathematics and science classrooms where the teachers have received curriculum-specific professional development and the program is well-implemented

indeed have the opportunity to learn more math and science content (COMAP, 2002; Weiss, et. al., 2002;). It is well-documented that curricular materials play a pivotal role in the American classroom, especially in mathematics. Studies indicate that because these materials provide the organizing structure for daily activity, they ultimately determine what mathematics students learn and how they learn it (Ball & Cohen, 1996; Trafton, et. al., 2001; Valverde, et. al., 2002). Questions remain about the degree to which and the ways in which student learning is enhanced. While our research may well shed light on these issues, the purpose of this study does not include a detailed analysis of student learning.

Ultimately, our purpose is to help both researchers and practitioners better understand the very real and complicated challenges of putting one of these innovative curricula into place. Many mathematics educators advocate for this kind of comprehensive and rigorous program in their districts, or profess a desire to teach it in their school, but the realities of implementation prove far more difficult than they anticipate. The tendency is to underestimate the barriers and the power of tradition. Few foresaw the pockets of opposition that would emerge: from veteran teachers, quite satisfied with their traditional textbooks; to parents and students, who worry about standardized test scores and college admissions. Indeed, the data suggest that of all the K-12 disciplines, high school mathematics is arguably the most deeply entrenched, the most "gridlocked," and the toughest in which to reform instruction.[2]

Data Collection

We began our study when these programs initially appeared on the textbook market – just as the five NSF-funded curricula had gone to full publication. Most 9th grade or Year One books were first available for purchase in the spring and summer of 1998, with the next book in each series appearing each subsequent year. This effectively meant that all five curricula were first available in their entirety in the fall of 2002. This was also a time when the use of non-traditional math programs was becoming a much more politicized issue across the nation. The "Math Wars" were well underway in reform-minded states such as California and organizations like "Mathematically Correct" had begun their attacks on any curriculum designed to reflect the vision of the NCTM *Standards* (Reys, 2001). Our data collection began in the midst of this turmoil, in the spring of 2001. For more details regarding our data collection process, see Appendix B.

The Sites

The short descriptions below provide an overview of our five sites and a glimpse into the lives of the people, schools, and districts that we encountered over the course of our multi-year study. They are intended to provide brief context and background. The actual

[2] We note here that in our experience evaluating systemic reform efforts (for example, the National Science Foundation's State Systemic Initiatives, Rural Systemic Initiatives, Urban Systemic Programs and Local Systemic Change projects), it is almost always the domain of high school mathematics that proves least involved and least influenced. See Inverness Research Associates at www.inverness-research.org.

stories appear as chapters in this manuscript.

***Core-Plus* in Bellevue, Washington**

Bellevue, Washington is a wealthy suburb of Seattle, where residents are accustomed to well-maintained school facilities, good teaching, and high student achievement. The district prides itself in being forward thinking and on the "cutting edge" when it comes to curriculum. So when Superintendent Riley demands that a single program be selected for use in all four high schools, district mathematics leaders suggest that math teachers choose from one of the five NSF-funded curricula. Even though elements of the decision feel rather top-down, teachers are involved in piloting units from all five programs and ultimately, in voting on their final selection – *Core-Plus*. Not everyone is initially pleased with the decision and a few avid critics remain. However, enthusiastic leadership, combined with professional development for all those who want to participate and a supportive state context, continues to strengthen the effort. A trajectory of ever-improving test scores on the mandatory state assessment, particularly among traditionally lower achieving groups, has also contributed to the staying power of *Core-Plus* in Bellevue.

***Mathematics: Modeling in Our World* in Bald Knob, Arkansas**

The Bald Knob story demonstrates how an innovative NSF-funded curriculum can serve as the driving force for strengthening and enriching the secondary mathematics core of a small rural district with only one high school – leading to the teaching of new topics, improved classroom practice, increased student interest, higher test scores, and more students completing advanced-level mathematics courses. It is also an example of how tenuous such innovation can be, especially when both the vision and leadership rest with a single person. Even when similar initiatives are underway at the middle-school and elementary levels, which was the case in Bald Knob, stewardship and passion for the high school reform effort must be widely shared by the group rather than tightly held by an individual. Some might argue that the Bald Knob High School Math Department did share a collective vision and support for the new program as a whole. However, a certain amount of resistance is a given at the high school level and in a department where two is the majority, the beliefs of a single staff member can completely change the tenor of the group. Under these circumstances, a challenging program like *Mathematics Modeling our World (MMOW)* can be as quickly dismissed as it is adopted.

***Math Connections* in Boston, Massachusetts**

Boston's implementation of *Math Connections* illustrates the way in which curriculum can be a cornerstone of a far-reaching plan for comprehensive district-wide reform. According to Superintendent Payzant's vision, requiring the use of Standards-based curriculum and committing the resources to ensure that teachers are supported in doing so, can drive the systematic improvement of instruction – especially in a district which has been challenged to effectively serve underachieving students. However, because of the Superintendent's convictions and desire to effect change immediately, there is little time for teachers to buy in to the specific program or the broader philosophy of integrated, Standards-based mathematics programs. The result is that for many teachers the curriculum is not a program but a series of related texts, and as such, can seem inadequate and even inappropriate for their often ill-prepared students – a fact that could hinder the district's plans for broader reform. Still, the district's own mandates and a high stakes state accountability system force people to take the curriculum seriously, and that may be the first step towards long-term instructional change.

***Interactive Mathematics Program* in Denver, Colorado**

Ranum is a middle-class, suburban high school located north of Denver. This case illustrates the role that curriculum can play when teachers are highly motivated to change their practice. Spurred on by the publication of the NCTM *Standards* and early 1990s' reform-minded mathematics professional development, Ranum teachers seek out and

embrace the *Interactive Mathematics Program* (*IMP*) curriculum; it becomes a vehicle for their professional growth. According to the teachers, the curriculum helps them realize the potential and power of their own teaching and of their own students when grounded in a mathematically rich, constructivist program. The fact that Ranum's principal has a clear vision for program improvement and also for the growth of the Math Department helps the school foster a true mathematics education learning community. Still, this story also demonstrates the true vulnerability of a grassroots effort, and the extent to which strong curriculum is not necessarily sufficient to carry and sustain a change in culture. The success of *IMP*'s implementation and its staying power at Ranum proves to be highly dependent on the support of the principal and the environment he has established within the school. When he leaves, a small-but-vocal group of parents gain an opening, and ultimately, the leverage they needed to topple the effort. However, there are residuals left behind and it is telling that Ranum ultimately chooses to implement *Core-Plus* as the replacement for *IMP*.

***Systemic Initiative for Montana Mathematics and Science Project* in San Antonio, Texas**
In the Texas case, the story takes place in Harlandale, a low-income, largely Spanish-speaking suburb of San Antonio. It shows how an innovative math curriculum, such as *Systemic Initiative for Montana Mathematics and Science Project* (*SIMMS*), can serve as a central tool for much wider equity-based reform within a single school site and how another reform effort, such the San Antonio USI, can provide extra incentive to initiate the selection and implementation process. At Harlandale High School, the positive changes that teachers experience in their classrooms and among their students deepen their commitment to staying the course of implementation. However, breaking from the path of tradition and moving an entire school in a new direction takes more than high-quality curriculum and institutional will. Without the unyielding efforts of the Math Department chair, the dedicated support of the principal, and the careful selection of new faculty, there are simply too many prevailing forces that coalesce to thwart the effort. So far Harlandale has maintained a path of implementation that reflects constant vigilance, and the results speak for themselves.

While they cannot substitute for the full cases, the summaries above give some sense of the rich cases we documented. A conscientious effort was made to carefully and accurately write down each story so that once finalized, after multiple reviews from our school and district participants, they could serve as the foundation for further research and comparison.

Findings

For the most part, we have tried to refrain from researcher commentary in the telling of our implementation stories, in hopes that readers will have the opportunity to draw their own conclusions. In the final chapter of this manuscript, however, we present a summary of our findings based on a cross-site analysis of the five cases. In the summary, we detail how these implementation efforts differ from other textbook adoptions, what elements the stories share in common, how the process influences classroom practice, and what factors appear to have the greatest impact on the implementation process. We conclude with our reflections on reducing the "gridlock" that so often characterizes improvement efforts in high school mathematics.

CHAPTER 1

Core-Plus[3] in Bellevue, Washington

Preview

In a high-achieving, largely affluent, suburban district, the superintendent views the implementation of an NSF curriculum as a way to both unify the district's high school math program and to keep the district on the cutting edge of mathematics education. The district-wide mission is to have every student participating in an Advanced Placement course or the International Baccalaureate program. District leaders view the *Core-Plus* curriculum as an effective way to move Bellevue high schools towards attaining this goal. This profile illuminates the strengths and issues inherent in a district-mandated implementation strategy that includes the piloting of new materials, multiple opportunities for teacher input prior to curriculum selection and implementation, and voluntary participation in professional development. It examines the introduction of a reform curriculum into a system where the majority of teachers and students have been traditionally successful.

THE CONTEXT

East of Seattle, nestled in the foothills between Lake Washington and Lake Sammamish, is the suburban community of Bellevue – home of the Microsoft Corporation and many of Washington state's wealthiest residents. While only a few miles from the Northwest's largest city, Bellevue's location at the edge of the Cascade Range and in the shadow of Mount Rainier gives it a decidedly non-urban feel. There is a designated downtown area with a small cluster of high-rise buildings and many upscale shops. Still, much of Bellevue consists of upper middle-class homes, generally built in the last 60 years, interspersed with newer apartment buildings and low-rise business complexes.

The Bellevue School District serves approximately 15,000 students, who live either in Bellevue proper or in one of a handful of smaller, surrounding communities. It is a K-12 district, comprised of 16 elementary schools, five middle schools, four high schools, and two alternative schools. By Northwest standards, Bellevue's 30% minority

[3] The official name of the curriculum is *Contemporary Mathematics in Context: A Unified Approach.* However, it is more commonly know as *Core-Plus*, the name of the curriculum development project that created it.

enrollment makes it fairly diverse. The most recent data available (taken from the 2000-2001 school year) indicate an ethnic breakdown of 68.9% Anglo, 2.9% African American, 20.3% Asian, 7.5% Hispanic, and 0.4% Native American. Trends indicate that demographic change is occurring slowly in Bellevue, with a decrease in the Anglo and African American population and gradual increases in the Hispanic and Asian populations. Only 16% of the student population district-wide presently qualifies for free and reduced-price lunch, and this number has remained relatively consistent over time.

Historically, Bellevue has benefited from its stable community, both in terms of the families it serves and the teachers it employs. However, over the past decade, transience and turnover have presented increasing challenges. With the rising success of the high-tech industry during the 1990s, long-time residents of Bellevue saw their housing costs soar, pricing many out of the market. Not surprisingly, teachers find it increasingly difficult to afford living where they teach – and this issue is exacerbated by a state-mandated salary cap that limits how much teacher salaries can vary across the state.[4] In addition, slower economic times in recent years have produced changes in the job and housing market that affect many local families, and can often lead to relocation.

Bellevue may not be able to pay its teachers at a rate that exceeds the state limit, but over the years the district has made use of local levy money to improve circumstances for teachers in other ways, such as paying for more staff than the state allocates. As a result, Bellevue has the funds available to hire more staff (i.e., additional teachers and instructional assistants) than many other Washington districts of comparable size. However, in the case of mathematics, district leaders find the pool of qualified applicants shrinking each year. The mathematics teacher shortage is a serious issue in Bellevue, and nowhere is it more blatant than in the high schools. Here, schools have been known to obtain parent permission to combine classes so that students can receive instruction from an experienced teacher. We were also told that widespread retirement among teachers has led to a situation in which, during the 2001-2002 school year, more than half of the Bellevue teaching force had less than five years of experience.

Despite the turnover among teachers, Bellevue has remained one of the top-performing school districts in the state of Washington and has every intention of remaining so. The district sets high expectations – for example, all high school students are required to take three years of mathematics for graduation. The parent community is both involved in their children's education and vocal about demanding the very best in return for their tax dollar. The parents in Bellevue tend to be educated citizens and professionals who expect high-quality, college-preparatory education from their public schools. They also have fairly traditional notions of what constitutes college-preparatory education – ideas that are based on their own experiences as high school students.

[4] This means that teachers in Eastern Washington, where the median home costs $150,000, earn the same amount as teachers in Bellevue, where the median home costs nearly $450,000. In fact, the disparity between starting salary and cost of living in Bellevue has made it nearly impossible to fill mid-year teaching vacancies. In 2001, the district had four openings at the end of the first semester, but could only fill two of them. Classes were merged to compensate for the teacher shortage, forming high school math sections with more than 40 students.

However, this parent group also expects Bellevue students to perform well on state tests, which in Washington go beyond the scope of the traditional mathematics sequence.

High school students in Bellevue participate in two state-mandated assessments. In 9th grade, students take the Iowa Test of Educational Development (ITED) as a test of basic skills. In 10th grade, students sit for the Washington Assessment of Student Learning (WASL), which is a performance-based instrument that tests students' abilities to apply what they know to more complex situations and problems. Piloted at the end of the 1990s, the WASL remains fairly new to many educators in Washington. It is a challenging and rigorous test that reflects the overall direction of the state with respect to education. In mathematics, for example, rather than answer dozens of multiple-choice questions, students must provide comprehensive written responses to a series of more complex problems. Below are two sample questions for the high school level, the first relating to probability and statistics and the second pertaining to geometry:

> **SAMPLE QUESTION #1:** On a local TV quiz show, Mr. and Mrs. Halpem are given two red blocks and two blue blocks that they must distribute into two boxes any way they wish. Mrs. Halpem will then be blindfolded and asked to pick one block at random from one of the boxes. If she picks a red block, the Halpems will win $1,000. How should the Halpems distribute the blocks to give Mrs. Halpem the maximum probability of drawing a red block? *Explain your answer in detail.*
>
> **Answer: 2/3 (you increase your odds by putting a red in one box and the remaining blocks in the 2nd box. 1⁄2+1/6=2/3)**
>
> **SAMPLE QUESTION #2:** Two poles, 60 feet tall and 20 feet tall, stand on opposite sides of a field. The poles are 80 feet apart. Support cables are placed from the top of one pole to the bottom of the opposite pole. How far above the ground is the intersection of the cables? What if the poles were 120 feet apart? *Explain your answer in detail.*
>
> **Answer: Intersection is 15 feet above the ground; if 120 feet apart it would still be 15 feet.**

As the two samples indicate, the free response questions that students encounter on the WASL are non-trivial, multi-step problems that require not only careful thinking, but also the communication of that thinking. The theory behind the heavy emphasis on writing in all areas of the WASL is that it forces students to collect, organize, and communicate their thoughts. In mathematics, the writing requires students to clarify their thinking in a way that they most likely would not if simply providing a numeric solution to a problem.

By 2008, students will need to complete the 10th grade reading, writing, and mathematics WASL assessments in order the meet statewide graduation requirement. The high stakes nature of the test combined with its performance-based design has provided impetus for many Washington districts to re-examine their programs across all curricular areas, recognizing that mastery of basic skills will not be enough to succeed on this test and creating impetus for educational reform across the state. Bellevue's decision to implement an innovative, new mathematics program at the secondary level appears due, at least in part, to this WASL-driven wave of improvement efforts in Washington.

Another aspect of the WASL that has affected decisions in Bellevue is the extent to which the test, because of its added rigor and changed reporting guidelines, tends to

call greater attention to lower performing students. Because the WASL results are reported as the percentage of students at standard or benchmark, the only way that a school or district can obtain high marks is to improve the achievement of their traditionally lower performing bottom quartile. As with most districts, despite Bellevue's long-time reputation for affluence and high achievement, the district actually contends with a range of socio-economic levels and academic backgrounds within its student population. According to district leaders, there is small but significant group of students whose low performance has been overlooked due to success of the majority. Students who fall into this category in Bellevue tend to be ethnic minority students who come from low-income households. It is this group that the Bellevue School District hopes to impact most by implementing one of the NSF math programs. However, in order to succeed, whatever the district chose needed to be challenging enough to satisfy their "high-end" students as well. In reviewing the five NSF-funded secondary math programs, the majority of high school mathematics teachers in Bellevue concluded that the *Core-Plus* curriculum had the best chance of meeting all students' needs across the achievement spectrum.

We visited the Bellevue School District midway through the 2001-2002 school year. This was the district's 3rd year of implementing the *Core-Plus* curriculum. Our multi-day tour took us through three of the district's four high schools. Bellevue's Math Curriculum Developer chose the three sites to best represent the range of educational settings and levels of implementation across the district. Of the three schools we visited, one was the school that had piloted *Core-Plus* prior to implementation. Another was a more affluent school where the teachers expressed more reluctance to implement the program. And a third school was somewhere in the middle, serving a more diverse population by Bellevue standards. While the three had fairly different stories to tell, together they created a consistent picture of their district's effort to make significant changes in the teaching and learning of high school mathematics.

Key People

The district-wide implementation of the *Core-Plus* Mathematics Program in Bellevue would most likely never have occurred without the vision and leadership of the current Superintendent, Dr. Mike Riley. Riley took the helm in 1996, strongly committed to creating a truly unified K-12 school district. For the 15 years prior, Bellevue had operated under a system of site-based management. During this period, the district played only a minor role in determining classroom curriculum. Teachers grew accustomed to selecting their own materials. Only in the last few years of Bellevue's site-based management era were there common district standards articulated for mathematics. We were told that, under these conditions, teachers drew on a collection of resources, resulting in little consistency within disciplines, grade levels, or buildings.

As the new Superintendent arrived in Bellevue, many teachers were frustrated by the time and energy required to modify and create curriculum each year. Riley recalls teachers asking him, "What can you do to help us stop re-inventing the wheel every year?" And he thought at the time, "Be careful what you wish for." The truth is that Riley believed the curriculum planning associated with site-based management was not

in the best interests of children and their learning. Soon after his arrival, he began taking steps to unify Bellevue's K-12 curriculum. Among his first moves, Riley began putting in place a team of district curriculum developers who were charged with moving the district in the direction of a single program for each grade band and subject area.

In mathematics, Riley chose Marsha Pink, a much-admired teacher from one of Bellevue's own high schools and an avid math reform advocate, to serve as the K-12 Mathematics Curriculum Developer. Pink, who had strong connections to math educators at the local, state, and national levels, took on her new role in the summer of 1997. At the time, a group of middle school math teachers were in the midst of piloting the *Connected Math Program* as part of a grant they had received during the prior school year. A group of elementary teachers were experimenting with replacing units from the *Investigations in Data and Space* materials. The high school math programs were very traditional with slight variations from site to site, but a number of teachers had expressed a willingness to consider other options. In addition, the Bellevue public schools were in their first year of involvement with a regional mathematics Local Systemic Change grant (funded by the National Science Foundation) known as "Creating a Community of Mathematics Learners" (CCML). The initiative's primary goal was to improve student achievement in mathematics across grades K-12, with curriculum providing the leading edge of reform. Put simply, many circumstances had come together in Bellevue that pointed to the implementation of NSF mathematics curricula across all grades K-12. From all accounts, Marsha Pink was the person with the mathematical knowledge and instructional vision necessary to successfully support and oversee the selection of the new programs that would be at the heart of Bellevue's district-wide mathematics reform effort.

When the time came to make the actual decision, a number of high school teachers also played pivotal roles in steering their colleagues in the direction of reform. One of these teachers, initially skeptical of all the NSF curricula, would prove to be an important player, ultimately leading the district-wide mathematics improvement effort. Surprising some of his colleagues, high school math teacher Eric McDowell, a self-proclaimed critic-turned-convert, would replace Marsha Pink when she chose to leave her position as K-12 Mathematics Curriculum Developer at the end of the first year of implementation.

THE MOTIVE FOR CHANGE

Due to the long-time academic success of most students in Bellevue, the attitude of many high school math teachers and parents has been "if it isn't broken, don't fix it." However, from the standpoint of the Superintendent and teachers working primarily with students in the standard track or below, a number of reasons existed to make changes in Bellevue. First, many believe that the district has an obligation to serve all of its students and was not doing so, due to the generally high achievement of the majority. Second, the state-instituted, high-stakes test (WASL) demanded much more on the part of students; initial results indicated that many more Bellevue students would struggle with this assessment in comparison to the test of basic skills. Third, there was a belief that

curricular reform well underway at the middle school and elementary levels would put increasing pressure on the high school Math Departments to also make a change. Finally, Bellevue had watched other districts in the region implement innovative curricula with considerable success. In terms of the district's overall reputation, it was important to remain in the forefront – to offer the best programs for students and to achieve the best results. This image of being on the "cutting edge" of what is happening in education also provided impetus to embark on the path of curricular change in Bellevue.

According to Bellevue's current Mathematics Curriculum Developer, Eric McDowell, the primary goal of the district's mathematics improvement effort is intended to bring up the "low end" of the achievement scale in Bellevue, "to meet the needs of students who have often been forgotten in this district." A review of test data for Bellevue students in grades 9-12 indeed indicates the presence of an achievement gap – between ESL and English-speaking students, between African American and Hispanic students and others, and between students from low-income and high-income families. For example, during the years 1996-2000, when Bellevue was trying to bolster its AP participation, the total tests taken by Asian and white students increased more than fourfold. During this same period, the total number of tests taken by African American students went from 0 to 20 and the total tests taken by students in the Mexican American/Other Hispanic groups together, grew from 7 to 24 – nowhere near the gains of their white and Asian counterparts. The WASL data tells a similar story, with Bellevue's more affluent schools boasting a much higher percentage of students at standard that their more economically and ethnically diverse counterparts, in some cases by more than 40 percentage points. District leaders have recognized that narrowing this achievement gap is their greatest challenge. They view the successful implementation of *Core-Plus* curriculum as a key factor in accomplishing this goal.

THE STORY

By the time Marsha Pink took on the role of District Mathematics Curriculum Developer in June of 1997, many of Bellevue's middle-school math teachers had already piloted and approved (via consensus) an innovative new program for the middle school. The new curriculum was the *Connected Math Program* (CMP) and plans were in the works to begin incremental implementation during the 1997-98 school year. Middle school math teachers in Bellevue had actually been involved in a pre-publication pilot of the materials, which entitled them to additional support from the curriculum developers in the form of teacher training. In addition, the district was participating in a Local Systemic Change grant, "Creating a Community of Mathematics Learners" (CCML) that had initially focused on the middle school level, providing teachers with considerable professional development (four release days as well as a Summer Institute) in support of their teaching CMP.

Because of the strong support for CMP at the middle school level, Pink used this set of materials as both a guideline and a comparison when she began exploring mathematics curricular options for the other grades. Her hope was to support the elementary and high school teachers in making their own choices that would align well

with CMP, creating a strong, coherent, and connected K-12 program district-wide. She believed that once teachers learned more about the high-quality, innovative materials available for elementary and high school, they would likely choose from one of NSF-funded curricula. She wanted them to decide for themselves, but she had strong feelings about what would be best for students and the authority to make the decision herself if it came to that. Particularly with respect to the high school, she was prepared to mandate a decision if the teachers did not choose to change on their own .

The *Investigations* materials surfaced quickly as the most likely candidate at the elementary level. A number of teachers across the district had been experimenting with similar materials for some time. Many still preferred to pull from a collection of resources that they had accumulated over the years from people like Marilyn Burns and Kathy Richardson. However, during the 1997-98 school year, other pieces came together that created further momentum towards implementing *Investigations* district-wide. First, the district received an Exxon grant that provided support for three Math Lead Teachers at each elementary site. The district also offered funding for four release days and continued training from Marilyn Burns Educational Associates, who had worked with Bellevue teachers in the past and were very familiar with the *Investigations* materials. The elementary teachers were also given an opportunity to participate in bi-annual, district-wide, grade-level meetings – an experience that proved pivotal to successfully implementing the new elementary program. Finally, the CCML was shifting its focus to the elementary level during 1997-98, resulting in additional professional development opportunities for elementary math teachers. The CCML offerings included a series of workshops based on Deborah Schifter's *Developing Mathematical Ideas (DMI)* materials that teachers found particularly valuable. Perhaps as a result of these added incentives, Bellevue's elementary teachers gradually came to an agreement that *Investigations* would be their best choice.

With consensus building around math curricular choices in grades K-8, the district was in a position to begin making these selections official. During the summer of 1998, the district administration in Bellevue mandated that all middle school math courses be based on the CMP materials. The decision was not without incident, but because of the Superintendent's strong support and his willingness to work closely with individual schools, the district managed a successful transition without too much upheaval. At one point, he told a group of middle school teachers, "This is our district-adopted curriculum and if you are not willing to teach it, then you are welcome to leave." And some did. Marsha Pink recalls the process as painful but says, "I knew that this was better math for kids and that once teachers could open their hearts to what was best for kids they would be OK." Her prediction proved accurate.

It was during the next school year (1998-99) that Marsha Pink began preparing Bellevue's high school Math Departments for the changes that lay ahead. Ideally, she wanted the teachers to make their own decision. She also knew that given the selections now in place at the elementary and middle school levels, choosing from one of the five NSF-funded secondary math programs made the most sense, and this became her message to all the high schools. It was not received with particular warmth or enthusiasm. If she had to strong-arm the decision, Pink knew that she had the support of Superintendent Riley. Still, she did not want the selection process to come to that.

Midway through the 1998-99 school year, in hopes of rallying support among her colleagues, she took four high school teachers to the neighboring Edmonds School District to attend a three-day COMPASS workshop. Edmonds was in the final years of an NSF Teacher Enhancement grant at the time and their project leaders had invited the Directors of the COMPASS implementation center to help them become better acquainted with the five NSF curricula and the issues involved in implementing such an innovative program.

When the group returned to Bellevue, they decided to have one or two teachers from each Bellevue high school take one of the five programs and to pilot a sample of the materials during the remaining months of the school year. Teachers volunteered to participate in the pilot. In the divvying process, teachers from Marsha Pink's former high school, a place where teachers had a reputation for working together and operating as a cohesive department, tried *Core-Plus*. At another high school, where the teachers tended to operate more independently, the volunteers piloted IMP. The distribution of programs across schools during the piloting process may or may not have affected the final outcome.

At the end of the spring term, Bellevue's secondary math teachers convened for a two-day meeting in which they shared their experiences and began working towards a decision. Marsha Pink invited the Directors of the COMPASS implementation center to attend the meeting as well, anticipating that they would present objective information on all five programs that would complement the reports on the various pilots. However, prior to the meeting, in talks among themselves, the word was already circulating among the high school teachers that Bellevue would either go with *Core-Plus* or continue with a traditional program. Marsha Pink tells a slightly different version of the story. From her perspective, remaining with a traditional program was never an option.

The meeting took place as planned with teachers reporting to each other on their experiences with different curricula. According to Eric McDowell and Marsha Pink, the general feelings about the programs were as follows:

> *Math Connections* was not perceived as enough of a change from what teachers were already doing. It was also only a three-year program and Bellevue needed a four-year curriculum.
>
> Teachers described *IMP* as highly innovative, but a little contrived in terms of the problem-solving contexts presented. It also did not look like a math book, making it too big a leap for Bellevue's achievement-oriented teachers, students, and parents.
>
> *ARISE* did not generate strong feelings either way. Teachers liked many of the problems, but questioned some of the ordering of topics.
>
> The teachers who tried *SIMMS* reported liking what they saw, especially the integration of technology. However, in terms of style and layout, it did not seem polished enough for the Bellevue audience.

> The teachers who tried *Core-Plus* found it challenging and liked the authentic quality of the applications. They believed it was a viable option for Bellevue, but expressed concerns about the amount of reading required on the part of students.

At the end of the first day of their meeting, only the school that had piloted *Core-Plus* endorsed the notion of pursuing this direction for the entire district. Other teachers needed further convincing. Marsha Pink recognized that consensus would be impossible, but she felt confident that if they could create some critical mass, a decision for *Core-Plus* was possible. A number of teachers, who were not necessarily in favor of *Core-Plus*, were supportive of moving away from the traditional approach because of the WASL. A couple of teachers, not knowing much about the program, admitted that they were simply attracted to the sound of the name, *Core-Plus*, that it sounded like something for high-achieving students.

During the second day of the meeting, Pink worked closely with a couple of key teachers whom she believed needed to be on board before taking a vote. One of those teachers was Eric McDowell. McDowell, who describes himself as a skeptic initially, tells the story of how the Bellevue high school math teachers ultimately saw their decision as choosing between one of two things: 1) a conceptually rich program for which they would need to supplement some practice (i.e., *Core-Plus*), or 2) a program that was strong in practice for which they would need to supplement rich problems and activities (i.e., a traditional textbook). As he explained, "When put that way, the decision seemed obvious. We knew we could find lots of practice problems." In addition, over the course of the two-day meeting, McDowell had become increasingly convinced that *Core-Plus* could indeed better serve the needs of <u>all</u> Bellevue high school students than the traditional sequence he had taught his entire career. In the end, more than 50 Bellevue math teachers attended the final meeting in which the decision was made to choose *Core-Plus*. Although the choice was not unanimous, and many felt pressured into making their selection, they all voted.

Shortly following the vote, Superintendent Riley made official the district mandate of *Core-Plus* as Bellevue's designated secondary mathematics program, much to the dismay of some veteran high school mathematics teachers. Within weeks, the district had placed a large order with the publisher, Glencoe/McGraw-Hill. The textbook representative assigned to Bellevue quickly recommended that the district get in contact with the curriculum developers at Western Michigan University, advice that the district had received from the COMPASS Directors as well.

Marsha Pink chose to stay on as Bellevue's K-12 Mathematics Curriculum Developer through the first year of the *Core-Plus* implementation. However, the process of unifying the high school math program had proven so political that she ultimately felt it better for everyone if she stepped down. Although she too had only recently been a high school math teacher, her strong feelings about what was best for students and her role in the curriculum decision-making process ultimately alienated her from a number of her colleagues. "Some folks pretty much hated me by the end," she told us. Both Marsha Pink and Mike Riley asked Eric McDowell to apply for the Curriculum Developer position. He turned them down twice, citing other priorities and a lack of

experience. Eventually, they convinced him. His lack of experience with math reform did not prove to be a liability. On the contrary, the high school teachers considered him one of their own – and some believed that this might make implementation of the new curriculum more palatable for those math teachers who were less than happy with the *Core-Plus* decision.

Implementation Strategy

Bellevue chose an incremental, district-wide, single program implementation strategy, whereby all high schools introduce *Core-Plus* courses one year at a time, beginning with Course 1 in the Fall of 1999, until the traditional sequence of courses is replaced with a series of integrated courses over four years. Although Bellevue's implementation strategy eliminates the traditional program, the names of the new courses are not radically different and the strategy maintains a two-track menu of offerings. The standard path begins with Integrated Algebra/Geometry 1 in 9th grade, followed by Integrated Algebra/Geometry 2 in 10th grade and Integrated Algebra/Trigonometry 3 in 11th grade, and concludes with either Integrated Algebra/Pre-Calculus 4 or AP Statistics in 12th grade. The accelerated path begins with Honors Integrated Algebra/Geometry 2 in 9th grade, followed by Honors Integrated Algebra/Trigonometry 3 in 10th grade and a choice of Honors Integrated Algebra/Pre-Calculus 4 or AP Statistics in 11th grade. Students who opt for Honors Integrated Algebra/Pre-Calculus 4 in 11th grade can enroll in AP Calculus as seniors.

Although Superintendent Riley chose to mandate the *Core-Plus* materials in Bellevue, he did not require the professional development that supports quality teaching of the new curriculum. His argument is that high school teachers know what they need in terms of training and can decide as professionals how they will use their designated professional development hours. In Bellevue, there are 180 instructional days and an additional 20 calendar days for teachers. Of these days, 10 are up to the individual teacher's discretion. The other 10 are to be used for one of two options: attending a curriculum-sponsored workshop or participating in a lesson study session. According to these guidelines, teachers were given the option but not required to attend training on *Core-Plus*.

Compared to Bellevue's math curricular reform efforts at elementary and middle school levels, Marsha Pink explained that there have not been resources available to support the teachers to the extent that she would like. While teachers were given similar number of professional development days, there also has been only minimal external grant support – a few offerings near the end of the CCML LSC grant. Unlike what occurred with the CMP implementation, most of Bellevue's high school Math Department have received little or no training directly from the original developers of *Core-Plus* or their designated facilitators. Instead, the district has used more of a "trainer of trainers" model – meaning that the curriculum-sponsored sessions for *Core-Plus* are both voluntary and peer facilitated. At the time of our Bellevue visit, only four teachers (among them Eric McDowell) had participated in *Core-Plus* workshops at Western Michigan University, and the district was relying on these teachers to serve as local facilitators for the rest of the district. The curriculum developer's preference is for all

first-time users to receive training from their staff prior to teaching any course. However it is important to note that in February 2002, the developers of *Core-Plus* chose the Bellevue/Seattle region as the site for its Regional Users' Conference, providing an opportunity for essentially all Bellevue high school math teachers to experience high quality professional development from the people who know the curriculum best. Many teachers attended on a voluntary basis.

Below is the schedule of how the *Core-Plus* implementation proceeded in the Bellevue School District:

Date	Activity	Notes
Summer 1996	Dr. Michael Riley arrives in Bellevue	Process of "unifying" district K-12 begins
Summer 1997	Marsha Pink comes on board as Mathematics Curriculum Developer for the district	Pink was a high school teacher in Bellevue through spring of 1997
1997-1998	Bellevue implements the *Connected Math Program* district-wide at the middle-school level (grades 6-8)	Between grants and district support, teachers receive extensive training as part of the implementation process
1998-1999	Marsha Pink and four high schools teachers attend COMPASS multi-day session in Edmonds, Washington	Participants learn about the five NSF programs and what it takes to implement them
Spring 1999	Mathematic teachers from each Bellevue high school volunteer to pilot units from the five programs	One school pilots *Core-Plus* and likes it – none of the other schools like the other programs they are piloting
Spring 1999	COMPASS central site Directors facilitate two-day workshop for Bellevue's high school math teachers	The teacher vote to implement *Core-Plus* takes place following this meeting
Summer 1999	Four teachers go to Kalamazoo, Michigan for initial training in Core 1 and Core 2 courses	Teachers return to Bellevue to provide training for their colleagues who will be teaching the new program
1999-2000	Core 1 and Core 2 courses offered in all high schools and middle schools	*Core-Plus* in the middle schools assures curricular continuity for high achievers in grades 6-8
Summer 2000	Marsha Pink leaves position as Mathematics Curriculum Developer position and Eric McDowell is hired to take her place	Focus is on the leadership transition, with individual schools taking responsibility for training teachers with respect to *Core-Plus*
2000-2001	Core 1, Core 2, and Core 3 courses in place district-wide	District policy of "early-release Wednesdays" provides individual Math Departments the opportunity to meet weekly
Summer 2001	*Core-Plus* teachers are given the option to participate in two days of *Core-Plus* training as part of the districts "Learning Improvement Days"	The two-day session is voluntary and moderately well-attended
2001-2002	Core 1, Core 2, Core 3, and Core 4 courses in place district-wide	District policy of "early-release Wednesdays" provides individual Math Departments the opportunity to meet on a weekly basis
February 2002	Seattle/Bellevue region serves as the site for the *Core-Plus* Regional Users' Conference	Many Bellevue teachers attended

THE REAL WORK

Although teachers participated in the decision-making process, Bellevue's move towards an NSF-funded program in general and the implementation of *Core-Plus* in particular was ultimately a district mandate, which can pose problems at the high school level. First, as a group, high school teachers are accustomed to operating independently. They are often perceived as the math experts in their districts, given the authority to choose not only their own curricular materials, but also those for the lower grades. Second, in places like Bellevue, the high school math offerings had remained relatively unchanged for decades. With the implementation of *Core-Plus*, teachers were being asked to teach completely new courses, like "Integrated Algebra and Geometry" or "AP Statistics" and perhaps most importantly, the expectation (or at least the district's stated goal) was that all students would make it to the AP level.[5] Not surprisingly, long after the decision had been made and the books purchased, a considerable amount of grumbling remained on the part of some teachers. They continue to criticize the new curriculum as being less rigorous and more confusing than materials they have used in the past. According to Eric McDowell, "Until you do it, it's easy to dismiss it. It's hard to see the rigor just by looking at the book."

Unfortunately, Bellevue's policy of making *Core-Plus* training voluntary resulted in only a limited number of teachers learning the ins and outs of the new curriculum before attempting to teach it. During our visits to high schools, we encountered very few Bellevue teachers who had experienced professional development facilitated directly by *Core-Plus* staff. The majority of teachers we met had received "second generation" training from their colleagues in Bellevue, and a significant minority of teachers were using the new program without any training at all. We did not hear teachers saying that training was necessary to use the *Core-Plus* materials. However, they did tell us that the training helped. One recently hired teacher reflected, "It's been a really tough year. This program is not easy to teach. Although it probably would have helped to go to some of the trainings. Now that I think about it, it probably would have helped a lot."

Outside of the teacher group, in the community at large, the parent response to *Core-Plus* has been relatively quiet. Early on, a couple of parents made connections with the "Mathematically Correct" effort in California and attempted to ignite a similar conflict in Bellevue, but they did not succeed. According to Superintendent Riley, the parent resistance has been minor. He believes that his consistent message of support for the program combined with the strong improvement in student achievement data over the course of the *Core-Plus* adoption has helped quiet any criticism. Eric McDowell confirms this trend, saying that he still gets a few calls. However, most of the ongoing parent complaints have to do with teachers not being prepared or fully qualified to teach the curriculum. The reality is that Bellevue struggles to find highly qualified, certified math teachers due to the combination of comparatively low pay and competition from

[5] Because of the college-bound nature of Bellevue's student clientele, many students take four years of mathematics. Students who are not planning to pursue college majors that will require math are encouraged to enroll in AP Statistics after the completion of their Year 3 *Core-Plus* course.

other local industries. At the same time, *Core-Plus* demands more on the part of teachers – in terms of both content knowledge and pedagogy.

Degree of Implementation

When we observed math classes in Bellevue high schools during the winter of 2002, we saw almost exclusively *Core-Plus* offerings.[6] The three Math Departments each had their own perspective on the new curriculum and the extent to which it was working in their school; these perspectives were largely a function of the level of buy-in on the part of teachers, and support for the implementation on the part of department chairs. Some teachers reported working closely with members of their department to implement the new program; others indicated that they prepared very much as they had in the past – on their own. However, over the course of our classroom observations, we experienced much more variation from classroom to classroom than we did from school to school. For example, we saw students sitting in groups in some classrooms at each school, but not in all classrooms at any one school.

Other observable structures indicated the presence of a secondary mathematics reform effort. Graphing calculators were readily available and in use, including overhead versions for teachers. The student work posted in classrooms combined with what students told us indicated that teachers were assigning more long-term projects in addition to daily homework assignments. Also, classroom discussions pointed to new topics (often related to statistics and probability) and new approaches to old topics (particularly when looking at families of functions and their graphs).

However, some indicators of math reform did not surface in Bellevue classrooms during our visit. For example, the instruction was largely teacher-centered and teacher-directed. The overall structure of the lessons we observed consistently followed the traditional model of beginning the class period with a warm-up problem, reviewing and/or correcting the previous night's homework, discussing some new material, and assigning the next day's homework assignment (usually with an opportunity for students to begin work). Occasionally, we saw students presenting mathematics to their peers at the front of the room. Opportunities for students to articulate their thinking with respect to a new idea were usually limited to small group discussions and these tended to focus on finding solutions to problems rather than clarifying student thinking.

When we asked students what they thought of *Core-Plus*, their reactions were decidedly mixed. Some found it a marked improvement over what they had done in the past, saying things like, "It's pretty cool. I think the problems are interesting. They're really different than the kind of thing you see in most math books." When asked to explain, the same student replied, "They're sort of more complicated and more real life. You know you can't just follow a pattern with these." Others found the reading and writing demands too time consuming. As one Core 4 student told us, "I just think it's not a very efficient use of our time. Like this stuff on the derivative, I just asked my dad and he showed me how to do it. It was a lot faster than going through all this."

[6] For comparison purposes, we also observed a few examples of upper division courses that were to be phased out during the next academic year.

From what teachers and students told us, we get the sense that they view *Core-Plus* as a textbook series rather than a comprehensive secondary program. The change they see is focused on the math content as presented in the book, not necessarily about shifts in classroom practice encouraged by the new curriculum. It seems that in Bellevue the implementation of *Core-Plus* is more about letting the curriculum be what teachers want instead of closely implementing what the developers have envisioned. In many of the classrooms we visited, it is simply a new set of materials being taught in the traditional method. Nonetheless, Bellevue is reporting results – exactly the results that district leaders hoped would accompany adoption of an NSF-funded program. According to the Superintendent, "Everything's up! Our WASL results have just soared! And so many more kids are taking AP, which is our stated goal." A look at the number of students taking Math AP Exams from 1998-2000 shows a definite increase during the first few years of the *Core-Plus* implementation:

In 1998, 138 AP Math Tests taken (119 – 86.2% – passed)
In 1999, 255 AP Math Tests taken (188 – 73.7% – passed)
In 2000, 330 AP Math Tests taken (236 – 71.5% – passed)

This trend reflects a percentage gain of 139% in the number of students taking the tests from 1998 to 2000 and a percentage gain of 98.3% in the number of students passing the tests during the same period. According to Bellevue's criteria, *Core-Plus* is showing signs of success.

Enabling Factors

Without the Superintendent's directive to find and articulate a single district program that would meet the needs of all students and align with the WASL, it is unlikely that the Bellevue public schools would have implemented *Core-Plus* in all of their high schools. That Mike Riley has remained in Bellevue as Superintendent to provide ongoing, clear and unyielding support throughout the implementation process has been a significant factor. However, Riley could not have done the work alone.

Early on, during the selection stage, Riley needed someone who knew not only the mathematics, but who also believed deeply in the ability of all students to learn mathematics. He needed someone who was savvy about math reform. He found that person in Marsha Pink. Pink was passionate about the need to change the status quo in high school mathematics. She was willing to devote extra time meeting with concerned parents, collaborating with teachers, and just sitting down and doing the math with people if that was what it took to convince them. But perhaps most important, her commitment to the cause ran so deep that she was willing to withstand the negative and, at times, very personal backlash. In short, she was willing to sacrifice herself for a larger cause. She told us she reflected back on the *Core-Plus* decision, "I'm a change agent. I don't let the personal attacks bother me. The truth is, it's a huge hill. You're pushing, pulling, dragging – anything it takes. And it's ugly. People just don't want to change."

Had Marsha stepped down after the first year of implementation without a strong successor in the wings, momentum around *Core-Plus* might have waned. However, Eric McDowell proved to be an optimal combination of early critic, accomplished teacher, and charismatic leader, to oversee the next stage of implementation. In addition, the district had adequate financial resources to provide professional development for teachers and to purchase additional materials, especially graphing calculators. Bellevue also benefited from participation in a Local Systemic Change grant, which helped strengthen teachers' vision of reform and provided further opportunities for professional growth in the service of improving mathematics instruction. Finally, the immediate improvement in test scores made it impossible for community critics to credibly argue that the new curriculum was somehow damaging to students.

ONE YEAR LATER

More than a year after our original study of Bellevue, *Core-Plus* remained solidly in place, in its fourth year as the district's officially adopted secondary curriculum. The leadership also showed little sign of change, with Eric McDowell continuing in his position as Math Curriculum Developer and Mike Riley as Superintendent. As the district anticipated its fifth year of *Core-Plus* implementation, Bellevue's secondary math WASL results were maintaining a consistent upward trajectory, making them among the highest in the state of Washington.

In addition, many more Bellevue teachers had had the opportunity to work directly with *Core-Plus* staff and developers since the time of our initial visit. During the summer of 2002, the Bellevue/Seattle region served as the only National Training Site for *Core-Plus* outside of Michigan, enabling the district to send six teachers to Core 1 training, 12 teachers to Core 2 training, eight teachers to Core 3, and five teachers to Core 4. And in February 2003, the region hosted the *Core-Plus* National Users' Conference, providing yet another opportunity for Bellevue's secondary math teachers to interact with and learn from experienced *Core-Plus* professional development providers and curriculum developers.

When asked about the future of *Core-Plus* in Bellevue, Eric McDowell responded:

> *Core-Plus is still here because we're finding that it's working for us, which means that all of our students are doing as well or better than they were before we implemented the curriculum. And overall, our data is moving the way we want it to.*

He went on to delineate the gains that the district had experienced across multiple measures of student achievement, from PSAT scores to AP (Advance Placement) passing rates. For example, the most recent Math SAT scores indicate a 14-point gain in the average score for the district – a sizeable increase for SAT. Similarly, the district now has 46% of its eligible students enrolled in AP or International Baccalaureate mathematics courses. And the AP passing rate is up to 77%, compared with the national average of 68%.

McDowell explains:

> *So far, we continue to be very happy with the program. But we do supplement, especially for symbol manipulation. That's a definite weakness according to the test data. Basically, we don't buy into any program hook, line, and sinker. We think Core-Plus and Connected Math are the best out there, but they're not perfect. We identify the weaknesses and we address them and the great thing is that the people at Core-Plus, like the developers, are really open and honest. They share data with us and we share data with them. That part is great. I'm sure Core-Plus will be here another three to four years.*

The district also has a number of plans in the works over the next three to four years aimed at maintaining its course of reform-minded improvement and increased student achievement, particularly in mathematics. In an effort to make Bellevue students competitive on an international scale, the district has negotiated a long-term contract with Dr. William Schmidt, from Michigan State University, to provide consultation and administer district assessments grounded in the work of the TIMSS study. Similarly, a local group is currently promoting an increase in high school graduation requirements from three years of math and three years of science to four years of each subject. In Bellevue, the impetus for change continues to be providing the best possible learning opportunities for all children, so that each youngster can make his or her own academic choices based on affinity and interest, rather than having those choices limited by under-achievement.

CHAPTER 2

Mathematics: Modeling Our World
in
Bald Knob, Arkansas

Preview

In a small, rural district one accomplished and influential high school teacher sees an NSF curriculum as a vehicle for simultaneously bolstering the math achievement of the district's lowest performing students and improving the mathematical learning experiences of all students. He takes on the task of implementation as his personal mission, convincing the rest of the Math Department to join him.

The Bald Know story illustrates how other regional reform efforts can provide opportunities for teachers to learn about reform curricula as well as strategies for implementation. The profile suggests, at least in the case of math reform, that it may be possible to teach "old dogs new tricks." It also exemplifies some of the challenges and benefits associated with a parallel track implementation strategy. Schools and districts that select this route continue to offer the traditional sequence of high school mathematics courses as an elective option, typically for their highest achieving students, while the remainder of students and teachers attempt something entirely new and different.

THE CONTEXT

"Where the Ozarks meet the Delta," proclaims the Chamber of Commerce's welcoming sign. About 60 miles northeast of Little Rock lies the town of Bald Knob, Arkansas. A small community with a population of about 2800, locals describe Bald Knob as close-knit, rural, and quite poor. The drive through downtown consists of one main street and its tributaries – leading past many smaller, wooden houses and a modest collection of privately owned businesses. A closed factory and faded signs give the impression that Bald Knob has seen better days, while fast food chains and major national franchises remain absent from the retail landscape.

Jobs are scarce here too, forcing most residents to work outside of town. Some commute to nearby Searcy – about 10 miles away and 10 times the size of Bald Knob. Others drive as far as Little Rock. Lack of affordable housing also poses a challenge in

Bald Knob. Homes and land come up for sale infrequently, and when they do, they are expensive – at least in relation to comparable properties in the surrounding region. Many attribute this situation to a water problem. Bald Knob has a reputation for poor water quality, which makes contractors and developers hesitant to invest in the town – resulting in very few new homes being built. Still, despite the difficulties associated with finding employment and securing housing, the citizens of Bald Knob value its friendly small-town feel, and the population has proven quite stable over time.

The Bald Knob school district is larger than might be expected for a town of this size. Busses transport many children from surrounding areas, as far as 10 miles away. In total, the district serves more than 1300 students with one elementary school, one middle school, one high school, and a vocational education center. Most of the district's buildings were constructed in the 1950s and 60s. All facilities, including the administrative offices, are located immediately adjacent to one another, creating the feeling of one large K-12 campus. With more than 200 staff members, the school district serves as the largest employer in town and offers salaries that surpass any other available employment in the vicinity. As a result, teaching positions are highly coveted and turnover is rare.

For the most part, change comes slowly to a place like Bald Knob – families stay in the community for decades; teachers spend their entire careers in one or two schools. However, we happened to visit the school district during a time of considerable change. In the fall of 1998, the Math Department at Bald Knob High School had undertaken the challenge of implementing an innovative, new math curriculum called *Mathematics: Modeling our World*. Our trip to Bald Knob took place during academic year 2000-2001, the third year of implementation. At the time, Bald Knob High School's Math Department was offering its third new math course in three years and continuing to get to know its first new, full-time math teacher in almost a decade – an experienced colleague from Searcy who arrived the year before. According to the National Center of Educational Statistics, the student population remained fairly consistent that year with1322 students in grades K-12, 53% of whom qualified for free and reduced lunch. The vast majority of the students were Caucasian (94%) accompanied by 3% African American, 2% Hispanic, and 1% Native American.

Key People

In the upper grades, the Bald Knob School District has attracted a small group of particularly capable and committed math teachers. To a person, they express a love of their profession and a respect for their colleagues that one seldom encounters on a district-wide basis. At the high school, there are three full-time math positions and one part-time. The three full-time math teachers all hold college math degrees and have 60 years of combined experience. Their classrooms are clustered together at one end of the hallway, making it easy to collaborate and to provide collegial support – if only in an informal manner. The part-time math teacher, whose primary duty is coaching, teaches a remedial pre-college math course targeting those seniors who have historically struggled or lost interest in mathematics. As a department, the group professes an openness to new ideas and a sincere interest in helping all students succeed mathematically.

Two math teachers at the high school play particularly important roles in Bald Knob's implementation story. One is department chair Thurman Smith, who has taught in the department for more than 35 years. The other is his good friend and one-time student, Brad Roberts, who himself has taught math at Bald Knob high school for nearly two decades. These two share a great deal of mutual respect as educators and friends. Their teaching styles, however, differ – with Smith being more of a traditionalist and Roberts showing more interest in new methods and alternative practices. Both have strong reputations beyond Bald Knob for their skills and experience as math educators. We are told that there is not a committee in the state of Arkansas involving math teachers that does not include one or both of these two men. In fact, it was their involvement on one of these committees that ultimately provided the opportunity to become familiar with the *Mathematics: Modeling our World* (*MMOW*) curriculum.

At the time that Bald Knob High School chose *MMOW*, all three full-time teachers in the Math Department figured prominently in the decision. The third teacher was Bill Davis, who had taught mathematics for 28 years, nine of which were with Smith and Roberts at Bald Knob High School. However, only one year into the implementation process, Davis chose to leave the high school in order to become principal of the middle school – his present role in the Bald Knob School District. Mary Ann Roberson, an experienced teacher from a neighboring district, was hired to assume Davis's duties. She has taught a combination of *MMOW* and traditional courses since arriving at Bald Knob in the fall of 1999.

THE MOTIVE FOR CHANGE

Prior to the *MMOW* decision, Bald Knob High School offered a standard multi-track secondary mathematics program organized around the traditional core sequence of courses: Algebra I, Geometry, Algebra II, and Pre-Calculus – and had done so with reasonable success. Because of the physical proximity of the middle school and the strong collegiality among teachers in both buildings, students experienced a fairly smooth transition from one level to the next. The majority of 8th graders participated in a course that reviewed basic skills and introduced Pre-Algebra topics, while a select group of their peers completed Algebra I at the high school. With the middle school and high school separated by little more than a driveway and two sets of double doors, transporting students from one site to another was a non-issue. This more advanced group of 8th graders could then enroll in Geometry as 9th graders.

Reflecting back, teachers in the Bald Knob Math Department tell us that they always knew that the upper quartile was well served by the standard sequence. Their concerns rested with the under-achieving students in the bottom quartile, who had needs that were not adequately met by what the middle school or high school had to offer. More and more students seemed to be struggling with the traditional approach. Brad Roberts remembers feeling like he was speaking a foreign language to many of his students and just not getting through the way he felt he had in the past. As former high school teacher Bill Davis explained, "We started realizing that there has to be another

way … that it's not the math they don't understand, it's how we teach it they don't understand."

Simultaneously, the Arkansas Statewide Systemic Initiative (SSI) in Math and Science was working to increase the achievement of all students in math and science. Funded by the National Science Foundation, the project encouraged math teachers throughout the state to consider some of the newly developed NSF-funded math curricula for grades K-12. In addition, the Arkansas Department of Education had begun articulating math standards, taking its lead from the *National Standards* published by NCTM in 1990. The state was also focusing more attention on student achievement, as measured by the SAT-9 standardized assessment.

A vocal and committed group of middle school math teachers representing schools across the state were eager to try new materials that truly targeted the needs of students in grades 6-8 without resorting to pre-Algebra or a review of fractions, decimals, and percentages. Almost as soon as the materials were made available, these schools were piloting the *Connected Math Program*. When middle school teachers at Bald Knob Middle School heard stories of their colleagues' success with the new program, they wanted to try it and did. By the late 1990s, as the five secondary NSF math curricula were going to publication, the Arkansas SSI was providing increasing opportunities for educators to learn about and consider these new programs firsthand. For example, a group of 24 Arkansas high school math teachers attended a *Core-Plus* leadership workshop in San Diego – Brad Roberts among them. What he experienced there piqued his interest, but he still had many questions and a hesitant department chair. When the SSI arranged for the Consortium for Mathematics and Its Applications (COMAP) to do a one-day workshop on its new secondary curriculum, *Mathematics: Modeling Our World*, the entire Math Department of Bald Knob High School chose to attend.

It was during the COMAP workshop that Roberts truly decided, as least for himself, that the NSF curricula might be worth trying. He was not yet sold on the *MMOW* program in particular, but he liked the contextual approach taken by both *Core-Plus* and *MMOW*. He also had the support of his department, as well as the Arkansas SSI, to pursue his growing interest. As circumstances would have it, the math textbook series then in place at Bald Knob High School was published by Southwest Publishing, which also had the rights to *MMOW* at the time. In the end, the selection of *MMOW* probably had as much to with the skills of a highly attentive publishing representative as it did with any substantive differences between the two programs.

THE STORY

Following the COMAP one-day introductory session, interested parties from the Arkansas SSI and Southwest Publishing worked together to offer a second workshop for Arkansas high school math teachers. This was a two-day training that supported piloting of *MMOW*'s Course One. As an additional incentive, participating teachers received complimentary materials: a copy of the teacher's edition for Course One, a Course One student text, a videotape to accompany the program, a CD-ROM containing additional

support materials, and a classroom set of student booklets for a single unit. Three teachers from the Bald Knob School District attended this workshop – two from the high school and an 8th grade teacher from the middle school. When they returned to the district, the three began making arrangements to try the new materials with their students.

Brad Roberts and Bill Davis were the high school teachers. They combined two Algebra II classes so that they could team teach, and worked on the recommended *MMOW* unit for about a week. At the end of this trial period, the teachers solicited student feedback and according to Roberts, those responses alone were enough to convince him that this was the right direction to take. One comment from a college-bound 11th grader was particularly memorable. She wrote, "I think I've learned more math in these past five or six days than I have in the past three years." They tried a similar experiment at the middle school, pairing one of Roberts's 9th grade math classes with an 8th grade math class – again the results were very positive.

At this point, momentum for piloting and eventually implementing *MMOW* was building. However, questions about how to adequately fund the necessary teacher training persisted. Roberts and his colleagues were well aware that providing professional development for teachers would be a critical piece of any implementation strategy. Help came from the Arkansas SSI and COMAP itself. Through the SSI, the Bald Knob District was able to organize a small consortium of neighboring districts to implement the curriculum along with them, thereby making available grant funds to support teacher training. With more schools intending to adopt the materials, COMAP also agreed to offer a considerable amount of training free of charge – including 100% of the first week-long summer workshop. COMAP's resources for this type of district-level support stemmed from its role as a satellite site for the national high school math implementation center, COMPASS. Between COMAP's generous offer and the strong existing relationship with Southwest Publishing, the choice was clear: Bald Knob would select *MMOW*.

One hurdle remained: convincing the principal. Simply put, Brad Roberts made Bald Knob High School's key administrator an offer he couldn't refuse. He relates the following story:

> *I basically told him that MMOW was what I wanted to do and that if he'd let me do it, I'd take full responsibility for the test scores. They were on my head. But if he fought me on this, then the test scores were all his. He needed to be the one who took responsibility for them.*

With all necessary players at the high school fully on-board, plans began to roll out the first *MMOW* course in September 1998.

Implementation Strategy

A number of implementation questions that have caused serious conflict in other districts raised little debate in Bald Knob. The first was whether the high school would implement *MMOW* wholesale or leave the traditional curriculum in place as an alternative track. It seems to have been assumed from the outset that a traditional sequence would remain in place – primarily to serve more advanced students. Also, with an accomplished veteran teacher like Thurman Smith in place, who had successfully taught the most advanced courses for decades, the department saw no sense in abandoning them. A second issue was how best to begin offering the new *MMOW* courses. Based on what they had heard from curriculum developers at various workshops, particularly those connected to *Core-Plus* and COMAP, the Math Department chose an incremental strategy. Beginning with Course One for 9th graders, they would introduce one new course each fall, so that the full program would be in place after four years. Another major question that almost always surfaces as a school implements an integrated program such as *MMOW* is what to name the new courses. However, due to state reporting requirements in Arkansas and the limits of their computer system, the *MMOW* courses at Bald Knob High School have been given traditional titles such as Algebra I, Geometry, and Algebra II – even though their content is markedly different from prior courses with these same names.

Another critical piece of Bald Knob's parallel track implementation strategy was their choice to make the new program their core math curriculum. The traditional series remained, but as an alternative for students with a demonstrated affinity for mathematics or a particular interest in math-related pursuits. This structure made it much more difficult for the new curriculum to become marginalized as something only for under-achievers or students with special learning needs.

THE IMPLEMENTATION OF *MMOW* AT BALD KNOB HIGH SCHOOL
CALENDAR OF EVENTS

Date	**Activity**	**Notes**
Summer 1998	All Bald Knob High School math teachers participate in week-long training for Course 1	Facilitated and funded by COMAP
1998-1999 School Year	*MMOW* Course 1 offered for the first time to the majority of Bald Knob High School (BKHS) 9th graders	Taught by BKHS teachers, Brad Roberts and Bill Davis
Summer 1999	Week-long training for Course 2	Facilitated by COMAP, funded by the Arkansas SSI and Bald Knob District
Summer 1999	Week-long training for Course 1 Bill Davis takes new position as middle school principal	Funded locally and facilitated by Roberts
1999-2000 School Year	*MMOW* Course 1 and Course 2 offered to 9th and 10th graders	Taught by Roberts and Roberson (replacement for Davis)
Summer 2000	Week-long training for Course 3	Facilitated and funded by COMAP
Summer 2000	Week-long training for Course 1 & 2 combined	Funded locally and facilitated by Roberts
2000 – 2001 School Year	*MMOW* Course 1, Course 2, and Course 3 offered to grades 9-11	Taught by Roberts, Roberson, and Smith (Math Dept. Chair)
Summer 2001	Week-long training for Course 4	Facilitated by COMAP
Summer 2001	Week-long training for Courses 1,2 & 3 combined.	Funded locally and facilitated by Roberts

The series of events laid out in the table above indicate the extent to which professional development has played a central role in Bald Knob's implementation strategy. As the high school principal tells us, "The thing about the new program is that teachers have to be trained to use it. The training is so important!" In Bald Knob, the expectation is clear that a teacher should not and will not be assigned to an *MMOW* course without first having received the necessary training. For example, when math teacher Bill Davis left the high school in 1999 in order to lead the middle school, his replacement was told that she would need to attend two full weeks of summer training before beginning her job in September – one week for Course One and a second week for Course Two. "And I couldn't have taught those classes without it," she says.

Also noteworthy in the table is Brad Roberts's role as trainer for approximately half of the *MMOW* summer workshops. At the end of the first summer training, prior to actually implementing *MMOW* in the classroom, Roberts was invited to attend a COMAP leadership conference. With a combination of local funds and money from the SSI, he

went to the meeting and began taking the necessary steps to become an official COMAP trainer for the *MMOW* program. Having an in-house trainer for the new math curriculum afforded the district and the high school a number of advantages. Roberts's ever-growing knowledge of the program, his personal connection to COMAP staff, and the lower costs associated with having a local trainer are just some of the benefits. As the implementation schedule indicates, with Roberts able to take over some of the training responsibilities, COMAP staff came to town primarily to facilitate the initial training for all new courses (i.e., Course One in 1998, Course Two in 1999, and Course Three in 2000). They also continued to provide telephone and email support from a distance as needed. As the implementation has progressed, Roberts has taken responsibility for designing and facilitating the summer workshops for existing courses. Funding for these sessions comes from a variety of sources including Eisenhower money and registration fees paid by teachers outside of the Bald Knob School District.

An equally important part of the implementation effort in Bald Knob, invisible in the above table, is the generous amount of on-site support that the math teachers provided for each other throughout the process. As one teacher put it, "When we have a question, we go to somebody and we ask. We are not ashamed to say, 'hey, I don't understand this, or this is not clicking. Or what am I missing? Or how are we supposed to be doing this?'" In the first two years of implementation, the Math Department also tried to organize teaching assignments so that no one teacher was responsible for all sections of a particular *MMOW* course – providing a built-in source of peer support and creating more opportunities for collaboration.

With the introduction of Course 3 during the year of our visit, the newest member of the department found herself alone and readily admitted, "I'm struggling." Still, she reported feeling very comfortable turning to her colleagues for help whenever she needs it: "they are always there to help me." Both the administration and the Math Department of Bald Knob High School recognize the challenges associated with implementing a program like *MMOW* – the new curriculum is simply so different from what teachers have done in the past. They have also chosen to let math teachers rely on each other as their main source of support during the school year rather than organizing mid-year professional development. An advantage of this strategy is the opportunity to create a true community of learners within the Math Department, a cohesive group of colleagues who are continually collaborating to improve their practice. However, there are disadvantages as well – one of them is the lack of opportunity to receive outside feedback in the midst of the implementation process.

THE REAL WORK

According to the members of the Bald Knob Math Department, the most challenging part of the transition to *MMOW* was making the changes to their pedagogy that the curriculum demands. When they began implementing the program, this was a department rich in years of teaching experience and math content knowledge. All of the teachers had taught the core ideas of high school mathematics for years, if not decades. They were accustomed to opening any published high school math textbook and feeling they could teach from it without issue and with little preparation. However, teaching *MMOW* requires a different set of skills. Standing at the front of the room and carefully explaining a concept is not enough. Teachers also cannot rely on the high school math teacher "standby" of demonstrating a new technique and then helping students work through numerous practice problems. *MMOW* requires that the teacher serve much more as a facilitator, thoughtfully guiding students' activities and discussions so that they can make their own discoveries and take personal ownership of what they are learning. As a result, the word "preparation" has taken on a whole new meaning for the teachers of the Bald Knob Math Department. One teacher told us,

> *You know, after teaching for so many years, I'd gotten used to very little prep. I mean I could basically check the next topic in the book and talk to students off the cuff if I had to. But when I got into this, I thought, oh, they're gonna ask me all kinds of crazy questions. And believe me they do. I'm looking things up all the time … going on the Internet … it's really something.*

The teacher is referring here to the variety of problem-solving situations presented in *MMOW* due to its focus on mathematical modeling. This contextual richness creates a desire to prepare not only for the mathematics of the lesson, but also for student questions regarding the context in which the mathematics is embedded.

It follows that the new curriculum has also been an adjustment for students. There is more to read and less to memorize. They are fewer opportunities for working independently and greater expectations for working collaboratively in small groups. Some are frustrated that their teachers do not explain things more. They miss the more passive role that accompanies direct instruction. According to members of the Bald Knob Math Department, most students have responded positively to the challenges of the new curriculum.

The teachers and administrators also tell us that community concerns about the new high school math program have been rare. Actually, complaints so far have been limited almost entirely to parents' frustrations with not being equipped to assist with their children's homework. The Bald Knob community has a long history of respecting teachers as educational experts and supporting their decisions; the tradition has held for the *MMOW* implementation as well. Parents may question the look of their children's homework or textbook, but ultimately believe that the school knows best when it comes to teaching mathematics.

The administrators we encountered in Bald Knob also spoke highly of the new program. The high school principal told stories of higher math test scores and students working on things he had never seen before in a math class, like "packaging problems." Even the new superintendent had positive things to say: "The math program has already helped us meet more of the standards in terms of the Arkansas test. The teachers say it will help our scores because it's more hands-on and there's more reading." The test scores to which administrators refer are the 10th grade mathematics scores on the annual SAT-9 test.

The 10th grade SAT-9 scores are also the scores for which Brad Roberts agreed to be responsible at the time of the *MMOW* implementation decision. Prior to the implementation of *MMOW*, Bald Knob High School students had scored at or below the national mean for the SAT-9. However, according to the data analysis conducted by Roberts during the first two years of implementation, with *MMOW* in place, Bald Knob students were actually scoring above the national mean. In addition, the difference in pre-*MMOW* and post-*MMOW* scores was statistically significant. Although these were only preliminary results, the initial outlook was encouraging.

Degree of Implementation

When we visited Bald Knob in the winter of 2001, we had the opportunity to observe at least one *MMOW* class for each of the three full-time math teachers at Bald Knob High School. By the third year of implementation, even the highly traditional department chair, Thurman Smith, was teaching a *MMOW* class – it was admittedly his first – a section of Course One. What we saw reflected very much where the school was in the implementation process. Teachers were at various levels of comfort with the curriculum and with the role of facilitator. They were modifying their practice by seating students in groups, giving them collaborative tasks, and providing more opportunities for students to communicate about mathematics.

The teachers were also quite candid about the personal and professional challenges that they were confronting each day in trying to take a more innovative approach to their mathematics instruction. As the newest member of the department told us: "It's different, but I think it makes me a better teacher … it makes me work harder." Despite the difficulties they experienced, the math faculty at Bald Knob High School uniformly expressed a strong shared vision and belief in what they were trying to accomplish and for whom, no matter how traditional their practice might have been in the past. We suspect that this is largely a result of the collaborative nature of the implementation decision in Bald Knob.

Nowhere were the challenges and benefits of implementing the new curriculum more profound and salient than in Thurman Smith's Course One class. Here was a true master teacher – someone with decades of experience, mastery of his subject, a deep knowledge of students and their common misconceptions, and an obvious love of teaching. Thurman Smith knows the mathematics so thoroughly that he can concentrate almost completely on the pedagogy. As he reflected on the changes that he finds most difficult, namely no longer being in the front of the room and doing most of the talking,

he seemed to relish the opportunity to change as a means of better serving the needs of his students. After watching a group of students struggle with a particular problem, he confessed:

> *This is the hardest part for me -- to keep my mouth shut and to just them let find their way. It takes a lot more time, than me just standing up there and telling them, but these kids need something different from me…different from what I've done in the past. I can definitely see that.*

Smith is a veteran secondary teacher who recognizes the personal and professional challenge of making significant changes to his classroom practice at the end of a very successful career in education. However, rather than balk at the change or take issue with the curriculum, he is enjoying the opportunity to learn something new, especially because he sees it as a way to better meet the students where *they* are, rather than where he is. He tells us that he is working harder in his *MMOW* course than in any of his other classes, but that this life-long learning process is one of the greatest benefits of teaching. "The day I wake up and say, 'I *got* to go to work today,' that's the day I hang it up." Anticipating the full implementation of the *MMOW* curriculum in Bald Knob, Smith described the Course Four book as "truly excellent." He looks forward to teaching the course in the near future.

Enabling Factors

A whole set of circumstances converged in Bald Knob to make something unusual happen with respect to secondary math education. At the time of the curricular decision, the department consisted of four men, three of whom had taught together for many years, mastered the mathematics content, and who cared deeply about children. From the outset, Brad Roberts was perceived as "the young pup," the more liberal, progressive-minded of the bunch. Still, his senior colleagues trusted and respected him enough to say, "Go find out about this, and if you really think it is good, we will try it." That kind of willingness and support is what ultimately enabled this curricular change.

The Bald Knob context is also somewhat unique in that, due to its small size, there was really no one outside of the Math Department who would question the judgment of the 30-year mathematics department chair. That means that there was essentially no resistance here as the decision came about – at either the administrative or community level. Added insurance came from the fact that the honors students were doing well and that the honors program (the traditional sequence) was to remain in tact. (In general, the parents most likely to complain are often parents of the honors students.)

Also important to note, during the 2000-2001 academic year, the Bald Knob School District had sufficient budget to purchase graphing calculators for every student and to fully fund two weeks of professional development for each math teacher. The strategic distribution of members of the Math Department across courses, combined with well-supported professional development, meant that no teacher took on an *MMOW* course without prior training. Under the leadership of Brad Roberts, teachers also felt some freedom to modify courses if necessary. Roberts had actually worked with the

department in the first year of implementation to re-order some of the units so that the *MMOW* would better align with the Arkansas state standards and assessment. As a general rule, there are definite pros and cons to this practice of restructuring courses, but it has posed no serious problems in Bald Knob – for the people who developed the program or for the people implementing it.

TWO YEARS LATER

Many things changed since in the months and year that passed after our visit to Bald Knob in 2001. The town voted in a sales tax to improve the quality of its water and passed a bond initiative to build a new high school. However, Brad Roberts will not be teaching in the new high school. He has since left Bald Knob in order become the assistant superintendent of a nearby district, called Midland, just 15 miles up the road.

When Brad Roberts left Bald Knob, so did all of the high school's *MMOW* Courses. There was no phasing out, the program simply ended. Roberts was disappointed, but not surprised. One math teacher at the high school, the one with only half-time duties, had never liked the program; another had always viewed it as very challenging and, due to some family issues, was finding it increasingly difficult to devote the necessary time to preparation; and Roberts' replacement was a first-year teacher who had been his student teacher the year before. None of these three people was in a position to be an advocate for the program. That left the Department Chair, Thurman Smith. Smith liked *MMOW*, but he also knew the level of work required to do it well – and under the circumstances, he felt it was more than he could handle. Roberts says he cannot blame Smith – especially after 36 years of teaching successfully in the same school with essentially the same sequence of courses. Roberts said,

> *The reality is that I still think it's the best program, but we still have enough of the old heads that say 'this is the way I teach and this is the way I was taught,' that I think we're going to be fighting this thing for probably another 10 to 15 years … until these kids now, the ones that are going through programs like CMP[7] can get through and start teaching. By then we should be able to change the college too.*

Reflecting on what has happened in Bald Knob, Roberts went on to explain that the program did not end because it was unsuccessful. The SAT-9 results indicated a steady trajectory of improvement. The students liked the program and the parents did too. Changes in personnel and administration had created some problems. But in the end, it was more a matter of personalities, philosophy, and time that contributed to the program's demise.

In the past few years, Brad Roberts has come to understand that implementing a new high school mathematics curriculum, even in a district with only one high school, is about so much more than designing new courses and changing pedagogy. It is about

[7] CMP refers to a standards-based middle school math program also developed with funding from the National Science Foundation called the *Connected Math Program*.

creating buy-in and changing attitudes. It is about truly moving the *whole* system, and not only in grades K-12, but beyond to the college level – so that there is a consistent message from pre-school to higher education. Only then does he believe that real and lasting change will occur. Through his new job in Midland, Roberts feels he is better positioned to shape this sort of system-wide effort. His goal is to stay the course of challenge and improvement rather than succumbing to the path of least resistance, and it is about making a deep, personal commitment to "what you know in your heart is right for kids."

CHAPTER 3

Math Connections in Boston, Massachusetts

Preview

Convinced that the majority of students are underserved by this large, urban district's multi-tracked, highly sequential menu of course offerings, a reform-minded superintendent decides to invest in an innovative mathematics curriculum as the leading edge of his broader plan for district-wide improvement. The decision is made quickly and in matter of months the new mathematics program is in place. In an effort to bolster the implementation effort and garner teacher support, the superintendent provides a wealth of additional resources at the building level and professional development opportunities for teachers. However, the challenges associated with getting such an innovative program established throughout the district remain daunting.

CONTEXT

The District

Boston is the site of this country's first public school, Boston Latin School, established in 1635. The city school system was created only twelve years later. The character of the district, like the city, has always been deeply rooted in the ideals that created that first public school, and both city and district are justly proud of their history. Boston Latin School still exists today and is recognized as one of the best public schools in the nation, a fact that the district proudly publicizes. Indeed it is known as the top academic school in the state. But now it is just one of 130 schools attended by over 63,000 students, and Boston Public Schools (BPS) must meet the needs of a very diverse population.

The city and district profile has changed. The last century brought an influx of minorities to Boston. The city became divided into distinct neighborhoods based on race and ethnicity. In the 1960s as the demographics started to shift more dramatically, several changes occurred; for example, many economically advantaged white residents departed the city to have access to suburban schools. Today almost half of BPS students are African American and Haitian/Dominican, and another third is Hispanic. Fourteen percent are white. Two-thirds of students are eligible for free or reduced lunch, and one-fifth are designated in need of "special education."

Twenty-five years ago, in response to a court order, the district established a policy of busing students across the city to desegregate schools. The practice of busing students worked in the sense that schools are more integrated. However, given the current context, it became clear to many that not only was busing no longer relevant, it was counterproductive. Students (and parents) rarely felt ownership of schools on another side of the city, and "race-based assignments" actually did little to foster supportive school environments. Consequently, recently a relatively new BPS administration set out to re-examine the issue of school enrollment more broadly, viewing it through a more equity-focused lens.

The district instituted two new policies as a result of the review. First, in 1999 the original busing policy was rejected in favor of having as many students as possible attend schools within walking distance of their homes. In the new school assignment plan at least half of an elementary or middle school's spots are allocated to neighborhood students. Secondly, high schools are now open to any student across the city. Students may request to enroll in the high school of their choice; if spots are available they may attend. If their preferred school is full, they can end up with another, sometimes "less desirable," school assignment.

These two decisions represented a real departure for BPS and how it enrolled students in its schools. On the other hand, administrators decided to maintain the long-time policy that designates three of the district's eighteen high schools as "exam" schools. Exam schools, one of which is Boston Latin, enroll only those students who pass an entrance exam. Overall then, the opportunities and supports to attend the most desirable schools have increased, and yet students must be knowledgeable and savvy about the system to take advantage of them.

Reshaping the school assignment program occurred within the context of a major district overhaul and systemic reform effort started in 1996, much of it initiated by a new superintendent. A five-year initiative known as "Focus on Children" was the overarching improvement theme and prioritized a focus on student work and data, best instructional practices, teacher professional development, and community outreach. Other mandates modified expectations for teachers and students. State recertification of teachers now must occur every five years. A district policy officially ended so-called social promotion of students, a practice that had dogged BPS for years. Four years of high school math and Algebra II became requirements for graduation. In addition, the recently adopted state exit exam has a reputation for being one of the most difficult in the nation. The high stakes accountability movement sweeping the nation had reached Boston.

West Roxbury and Dorchester High Schools

At the district's eighteen non-exam high schools teachers and students interact with the realities of the district's new policies daily. West Roxbury High School is a 1970s architectural throwback. Escalators emerge from the floor in the vast main lobby, and carry students and teachers to one of two connecting buildings. It has the feel of a college campus building in its size, with 1,300 students moving about the high-ceilinged halls. The teachers at West Roxbury tend to come and stay; 20- and 30-year veterans are not uncommon. Indeed, Principal Don Pelligrini has led the school since its opening thirty years ago. The school also has one of two programs in the city for "physically challenged" students. With its stable faculty and additional special programs, many students, whose demographics generally mirror that of the district, request to enroll there, a fact that is evident when 30 buses from all over the city arrive at the school each morning.

At Dorchester High School, in a brick school building that shows its age, the student demographics are slightly different than that of the district: 70% are African American, one quarter are Hispanic and 3% are white. Five or six years ago some of the district's most serious discipline problems happened at Dorchester High but Principal Robert Belle arrived three years ago and his tenure has contributed to the recent culture shift of the school. Major disciplinary issues are now the exception, not the rule. However, among the current student body of 900, only 17 of 250 freshmen requested to attend Dorchester High, meaning that over 200 students were assigned to the school because spaces at other schools were occupied. It has been a challenge to help students gain a sense of ownership of their school when they feel they have simply been "placed" there.

Key People

Superintendent Thomas Payzant took over the helm of Boston Public Schools in 1995. We did not interview Payzant directly, but his vision and priorities were heard clearly in voices at every level of the district. A former superintendent in San Diego and assistant secretary at the US Department of Education, Payzant is a seasoned and savvy educator. He is nationally regarded as a decisive administrator with experience in large-scale instructional reform. To him, pushing through the decision to adopt an NSF-funded curricular program was a necessary, though not sufficient, part of his plan to create a high-achieving system.

Another critical person in the implementation story is Ed Joyce. Ed Joyce has spent his career in various positions in BPS, most recently as math teacher and assistant principal, and now works as the district's Senior Program Director for Mathematics 6-12. As far as the teachers and principals are concerned, he is the face of the adopted curriculum, *Math Connections*. Although he officially started his current job two weeks after the adoption occurred, he has effectively overseen the program's entire adoption and early implementation process. Ed Joyce spends a lot of time explicating the Superintendent's vision for instructional reform, and mathematics in particular, to teachers and other administrators, and as he does so he displays genuine high regard for

both the man and the vision. At its heart, the now shared vision seeks to break a cycle of low achievement that has prevailed for many years in this urban district. The initiatives now in place hold teachers and students to high standards, but with the recognition that key supports are needed to help them meet those standards.

High school math coaches are one example of the kind of support promised by the Superintendent. When it was decided to adopt new curriculum, the district committed significant resources for "coach" positions to assist teachers with the new materials. Seven math coaches work with Ed Joyce, and they play a vital role in math reform at the school level. Mary Corkery has "coached" or served as a "math specialist" or resource teacher at West Roxbury High School for eight years, and was a math teacher before that. Cathy Draper is the math coach for Dorchester High School. She is an outside consultant and has worked with the school for three years. She is assisted by Rudy Weekes, a fifth year teacher who is also a part-time "math specialist" working with 9th grade teachers.

THE MOTIVE FOR CHANGE

The motive for change in Boston is multilayered. First, in the late 1990s, as part of the system overhaul, district-level administrators took stock of the district and saw they were at a crossroads in terms of high school mathematics. While exam school students, like those at Boston Latin, always scored among the highest in the state, administrators recognized that a large portion of Boston's high students were not "making it." In some schools 80% of incoming 9th graders had failed math in 8th grade but still moved on to high school. Clearly, not all students had access to high-level and meaningful mathematics. The view of the administration was that something had to shift. Boston faces issues common to most large urban districts, and obviously this was not the first time the system had contemplated change, but with new leadership and the recent publication of NSF "reform" high school curricula, it seemed a fitting moment to take specific, directed action. Led by Superintendent Payzant, the district invested in the idea that curricular reforms, working in conjunction with other supports, could leverage changes in the classrooms of urban students. Ed Joyce articulated it this way:

> *There is this issue of equity and access that you really have to take on squarely in urban schools. Most of our students will probably fall into the lower half of academic performance in mathematics. We know what we were doing was not working, period, and we know the stakes are very high. This is not just about graduating high school – that is no small thing – but about developing the skills that have been traditionally associated with mathematics; they are much more highly valued in today's world. You have to worry about a society that is willing to take huge blocks of people in poor, urban areas and say, 'don't worry about it guys, you'll be set.' They won't be.*

The argument for equitable access laid the groundwork for instigating some of the broader district reforms mentioned earlier. It also coincided with the introduction of new state standards and their associated assessment, the Massachusetts Comprehensive Assessment System (MCAS). While BPS was clearly moving toward making a curricular change, the MCAS more quickly propelled its decision to do so. Like other

state assessments being mandated around this time, the MCAS was designed to measure students' achievement as laid out in the state's Curriculum Frameworks in grades 4, 8, and 10. It was first administered in 1998. The first two years the tests were deemed "practice tests" so they had relatively little significance in the eyes of students (and teachers). Nevertheless, Boston students performed poorly enough – in 1999 6% of the graduating class passed, and in 2000 the passing rate was 19% – that the district administration quickly sought "more closely aligned" programs to help their students improve their achievement and their scores. As Ed Joyce put it, "Our Superintendent happens to have a big thing about alignment. [It's] common sense – if you are going to give a test, at least make sure you teach and practice stuff that is on the test." Fortunately for Payzant, the MCAS was viewed to be more philosophically aligned with his vision than most state tests – placing a high premium on critical thinking and deep mathematical conceptual understanding.

Consequently, BPS began a process of K-12 articulation and alignment in all disciplines. In 1999 a committee commissioned by the Superintendent evaluated the entire system's mathematics program. Supported by the Superintendent's vision and after a year of study, BPS voted to adopt NCTM Standards-based mathematics curriculum at all levels. Elementary schools chose TERC *Investigations*, and the *Connected Mathematics Program* was selected for use at the middle school level.

At the high school level the alignment/accountability pressure was acute. High schools had three years earlier adopted Prentice Hall's "Tools for a Changing World." In their examination of this text, committee members found Prentice Hall to be, first and foremost, insufficiently aligned with the MCAS. Even though the Superintendent's vision had at its centerpiece equity and access for all students, it was becoming clear that, in this era of increased accountability, performance on the state test was the critical measure of the district's achievement. One indicator, the state's policy that all students would soon be required to pass the MCAS in order to graduate, sent a strong message. As one building administrator remembers, it became apparent that "all things revolve around the MCAS; it's just the way it is." The search was on for a different, better-aligned program.

THE STORY

The Selection Process

In many ways, the BPS *Math Connections* selection process was driven more by idiosyncratic district circumstances and a broad desire to implement Standards-based curriculum than by a desire to work with a particular program. Ed Joyce's predecessor was active in NCTM and was increasingly familiar with the NSF-funded curricula. In the 1999-2000 school year, as interest in reform-based curricula and NCTM-based pedagogy was emerging at the high school level, she facilitated East Boston High School's decision to pilot the *Math Connections* curriculum for one year. As the district got more serious about choosing a program for the entire system, representatives from *Math Connections* and *Core-Plus* were asked to present their materials on a Friday in June 2000 to a group

of principals and teachers. Participants were to consider piloting one of the two programs the following year. Upon hearing the district's belief that compared to their current curriculum these materials more closely aligned with the MCAS, a small group of principals suggested that instead of piloting the programs, schools should simply adopt one of them immediately. One district administrator recalls, "The notion was 'If we're doing so poorly now, and you're telling us these are better aligned, why wait a whole year?'" (The previous adoption process had been thorough, yet laborious and lengthy.) In a decision which stunned the staff, the following Tuesday, the Superintendent agreed to a district-wide adoption, provided school faculties agreed on one program right away. Representatives from all high schools examined the two texts and voted within the next week. *Math Connections* and *Core-Plus* were both viewed as viable options. The consensus was that as *Core-Plus* required a reading level which exceeded that of the district's students, selecting *Math Connections* made sense. At the end of that June, teachers were enrolled in *Math Connections* materials trainings. The entire process took approximately three weeks.

The adoption decision was made very quickly, and yet – Payzant and his staff felt – necessarily, given the vision the Superintendent had for the district. Again Ed Joyce noted:

> *You need to know there were a set of values guiding that decision, and the adoption seemed clear. It was quick because the needs really hit at the bedrock values of the Superintendent, i.e., all students should have materials that are aligned and they should have teachers who are prepared and will faithfully implement the curriculum. When you really have those kinds of hard-core values, it makes it easier to make quick decisions.*

In the fall of 2000, with the exception of the exam schools, *Math Connections* was in place in all high schools.

Change Strategies and Steps

With the high school mathematics adoption the administration had several goals in mind: an equity-driven culture change in which all students, including those who were historically underserved, were given access to rich mathematics through innovative curriculum; alignment with the MCAS; and maintenance of the status quo where it was working, e.g., teaching and learning at exam schools. Payzant and his team recognized that trying to do all three was a tall order. However, their stance was that the potential benefits were significant and therefore warranted instituting seemingly unorthodox policies to effect systemic reform. They designed a broad-scale, multi-tiered implementation effort in which fifteen high schools would use one curriculum, adhere to pacing guides and enroll their teachers in long-term mathematics professional development sessions.

Implementation Vision and Structure

In their desire to use comprehensive curricular reform to address the district's history of huge variability in instruction and conditions, Payzant and his administrative colleagues had concurrence from teachers in principle. However, there was little time for all involved to come to a shared understanding of this vision or rationale behind curricular reform – behind an integrated mathematics program approach or this program in particular. With the adoption occurring relatively quickly, the district message regarding this curriculum was filtered to its bare bones. Teachers essentially heard that "the MCAS mattered" and *Math Connections* aligned to it, so they would begin teaching the curriculum in the fall, and would enroll in associated professional development in the summer and throughout the year.

Whether or not teachers were fully cognizant of them, the implementation strategy had some basic cornerstone ideas. First, *Math Connections* was designated as the core high school math curriculum. The administration did not seriously consider the idea of maintaining two parallel tracks as it sought equitable access to high-level mathematics and some form of instructional uniformity – the same rich diet of math for all students. Though there are three different "pathways" which afford students different amounts of time to work through the first book in the program, all incoming 9th graders in traditional high schools began with *Math Connections I – Book A*.

Still, Boston's three exam schools were permitted to continue to use their existing materials. This message, which seemed logical to administration staff, did not sit particularly well with teachers at the fifteen other high schools. They wondered why, if the curriculum was so good, the top students were not using it as well. Ed Joyce, among others, tried to explain the reasoning to teachers: Boston Latin School has the highest MCAS scores in Massachusetts (every student passes) and another exam school is consistently among the top scoring fifteen schools. He told us:

> *Requiring schools to change curriculum because their teaching isn't producing results doesn't seem particularly relevant for sites with the top scores in the state.*

Another key decision regarding the implementation was that it be incremental. Understanding the basic underpinning of integrated mathematics programs, Payzant and Ed Joyce agreed that the *Math Connections* implementation would have to occur incrementally for teachers and students to develop a foundational understanding of the information in Year I before moving on to Year II. In 2000-2001 the district started to implement the first year of *Math Connections* with its 9th graders. In the 2001-2002 school year 10th graders started work on Year II. Administrators, teachers and students largely found this strategy to be effective and necessary.

Third, the implementation plan included the use of a "pacing guide." In an effort to reverse past practices of teachers teaching at their own pace and discretion, the district math leaders put together a detailed schedule of lessons and activities to be followed carefully by anyone implementing the new curriculum. The math office expected weekly progress reports from every high school Math Department to ensure that all teachers are covering the *Math Connections* material in a timely, standardized manner. In addition,

there are mid-year and final exams made up by the district, and specific tasks that all students must complete to be reviewed by the district office.

This mandated teacher schedule has been particularly challenging for teachers. Many voiced their concern in terms of not being trusted as practitioners – either to teach a given curriculum as they see fit, or to teach to the needs of their particular group of students. One teacher said:

> *I have a distinct need in my classroom this year to go back and address integers. I can't do it because of the pacing guide.*

While most teachers are diligent about adhering to this guide, even those who support the curriculum itself complained that the guide was "…unrealistic. It doesn't take into account events of real classrooms…" Again the school environment plays a role: fire drills, for instance, are a common interruption on an average day at Dorchester, and if one or two a week cause a math class to be cancelled or abbreviated, it is difficult to maintain the pacing guide schedule. Still other teachers recognized the concerns of their colleagues but also found the guide kept them on task and helped them negotiate the many objectives, activities and standards they were trying to meet in each class period. Teachers in their second year of *Math Connections* implementation seem better able to maintain the expected pace. At this point, the pacing guide remains a non-negotiable element of the implementation. The district's position is that it "cannot prepare students for the MCAS exam, SATs or other higher math courses if we do not take steps to ensure that students have access to, and master, the material that is set forth in the curriculum standards and Massachusetts Framework for each grade or course."

Mandated Professional Development

The professional development that has accompanied the *Math Connections* adoption has also been a critical part of the implementation strategy. Fidelity of implementation – that is, remaining true to the teaching of the curriculum as designed – was so important to the administration that training on the use of the curriculum is required. The recent Boston teachers' contract stipulated increased professional growth hours in general, but in their first year of teaching *Math Connections* teachers have had to allocate 24 hours to mathematics, followed by 18 hours in their second year. This kind of requirement made it clear to teachers that this adoption represented a departure from what had previously been the norm in Boston.

The district staff development days allow teachers to get trained in the curriculum before they must teach it. For instance, five in-service release days help teachers become familiar with the materials. These have been facilitated by teachers from other districts who have taught the *Math Connections* curriculum themselves. Some teachers have felt that the material was "shoved down their throats" in training sessions, with little regard for the ability or experience of the teacher. But overwhelmingly, even among those who are resistant to the curriculum, teachers saw the training as essential. Most teachers were used to teaching curriculum without any professional development, and so they particularly welcomed, and found necessary, the days devoted to becoming familiar with the materials. One teacher commented, "We couldn't teach this program without [that

professional development]. This curriculum is very different that way; you must have context of the overall program to teach it effectively."

Another feature of the professional development effort is on-site support. When the adoption was finalized, seven math coaches were hired to work at the fifteen district high schools using *Math Connections*. The group of coaches meets weekly with Ed Joyce and also participates in regular trainings on *Math Connections* as only two have actually taught the program themselves. All spend approximately two days per week in a school, where they use collaboratively developed "training binders" (addressing both content and pedagogy) to provide trainings for grade-level teams, and work directly with teachers in their classrooms. The individual work with teachers varies somewhat, depending on the needs of the staff. At West Roxbury, for example, the coach (who has taught at least one section of *Math Connections* since its introduction in Boston) facilitates regular meetings to highlight student work and "best practices," and does demonstration lessons for many teachers. The Dorchester coach orchestrates similar opportunities for her staff, focusing particularly on sessions which "address the frustrations of teaching the large numbers of students who fail 8th grade and move on to 9th grade and 10th grade." In these and other schools, common planning time and release time is integrated into the schedule so teams of teachers can meet with the coach and/or each other to observe or share their practices.

In summary, mandating one core curriculum, implementing it incrementally, providing a pacing guide, and engineering ongoing materials' training and coaching served as the critical pieces of the Superintendent's plan for instructional improvement. While teachers were not always aware of connective tissue binding all the elements of the implementation process, Payzant and his staff deliberately designed each piece with a larger goal in mind. And as one district administrator saw it, a shift in teachers' thinking to that end was already evident in the second year of implementation:

> *We are seeing more teachers in professional development, we are seeing more teachers talk positively of professional development, we are running courses and people are signing up for them and for this culture of thinking and learning mathematics. I think we have some real indicators that it is trying to take hold. And from that, we hope we are going to generate changes in instruction.*

The following chart summarizes the key events of the selection and implementation of *Math Connections* in Boston Public Schools:

The Selection and Implementation of *Math Connections* in Boston Public Schools Calendar of Critical Events	
Date	**Activity**
1998	MCAS first administered in grades 4, 8, and 10
1999	Disappointing MCAS results published, and BPS completes a process of K-12 articulation and alignment, adopting NCTM math curriculum at elementary and middle school, searching for an aligned secondary math program
1999-2000	East Boston High School pilots *Math Connections*
June 2000	District-wide adoption of *Math Connections* for all high schools except exam schools, and first group of teachers participate in curriculum trainings for Year I
2000-2001	9th grade teachers implement *Math Connections* Year I, with the support of a district "pacing guide" and ongoing professional development sessions (24 hours required for first year Math Connections teachers)
Summer 2001	BPS teachers participate in *Math Connections* training for Year I and Year II
2001-2002	Implementation of *Math Connections* continues: 9th graders enroll in Year I, 10th graders in Year II. School year in-services continue (teachers in second year participate in 18 hours of professional development)

Degree of Implementation

In their second year of implementation, high school teachers in Boston are, to varying degrees, teaching the *Math Connections* program. Again, the implementation structures designed by the administration have ensured that this is the case. Of course, there is a range in the usage: especially at this early stage, some teachers were still wedded to familiar materials and methods, and thus in our observations we saw only elements of the *Math Connections* program interspersed into their courses. On the other hand, we observed teachers who were following the text and the pacing guide quite deliberately. They remarked that in the process they were beginning to reshape their practice – for example, asking students to articulate their own thinking and draw on their accrued understandings to solve advanced problems.

Some of these teachers truly believed in the curriculum and its potential to expand the mathematics experience for all students. This group taught the curriculum with the highest degree of fidelity and commitment. These teachers described the nuances of teaching high-level mathematics to students who have been part of a low-achieving culture their whole lives. As one Dorchester teacher explained:

> *I didn't come here to teach math; I came here to break the cycle for my students and math is the way I do it. But I would do it whether we had Math Connections, or Prentice Hall, or whatever you gave me. I really like Math Connections and it gives me some good things to hook into and build on. My students can't read a lot of it. I look at what they really need to know, I hone in on that stuff and I let a lot of the*

reading go and there are probably a lot of people that wouldn't agree with that. But the math is good and the math is real, and they need something real.

While they are interacting with the materials, in many cases the degree of implementation in these two high schools has been limited by the degree to which teachers have bought into the broader curricular reform effort in the first place. Many teachers have followed the district's carefully orchestrated implementation schedule, and many have taught the texts as outlined. However, a number still are critical of what they see as the mismatch between the curriculum and the needs of their students. They see evidence of the same low achievement as the district does, but do not see the district's implementation plan (of which the curriculum is one piece) as part of the solution. As one frustrated teacher noted:

We're not like everybody else. Less than 20% of our students stay in this school from grades 9 to 12. Only 16% of 9th grade students are passing mathematics; 80% will go to summer school. The district's response is that 'it hasn't been working for eight years so why not try it this way,' but these students don't even have the basic foundation to do middle school math… This curriculum assumes they have prior knowledge, for example, about order of operations and integers. They don't. They need something simple.

The teachers who experience this gap most acutely tend to supplement the *Math Connections* program with more skill-oriented practice and problems. Recognizing that the transition to this challenging program might be more complex than anticipated, the district also planned to designing some supplementary activities, which would be disseminated to all *Math Connections* teachers.

Degree of implementation has also been impacted by the reading level of the program. Teachers reported that the curriculum's reading level was too difficult for most of their students. Many perceived this incompatibility between the curriculum and students' literacy as a significant barrier to their teaching and students' learning. In response the district has developed a literacy guide called "Guided Reading Work" (highlighting new terms, facts and learning outcomes in the text's upcoming pages) to assist students, but teachers lamented the extra time it took to prepare students to approach a new chapter or topic – pushing them further behind the pacing guide expectations. A secondary ramification of the readability issue is that many teachers find it difficult for students to complete homework in the text, affecting their ability to assess the degree to which students understand the material.

Ed Joyce's position on this issue is the following:

I know that this is a very real challenge. Some kids can't read, so we want to give them math that just has numbers; then they don't have to read, so then we can just graduate them. Exactly what do they do with math in their life after that? Where do you go when you can't read the problem and be productive in your use of mathematics? It is a place we have to get past.

He further argues that when utilized regularly, literacy strategies such as Guided Reading Work eventually allow students to effectively use the curriculum.

The differing perspectives of the district and teachers on this issue underline the challenges that remain in Boston. While both groups believe that high-level mathematics must be accessible to all, and both groups want to support their students' mathematical development, their thinking about how best to do so often diverges. And as is often the case in a large district, engaging all parties in meaningful conversation about those different views takes time. The district invested heavily in the potential of Standards-based curricular-driven reform. The Superintendent, steadfast in his vision, pushed through the adoption of such a curriculum with unusual speed and right away, the program was centrally required and monitored with high school grade level expectations. Teachers were quickly immersed in the daily realities of teaching a new curriculum. As a result dialogue between administrators and teachers – about the system's rationale for selecting an integrated curriculum in the first place, and about the issues associated with a Standards-based implementation and their implications – is just beginning.

SIX MONTHS LATER

We spoke to Ed Joyce six months after our initial visit. According to him, the secondary math program in Boston had continued, with some modifications. In 2002-2003 BPS students in grades 9 and 10 enrolled in *Math Connections* I and II. Not surprisingly, teachers reported feeling more comfortable teaching the program their second or third time. Mid-year exams were recently given, and while the scores have not yet been recorded, anecdotally, teachers report that they have more satisfied with students' performance and that students seemed better prepared for the exam.

The district made a decision to leave *Math Connections* behind after 10th grade, opting for the "more traditional format" of Glencoe's *Algebra 2* text for juniors. While the district had never considered using *Math Connections Year III Book B*, they had planned to use Book A in 11th grade. However, a meeting of math administrators, coaches and teachers this year determined that "whether we like it or not" students needed to work with materials that "more closely resemble that which they might encounter in advanced or college-level mathematics courses." After looking for Standards-based Pre-Calculus and Calculus materials, BPS math decision-makers felt the Glencoe book aligned best with their 11th grade "Advanced Algebra" course, and that it would adequately prepare students for pre-calculus or calculus as seniors. Currently the entire district, including exam schools, is using Glencoe in the 11th grade and the Holt Reinhardt Pre-Calculus and Calculus series in 12th grade. Students who take more time to get through *Math Connections* Year I and II may take the Advanced Algebra course as seniors.

Professional development hours have increased. All math teachers are now required to participate in 24 hours of mathematics professional development (an increase of at least six hours from 2001-2002). The hours have been built around three topics: content, the instructional practices associated with using the text, and analyzing student

work. Beyond the required in-service time, 9th and 10th grade teachers new to the curriculum were able to enroll in 18 hours of training during the summer of 2002, and/or 30 hours on Saturdays during the school year. Eleventh grade teachers could participate in 30 hours of "pullout" training in 2002-2003. A teacher new to the discipline could therefore have access to 72 hours of mathematics during this school year. In addition, through a collaborative effort, there are new math content courses open to BPS teachers through Harvard Extension and Northeastern University. Teachers who enroll may either earn graduate credit or audit the courses at no cost. Currently over 100 BPS teachers are taking courses at Harvard (many for credit), and the Northeastern program will begin later this year.

Math coaches are facilitating much of the professional development, assisted by lead teachers in the schools who are conducting grade level in-services. The plan is to build a "leadership team" of these teachers (one at each grade level), supported by the coaches, in every school. So they can spend more time in schools, coaches are meeting every other week (instead of once a week) with each other and Ed Joyce.

MCAS scores, a primary measure of achievement in the district, were reported and they have been mixed. The district's overall scores, while slightly better than the state's in some areas, were essentially "flat." The number of West Roxbury students who passed last year's math portion of the MCAS test increased, from 41% in 2001 to 55% in 2002. At Dorchester the percentage rate of students passing math actually went down, from 31% in 2001 to 21% in 2002, though their English Language Arts scores improved 11%.

The district is eagerly awaiting the current 8th grade's arrival to high school in 2003-2004. The middle school has been implementing *Connected Math* for three years, which means that the first class of 9th graders with three years of *Connected Math* experience will enter high school next fall. Moreover, according to Ed Joyce, the 8th grade course teaches students "solid algebra." The district hopes and expects that this kind of preparation will positively influence the students' high school math learning.

CHAPTER 4

Interactive Mathematics Program
in
Denver, Colorado

Preview

The grassroots effort of a small group of teachers and a principal change the nature of high school mathematics instruction for all their students. While serving many upper level students, the school was not addressing the needs of all students; indeed, at one point only five seniors were enrolled in math classes. At Ranum, two particularly motivated teachers were inspired by one NSF-funded curriculum, and were given both free reign by their principal and a national grant to pilot the program. Due to its early success, a district change in curricular policy, and a gradually growing group of supportive teachers, the program was eventually expanded to replace the existing mathematics curriculum for the entire school. Ultimately, this profile illustrates the factors that can aid in the implementation of a new curricular program as well as those which can lead to its demise.

CONTEXT

Leaving Denver's downtown one can drive for miles, through neighborhood after neighborhood, before reaching the city limits. At a certain point the sprawl begins to resemble suburbs, though technically it is still part of Denver proper. Adams County lies west of Denver's center, and it houses a number of school districts. Adams County District Number 50 has 24 schools and approximately 11,000 students. Mirroring the general demographic trends in Colorado, the student population in District 50 has changed quite dramatically in recent years, and is now approximately 50% white and more than one-third Hispanic. The area is populated by a wide range of socioeconomic classes, with a middle-class majority.

One of the district's two high schools is Ranum High School. Approximately 1,400 students attend Ranum in a given year. On average, 80% will graduate and almost that many go on to college. Ranum graduates attend an assortment of community and local colleges in the area, and some students take college courses while they are still attending the high school. Over the years there have been a growing number of under-performing students. In response, recent programs have been instituted such as Alternative Core classes which allow students more time to take the number of courses required to graduate.

Physically, Ranum resembles any large suburban high school; there are several floors with wide hallways lined with classroom after classroom, each one a replica of the next. But an additional space – the Math Department office – distinguishes the math hallway from others like it. A spacious classroom that was converted into a work space and planning area for mathematics teachers a few years ago, the distinct office space gives the department – currently consisting of 10 teachers – a cohesion that other departments often miss the opportunity to create. It is a true professional workspace. Teachers gather there in between periods, and each of them has a desk. They plan and talk amid the shelves of books and stacks of student papers. The teachers in the department span a wide age and experience range, but the backbone of the department is a group of female teachers who have been at Ranum since the late 1980s.

Key People

Diana Obstfeld and Rita Quintana are among the more experienced teachers in the department. They have been at Ranum for 15-plus years, and have quietly shaped the tone and tenor of the department. In 1990 Diana Obstfeld, Rita Quintana and another teacher, Sandy Valerio, were among the younger mathematics faculty members when they started looking for ways to develop their teaching, seeking more for their students and themselves as practitioners. Unbeknownst to each other, each decided to attend a Lawrence Hall of Science EQUALS workshop in nearby Pueblo, Colorado. Their experiences there introduced them to a new construct of mathematics instruction, and ultimately provided the foundation for them to lead a department-wide effort to implement a new curriculum.

The other key person in the Ranum story is Principal Dick Werpy. He arrived at the high school a year after Rita Quintana and Diana Obstfeld went to Pueblo, in 1991. He saw what he characterized as a "low achieving" culture entrenched at Ranum, and set about instituting a host of new efforts to change the school environment for students and teachers. A former math teacher, Werpy was particularly interested in the math program at Ranum. He was dissatisfied with what he saw, particularly the low enrollment of students in upper-level math courses, and was willing to support, even push, his math teachers in their pursuit of instruction that would engage students in richer mathematics.

THE MOTIVE FOR CHANGE

Ranum High School underwent a series of changes in the early 1990s. First, with Principal Werpy's arrival came an examination of the school culture as a whole, which illuminated a host of issues Werpy wanted to address – everything from the high student retention and transfer rates to the fact that a total of only five seniors were enrolled in math courses. Werpy had a vision, and he set in motion a restructuring process of the high school so that, among other things, students worked in closer relationship to their teachers (e.g., by having three or four teachers instead of six), and staff members were expected to consider and engage in their own professional growth. Regarding math, he realized that in the current climate students "would never compete with only traditional

mathematics instruction" and that it was "lunacy to continue to teach math in the same ways" if students would never reach higher levels and gain a love of mathematics.

In the Math Department there were at least two teachers, Obstfeld and Quintana, who could not have agreed more. The NCTM *Standards* had recently been published, outlining an entirely new set of pedagogical guidelines and strategies for the teaching and learning of mathematics. Obstfeld and Quintana loved the document, and they set about trying to implement some of what they had read. However, they described their initial approaches as "choppy and incoherent" and sought additional support. The EQUALS conference introduced them to issues such as access and equity for math students – a new world of mathematics instruction – and they returned to Ranum buoyed by the experience.

After EQUALS came the Colorado Council of Teachers of Mathematics conference and other similar meetings, which, at the urging of Dick Werpy, they were able to attend. With permission to pursue their growing interest, the three teachers hooked into the web of a truly professional culture. "I think we just started networking. Every time we went somewhere we would see someone that we had seen in a previous place." With the expansion of their professional horizons, they began to implement what felt like radical approaches to their mathematics instruction. They liked what they saw in themselves and their students. Obstfeld in particular was experiencing a real change in her thinking and her practice:

> *While visiting another school I saw graphing calculators for the first time; I was awestruck! I came back to my own room, looked at my desks in rows in my classroom and thought: boring! I had to change. I changed over night – I put my desks in groups, had students work together, set up peer mentoring and I listened to them talk. I became the cooperative group queen!*

However, Obstfeld, Quintana and Valerio were still teaching with many of the same traditionally based curricular materials, and searched continuously for resources that aligned with the NCTM *Standards*. A critical turning point was a visit to Eaglecrest High School, where the *Interactive Mathematics Program* (IMP) was being implemented by a number of teachers with great success. The excitement about innovative instructional approaches took on new meaning as the trio witnessed the manifestation of these ideas in a published curriculum. They recognized the power in using a fully realized program instead of fragments of units or activities.

In late 1993 Obstfeld and her peers learned that funds to teach *IMP* were to be made available through a national *IMP* dissemination grant. The grant would fund training and materials for two teachers for two years, supporting two additional teachers in the second year. Obstfeld knew that even with the support of the principal, getting money from the district for a new curriculum would, at the very least, be a lengthy process. Outside funding might actually leverage the kind of change she envisioned at Ranum in a reasonable time frame. It was also important for her personally:

I almost quit teaching because I couldn't find resources to teach in the ways that I wanted. If we didn't get this grant, I was seriously considering leaving [the profession].

THE STORY

The Choice

Timing clearly played a role in this story as a confluence of factors facilitated the implementation of *IMP*. In summary: a small group of Ranum teachers were ready for a change and were supported by their principal. They connected with like-minded colleagues at professional meetings. Through these connections they visited Eaglecrest where an NSF-funded, Standards-based curriculum – *IMP* – was already in place and, by all accounts, was thriving. A regional office of *IMP*, known as IMP-Rocky Mountain Region (or IMP-RMR), was formed and set up shop locally. Finally, a national *IMP* dissemination grant was looking for schools to become part of their network. All the stars seemed to align, and point Ranum toward *IMP*. When the Ranum teachers began seeing the director of IMP-RMR at various gatherings, and she encouraged them to apply for the grant, they felt it was an opportunity too good to pass up.

In 1994, the two-year *IMP* grant was awarded, and Diana Obstfeld and Rita Quintana were each funded to teach one period of *IMP* Course 1 and one class together to a group of self-nominated students. To prepare they participated in *IMP* training the summer before the 1994-1995 school year began. The grant also provided them with a daily "resource/planning period" which enabled them to regularly discuss the process of teaching this vastly different curriculum. These planning periods were critical, for as Obstfeld remembered, "there was lots of talk, it took lots of talk…" during the early implementation phase. In addition, as stipulated by the grant, Dan Fendel from the national *IMP* office observed them in their classrooms, and that summer they attended another two-week session at the IMP-RMR Center.

Up until this point the three teachers had kept a fairly low profile among the rest of the Ranum Math Department. The department culture at the time largely reflected the views of many veteran math teachers who are reluctant to institute dramatic changes to a way of teaching that has been accepted as the status quo for several years. Even with the receipt of the *IMP* grant, most department teachers continued to teach their "traditional" text, watching the work of Obstfeld and Quintana from a distance. Not only were they using a different, integrated curriculum, but also the *IMP* teachers were engaged in a rather unique, as yet unexplored, opportunity to share practice. The department office did not yet exist, and nor did the collaborative culture. "Everybody was doing their own thing…" and so when Obstfeld and Quintana and a few others started collaborating, it was a bit of an anomaly. The scheduled planning time funded by the grant was an essential support for them.

We were able to vent, to use each other emotionally as well [as intellectually] and that is probably the biggest part of professional development – the opportunity to share with your peers. It was invaluable.

Change Strategies and Steps

The grant's implementation strategy worked well in a school like Ranum because it operated on the premise that implementation should be gradual. Only two teachers would work with the program for the first year, and an additional teacher would come on board the next year. Sandy Valerio had left Ranum around this time but another teacher, after observing the excitement of her peers and their students, took on the teaching of the additional section in the second year. And at least a few other teachers in the department began to ask more questions about what their colleagues were really doing. It seemed the program had started to gain some momentum.

A significant event occurred at the district in 1995 that would ultimately play an important role in the *IMP* implementation story. In the early 1990s there was little curriculum agreement or alignment. Schools and teachers had considerable autonomy in terms of deciding what topics to teach and what instructional materials to use. In 1995, at the district curricular review, the district administration tried to address this tendency and create a more clearly articulated and aligned curricular stance. Administrators adopted a policy that stipulated that schools use an "integrated approach" to curricula. The Ranum *IMP* teachers and Dick Werpy quickly took advantage of the timing of the decision. They immediately saw this broad district sanctioning of integrated programs as their cue to start what they had been hoping to do – phase out the traditional mathematics courses in favor of IMP. They adopted an incremental approach, adding one new *IMP* course each year.

This forced consideration of a more weighty decision: whether to make the *IMP* program the core curriculum in the school. For the original *IMP* advocates, this was never a question. Dick Werpy remembered thinking, "All kids are capable of advanced mathematics, but we had to change the structure and delivery system of that math…" and he saw *IMP*'s spiraling integrated program as a possible way to accomplish that goal. Some faculty members grappled with the multiple programs debate – why not simply offer *IMP* to <u>certain</u> students? *IMP* proponents argued that *IMP* would ultimately become a program for only high achieving students (or in an alternate scenario, that it would be studied by only the lower achieving students), and that the parallel track system would prove nothing. This argument prevailed. One teacher recalled:

> *It all kind of came together. We, the curriculum committee, truly believed that this is what we needed to do – that there shouldn't be any "traditional track" because we knew that [it] wasn't good for some kids and if we did do heterogeneous grouping it wouldn't hurt the upper level kids, and it would help the lower level. We decided that we would offer Interactive Math and that it would be implemented one year at a time. Instead of funneling kids out, we wanted to open it up at the top so that more kids would be taking classes at the junior and senior level. This is what we were hoping for and it has actually turned out that way.*

Two things happened around this time that contributed to the success of the implementation. First, parents – particularly those of college bound students – became involved in the conversation about the mathematics program. Dick Werpy had

recognized early on that a major change in children's mathematics programs would provoke some kind of reaction from their parents, be it positive or negative. Thus as a proactive measure he organized several Math Nights and parent meetings in which he explained the basic tenets of the new curriculum, the reason for the school's shift, and the rationale behind phasing out the traditional program. Parents were always concerned about the changes, and some chose not to enroll their children in the elective years of *IMP*, but in the early years of the implementation process, they were assured by Werpy's mathematical background and faith in the program. As the years went on, the need to communicate with, and reassure, parents would continue to one of the biggest challenges of the implementation story at Ranum.

Secondly, when it became clear that *IMP* was at Ranum to stay, some of the more resistant math staff members recognized the subtle shift that had occurred in the department culture, and they left Ranum. Some of the departures were due to retirements, but at least a few teachers purportedly left because they didn't agree with the decision to adopt *IMP*, and they realized that if they stayed they would be required to teach some *IMP* courses and adopt a significantly different approach to their practice. While not vocalized very loudly or very often, there was a fundamental philosophical breach in the department and those who stayed in one way or another aligned with the *IMP* cadre.

For the most part, those teachers who remained had warmed to *IMP* and the shifts it forced them to make in their own teaching. Ongoing professional development proved critical. All Ranum math teachers eventually participated in an extensive array of professional development experiences, including but not limited to ongoing summer workshops, annual retreats and quarterly meetings, and regular visits and email communication from project staff. *IMP* grants funded all such professional development, as well as teachers' visits to other *IMP* schools, substitutes, and stipends to read about and reflect on this new approach to teaching. Diana Obstfeld reflected the sentiments of many at Ranum when she said, "It was the first time I was ever treated professionally."

The journey was not without its bumps, and there were many times when the amount of work required was overwhelming. Networking and maintaining links with other *IMP* teachers in the state and nationally became critical for *IMP*'s longevity at Ranum. Aware of some of the initial resistance among some colleagues and parents, Obstfeld and the other *IMP* teachers sought out the support of other more experienced reformers.

> *We wondered if we were sure what we were doing was right. But then we went to those Gatherings on Saturdays, or to the two-week summer institutes, and we would come out so refreshed, and every time you turned around someone had a book or an article about how we were doing things right…*

It took four years before all math teachers were trained in and teaching *IMP*. When the national *IMP* grant concluded, the work had paid off; Ranum was awarded a regional grant from IMP-RMR which gave them five more years of funding for a host of training and support opportunities, which Ranum teachers attended with regularity. Another perk of Ranum's association with IMP-RMR was membership in the Rocky

Mountain Mathematics Leadership Collaborative (RMMLC), a grant which was awarded to the IMP-RMR group. A follow-up to the NSF TEAM 2000 implementation grant, the RMMLC was established to address an issue the IMP-RMR staff had noticed in their work: in schools where teachers were knowledgeable about the curriculum and the mathematics but also were in regular communication with the administration and parents, the changes in the curriculum and the teaching of math were more accepted. In contrast, in schools where communication within the school community was sporadic or absent, reform was characterized as "tenuous at best and often unsuccessful." Thus RMMLC was born and brought together school teams of teachers, principals, counselors and parents for a summer institute (followed by workshops during the year) to plan for specific activities that would support math reform within each school community. A Ranum team consisting of four *IMP* teachers, a parent, a counselor and Dick Werpy attended the RMMLC institute in summer 2000. Following this initial experience, it was expected that over the next two years team members would participate in follow-up workshops and hold regular team meetings at Ranum, supported by an RMMLC staff member.

On a more informal basis the math teachers tried to gather frequently to discuss IMP-related topics and to spend time in each other's classrooms. Noting the external support the school had garnered, the district agreed to pay for all *IMP* materials and at least some of the daily resource period for *IMP* teachers in their third and fourth years. This too was important, as one teacher noted, "It helps, especially with higher levels of *IMP*, to see it in action."

Evidence of broader change was seen across Ranum High School. With his vision for a "high expectations" culture, Dick Werpy pushed the entire school to reshape its thinking and practices of teaching and learning during his tenure. It is true that the Math Department was perhaps most influenced, and supported by, his vision. A number of indicators demonstrated the transformation:

- new math teachers were now hired only with the approval of the Math Department, and with the understanding that as the school was wedded to *IMP* and its philosophy, teaching in the Ranum Math Department would require a minimum of professional development days and at least some *IMP* teaching
- the department was all female for a time, unusual in a traditionally male-dominated field, and creating a particularly strong professional bond
- the math department office was established as more teachers recognized the need for time and space to share practice

It is worth noting that such an office, specifically designated for teacher collaboration, is not often found in other high school math departments across the country, and these teachers' conscious decision to create one went a long way to foster and promote their math department's professional culture. A commitment to the deeply held principles of *IMP*, combined with the supports they received, had forever changed the nature of teaching and learning for these teachers. Below is a general timeline of critical events that led to and supported the *IMP* implementation effort at Ranum High School:

Date	Activity
1993	Obstfeld and Quintana learn that the national *IMP* office is seeking schools to participate in its dissemination grant, and apply for the grant.
Summer 1994	Two-year *IMP* grant awarded to Ranum; Obstfeld and Quintana participate in *IMP* professional development at IMP-RMR, including two weeks of *IMP* training, three-day rendezvous weekend in August.
1994-1995	Three sections of *IMP* Year 1 are offered at Ranum for self-nominated students. Throughout the year, *IMP* teachers participate in quarterly Saturday workshops, a two-day "Immersion" at Eaglecrest for all new teachers of *IMP*, and weekly visits from mentors.
Summer 1995	Ongoing, similar professional development continues for Obstfeld and Quintana, as well as for one additional teacher preparing to teach Year 1.
1995-1996	Open *IMP* enrollment at Ranum; three teachers teaching *IMP*.
1996-1997	Adams 50 District adopts integrated curriculum policy; Ranum is awarded a five-year regional grant from IMP-RMR, and starts phasing out traditional math curriculum. *IMP* is required for all entering freshmen. Two more Ranum teachers trained for *IMP* Year 1. Total of five teachers now trained (out of 10).
Summer 1997	Two weeks of *IMP* training for all Ranum math teachers teaching Year 1 and one week for those teaching Years 2 and 3.
1997-1998	*IMP* is now required for grades 9-10. Continued professional development opportunities, with the addition of advanced "Broadening Our Horizons" sessions (for teachers with three or more years experience teaching *IMP*).
1998-1999	*IMP* is Ranum's core curriculum at grades 9-11
1999-2000	First year that Ranum is "all *IMP*," and four-year *IMP* students graduate. Dick Werpy leaves Ranum, along with central office personnel who supported *IMP*; Linda Torres is named principal. Two new math teachers hired who opt out of *IMP* professional development.
Summer 2000	Rocky Mountain Mathematics Leadership Collaborative (RMMLC) institute for teacher leaders and principal, and school leadership team, are formed.

Degree of Implementation

Every teacher in the Math Department teaches *IMP* courses after attending appropriate staff development. Teachers always (unless it is impossible) start with Year 1 and go on to teach Years 2, 3, and 4 only after they have been trained in the higher level courses. In our observations of a variety of classes, the design theory behind this strategy was clear: teachers who had taught all levels of *IMP* were quite comfortable in their roles as *IMP* teachers – facilitators, questioners and guides. On the other hand, less experienced teachers were grappling with the demands this new program required of them. While the quality of the teaching spanned a continuum, all the *IMP* teachers were employing certain strategies such as collaborative group work and discussion, and all classes were driven by student work and thinking.

Using various indicators, students' interest in mathematics classes has increased quite substantially. By the end of 2001, 50% of Ranum students were taking *IMP* 4, AP Calculus, AP Statistics, or Calculus, all of which are electives. Werpy and others believe that with a different kind of teaching and belief system in place, "the kids proved they could make it." In the third year of implementation (before the school was all-*IMP*), the department wanted to find out for themselves how the *IMP* students were faring. They

conducted an internal comparative study of *IMP* Year 3 students with other third year Ranum math students (i.e., those not enrolled in *IMP*). They gave all students the New Standards test, and while the two groups of students scored equally well on the basic skills portion of the test, the *IMP* students' ability to work through the problem solving portion of the test exceeded that of the other group. In addition, with *IMP* came other positive indicators including more girls taking Calculus, and as Rita Quintana simply stated, "all kids enrolled in high level mathematics."

IMP students we spoke to were generally positive about the program, yet they too noted its challenges. It seems that once they become accustomed to the structure of the program they feel more comfortable and fare better as well. One student in Year 2 described *IMP* as "more complicated" and "harder" than his math classes at another school, "but not too hard." He went on to say, "It's easier once you know the stories, and all the group work helps me to understand some things better." Indeed, students in *IMP* 4 spoke articulately about their experiences, and how their appreciation for *IMP* has grown over time. These students in particular have faced the perceptions about *IMP* as non-traditional, what some called "dummy math" head on:

> *I would like to point out that there is a misconception going around about IMP: 'oh IMP is so bad, IMP is…a story book and I want real math…It is okay if you get the wrong answer in IMP as long as you know how to do writing. If you have 2+2=5 and you are able to explain it, it is right.' That is really not true at all.*

Instead, they said:

> *It is more picking apart math. You don't solve a single problem without getting detailed – how you got it, where you got it from, everything.*
>
> *This is more discovery math than anything I have ever seen.*
>
> *I think if you actually have a real life situation, you remember it better, rather than the same equation after equation after equation.*

Some say it is "too wordy." But another counters:

> *I agree that it gets kind of wordy and that we learned a lot of stories. But really I think it is a program explaining different problems …and you are expanding [your mathematical understanding] each time you do the 'story'…Then you get to the universal [ramification of] what it means and you are able to apply the storyline to it.*

Not all students had the experience these students had, participating in the program from Years 1 to 4. Many students in *IMP* 1 or 2 were still struggling to adapt to the new look and feel of the curriculum, and their interactions with the program reflected as much. The original idea of an all-*IMP* school was a valid one, but required perseverance on the part of students, teachers and administrators.

Contextual Changes

When that perseverance faltered things began to dissemble slightly. In 2000-2001 Dick Werpy left Ranum High School to take an administrative position in another district. His departure caused two significant events. First, the new principal began her tenure with little knowledge of the Math Department's recent evolution or its rationale behind changing the curriculum. She was hired after the RMMLC institute and so had missed a critical piece of planning with the newly established leadership team. Lacking a deep understanding of *IMP* and the direction the department wanted to pursue, she also did not feel obliged to continue to involve the Math Department in the hiring process of mathematics teachers. This had implications for who was hired, their understanding of their department position, and their participation in *IMP* professional development. A few of these new hires have found *IMP* to be rather unwieldy and for some, lacking in rigor. Referring to teaching *IMP*, one experienced teacher who was new to the school told us, "This is the first time I have not enjoyed teaching math." He and a few others also feel there is no room for dissension in the department. They quietly teach *IMP* alongside more traditional math in their classrooms, and confess sometimes they move the chairs around after class to make it look like their students have been working in groups. It is highly likely that they would return to teaching the more traditional curriculum if given the option.

None of the other teachers deny that the challenge of teaching mathematics in the new ways required by *IMP* is significant. The call for getting at content in a different way, and for implementing student-centered pedagogy, is difficult even for teachers with ample experience. While it has been invigorating, it has been a long and sometimes steep uphill path toward change. The work has challenged all of the teachers, tested their own knowledge of mathematics, pedagogy and their own practice. Yet overall, many say while it is more work and takes extra effort, the majority say they are committed.

The second related consequence of Werpy's move was that the parent opposition to *IMP* grew more vociferous. Once Werpy and his assurances were gone, the same small but vocal group of parents who had been consistently skeptical of the curriculum's place in the overall Ranum program now grabbed the ear of the new principal and new superintendent. The fact that the RMMLC leadership team at Ranum did not meet as frequently as planned and had sporadic attendance at outside RMMLC workshops did not help the situation. The team (and thus the school as a whole) became reactive instead of proactive in its work with parents. Again, the group, while small, was comprised mostly of parents of "advanced level" students but also included some of those students designated "special needs." One parent, an engineer, reportedly remarked, "What is this garbage?" Even those whose feelings are less charged and who may see some merit in the curriculum were concerned that *IMP* would not adequately prepare their children for standardized tests, college and beyond. They wondered once again why there could not be two tracks – one *IMP* and one more traditional – to allow for some parental choice.

While the Math Department felt strongly about their decision to teach students with this curriculum, they also had to work with parents, knowing their support would be necessary for the curriculum's longevity at the school if key supporters like Werpy were gone. Also, some remembered wondering if in fact *IMP* "could be all things to all

people." Some of the parents' concerns about the curriculum, e.g., its pacing and what they saw as its lack of conventional skill building, seemed warranted to teachers. So though they had "dug in [their] heels" and committed wholeheartedly to this curriculum and its philosophy, as a group they decided that small amounts of "tweaking" or supplementing the program would not compromise its overall integrity and might even preserve the curriculum's place at Ranum. Thus they designed certain supplemental activities such as the "Skill of the Week" which pulls material from other curricula and standardized test questions to help students master very specific skills. With concessions like this, teachers felt perhaps they were making progress with parents. However, with the departure of Dick Werpy and the superintendent (also a former math teacher), the buffers had disappeared. The parents were not satisfied with modifications to the program. The new principal, who again was rarely part of the RMMLC leadership team or the Math Department's conversations, urged the department to maintain an open stance toward parents. After much discussion they devised what they see as a compromise solution, again in service of keeping *IMP* as a core Ranum offering. An alternative curriculum *Contemporary Mathematics in Context: A Unified Approach* – more commonly known as *Core-Plus* – was to be offered to a group of 60 incoming freshman the following year. *Core-Plus* appeased parents who saw it as a more traditional "core" program.

In hindsight, the implementation of a single curricular program proved much more complex and political than anyone at Ranum had ever imagined. The process revealed surprising philosophical divides in the community at large, and forced everyone involved to confront their values and beliefs about the teaching and learning of mathematics. One of the strengths of this particular implementation was that it was a grassroots effort, built over a decade, led by a few key decision-makers but with a growing body of supporters. Yet with the departure of even a few of those lead advocates (whose successors did not feel particularly committed to *IMP*), the effort lost some critical momentum, and the fragility of bottom-up reform became very apparent.

ONE YEAR LATER

At the end of the 2001-2002 school year, we interviewed Diana Obstfeld again. In one year, much at the school had changed.

Two major events occurred early in the year. In the late summer of 2001, scores from the new state standardized math test (Colorado State Assessment Program or CSAP) were released, and in Obstfeld's words, they were "horrible." As is typical with a test given for the first time, the entire state posted low scores (with approximately 14% of high school students passing). Two percent of Ranum students passed the test, much to Obstfeld and her colleagues' surprise. "We felt optimistic about the test; it's a good test, emphasizing problem solving and strategic thinking, things our students are strong in. There is no reason why our students didn't do well." She could only attribute some of the low passing rate to a decreasing motivation level among students especially prevalent with a new assessment, and she expected that scores would rise next year. Still *IMP* opponents saw the poor Ranum scores as concrete proof of their concern about the inadequacies of the program, and made the connection explicit to the superintendent. Additionally the principal asked teachers to "modify" their teaching of *IMP* so class time would include more direct instruction and opportunity to build performance skills. Secondly, the "pilot" *Core-Plus* program began in September with 60 freshmen. While the one teacher trained in the program liked it overall, there were clearly not enough support mechanisms in place to assess its success. Parents found it to be too difficult for students, and voiced this concern to the principal and district administrators. Some stated that *Core-Plus* was not the kind of program they had asked for when they requested an alternative to *IMP*.

In October 2001, a directive came from the superintendent, saying that he was unable to disregard parental opposition: *IMP* was to be phased out over the next three years, and the math program at Ranum would consist of *Core-Plus* and the *Discovering Algebra* and *Discovering Geometry* series from Key Curriculum Press – which is viewed as the type of program that parents had requested. "He said he had had it," remembered Obstfeld. "*IMP* had gotten a black eye."

Therefore, in the 2002-2003 school year, 9th grade Ranum students will take *Core-Plus* or *Discovering Algebra*, or one of a host of other choices which include Advanced Algebra 1 or a combined Algebra/Geometry course. By 2004 *IMP* courses will no longer exist at Ranum. Obstfeld lamented, "We went from being a single entry school in 9th grade to there being five or six choices for a freshman. So now there is clearly stratification by level" – something that the school had worked hard to eliminate with its efforts to make Ranum an all-*IMP* school.

At first, Obstfeld said she felt undermined. But now she says, "we're feeling okay – we ended up with *Core-Plus* and *Discovering Algebra*." And at least one voice of support remains at the district. Karen Lewis, the Director of Curriculum, will ensure that adequate professional development is offered to teachers teaching *Core-Plus*.

Meanwhile, some of the administrative positions at the school are turning over again, a fact that Obstfeld sees as a good sign for the Math Department. A new principal will start in the fall of 2002, offering the Math Department a potentially "clean slate." In addition, this is the first year that all the teachers in the department are returning. "At least one of us wanted to quit daily this past year, but we made it. The administration's all changing, but we're still here." Most important, she reported that the legacy of constructivist teaching and profound mathematical thinking is strong in the classrooms of those who taught *IMP*. Even though they may be using a more traditional program, she and her colleagues think about their practice and student work differently, and everything from grading to questioning to facilitating student understanding has changed.

"It was a very hard year," Obstfeld noted. And yet, given the current climate, she is encouraged by the steps that have been taken. "Perhaps *IMP* could become more viable for us in the future. Maybe it's naïve thinking, but Ranum could be open again to *IMP* in five years or so."

CHAPTER 5

SIMMS: Integrated Mathematics in SAN ANTONIO, TEXAS

Preview

As part of a larger equity-driven reform agenda, an NSF mathematics program is implemented in a large, urban high school where the majority of students are Spanish-speaking and all but a few qualify for free lunch or reduced-price lunch. High stakes testing serves as a key motivator in this profile due to a state-mandated end-of-course exam in Algebra, the Texas Assessment of Academic Skills (TAAS), and the district's history of low achievement at the secondary level. The Math Department chair and the principal play a powerful role in the implementation process, especially given that they share a common vision and a willingness to work together. The story illustrates some of the challenges and benefits associated with a school-wide, incremental implementation strategy, one in which the traditional mathematics curriculum is incrementally replaced by a new sequence of integrated courses, one year at a time.

THE CONTEXT

Just a few miles south of downtown San Antonio, but a world away from the tourists visiting the Alamo and browsing upscale shops, is Harlandale, Texas. Here, new pavement gives way to potholed streets; the older, bungalow-style dwellings look tended, but tired; and small, independently owned businesses dominate – their signage mostly in Spanish. Residents tell us that development projects are slow to reach this part of town. Even with the economic boom of the 1990s, the effects were only beginning to trickle down to Harlandale as the decade drew to a close. Still, the area boasts a rich cultural heritage, surrounded by a number of historic buildings including old Spanish missions. Harlandale also has its own school district, covering 14 square miles adjacent to the San Antonio Public Schools and serving a small, close-knit community that is home to some of the region's oldest and newest families. According to local leaders, many of the district's children are direct descendents of San Antonio's founders. Many are also newcomers to both Harlandale and the US.

The district has two high schools – Harlandale High School, which serves almost exclusively students from the local community, and McCollum High School, which serves the local community as well as the neighboring US Air force base. Harlandale was the district's first high school, opening in 1924. The school was rebuilt in 1953 – a rambling, cinder block structure that today houses more than 1800 students. Harlandale High School's student body reflects the demographics of its neighborhood – 98% of the students identify as Hispanic and 92% qualify for free lunch as well as free breakfast. In addition, about 24% of the students come from immigrant families, who often move on before their children finish high school. On average, Harlandale teachers can expect about 25% of their students to leave each year. Still, a much larger portion of the students come from families long established and stable in Harlandale – families that take great pride in their community, their school, and the area's rich cultural heritage. As a result, it is not uncommon for young people enrolled at the high school to be fourth and fifth generation Harlandale students. However, it is also not uncommon for students to be the first in their family to anticipate going to college.

Unlike some of the neighboring buildings that surround it, Harlandale High School reflects the pride of the community it serves. While arguably a building whose prime has past, fresh paint abounds and everything in the school shines – from floor to ceiling. The people inside also contribute to this polished image. The students appear sharply dressed, and purposefully so – no dirty jeans and t-shirts here. They carry themselves with confidence, greeting each other with smiles in a combination of English and Spanish. The adults in the building do the same. The mood is upbeat and purposeful – not what one necessarily expects in a public high school with Harlandale's demographic profile.

Another aspect of Harlandale High School that contributes to its strong community feel is the tradition of shared meals. *All* students receive free lunch as well as breakfast at Harlandale – a decision made by the principal. The equity-focused administrator recognized the stigma that students attach to receiving free meals at school and discovered that paying for extra food was more cost-effective than keeping track of who was eligible for breakfast and who was not. Teachers are also welcome to participate in these meals, making the cafeteria much more than a place to eat. Especially in the early morning hours, students and teachers can be found sitting around tables together, mulling over assignments or simply talking.

But Harlandale was not always like this. In the early 1990s, the school was a different place than it is today. Then, the building looked battered. The students were discouraged and exhibited little respect for themselves or their school. Vandalism and graffiti were perpetual problems. Morale was low. Teacher frustration was high. According to members of the Math Department, the majority of the students in first-year Algebra were 11th graders with a history of failure. Even as recently as five years ago, the passing rates on the state standardized tests were in the low 30% range at Harlandale. Today, they are nearly 80%. What could have brought about such a dramatic change? Clearly, there were many factors that came together – such as a need for improvement, proactive leadership, access to supplemental resources, a shared vision, and committed teachers. However, we are told that a key component of the change process at Harlandale proved to be selection and implementation of an innovative new math curriculum – one

that was viewed as a tool for simultaneously exposing students to more rigorous mathematics and addressing inherent equity issues in the existing set of offerings. The new math program was called *SIMMS Integrated Mathematics*, named after the program through which it was developed, the Systemic Initiative for Montana Mathematics and Science. We visited Harlandale in the spring of 2001, during the second year of its implementation.

Key People

Among the many people who supported implementation of the *SIMMS* curriculum in Harlandale, three played critical roles in bringing the program to both the district and the high school. First and foremost, Harlandale High School's Math Department chair, Gaby McMillian, recognized the curriculum as exactly what she had been looking for, successfully convinced her colleagues to try something new, and possessed the tenacity to see the implementation process through to completion. The second, Harlandale Principal Robert Jaklich, arrived just as Harlandale teachers were beginning to pilot the new materials and offered only support for the endeavor. The third, Harlandale School District's Math Coordinator, Jonnie Patranella, worked behind the scenes with both McMillian and Jaklich, before the two had even met each other. It is unlikely that any one person would have succeeded in fully implementing the new math program were it not for the others. Theirs was truly a combined effort.

Gaby McMillian came to Harlandale High School more than a decade ago. Despite her deep commitment to making a difference in the lives of young people, she found the conditions both depressing and overwhelming. In the mid-1990s, a dynamic new principal, with a strong belief in the ability of all students to learn and achieve, set Harlandale's turnaround in motion. However, this principal did not stay more than a few years. Fortunately, his successor, Robert Jaklich, proved equally committed to similar goals. Indeed, Jaklich, who came from a local middle school whose demographics paralleled those of Harlandale, took the vision one step further by giving special focus to curricular reform. We were told that both Jaklich and his predecessor were unyielding in their determination to "do what was best for kids." They cracked down on student discipline and critically examined teaching practices, leaving no room in the school for people uninterested in their vision for change. In fact, some described their willingness to initially clean house as "downright ruthless."

At the same time, Jonnie Patranella, the district's Math Coordinator was among the leaders spearheading the San Antonio Urban Systemic Initiative (USI), working to bring a new vision of K-12 mathematics education to the region. Gaby McMillian explains that it was Patranella who educated her and many others about the NCTM *Standards* and the potential for reforming high school mathematics. In addition, Patranella suggested that significant resources had been set aside to support high schools willing to consider implementing one of the newly published, integrated curricula that had been developed with NSF funds. With McMillian's encouragement and Patranella's support, Harlandale's Math Department began moving in this direction in the late 1990s. As a result, by the time Jaklich arrived at Harlandale High School, most members of the

Math Department were fully prepared to implement one of these innovative, reform-minded programs. In fact, some teachers were already piloting *SIMMS*.

Coincidentally, Jaklich had just come off an experience in which a grassroots teacher movement had led to the implementation of the *Connected Math Program* (*CMP*), and the results had been very positive. He heard from the District Math Coordinator during the interview process that a similar effort was brewing at Harlandale High School. For this reason when Gaby McMillian suggested that improving math school-wide would require a total reworking of the curriculum, Jaklich agreed wholeheartedly. Both envisioned a rigorous, Standards-based math program that could be made available to all students, doing away with the highly differentiated, traditional sequence of courses in which only a select few succeeded. They shared the belief that Harlandale students, under the right circumstances, were capable of much more than they were presently accomplishing. With Gaby McMillian's enthusiasm, Jonnie Patranella's avid support, and Robert Jaklich's leadership, the pieces began to fall into place to make big changes in math education at Harlandale High School.

THE MOTIVE FOR CHANGE

During the time of the *SIMMS* pilot effort, many like-minded forces were coming together around similar issues in the Harlandale Independent School District. There seemed to be a growing district-wide that belief something needed to change. The cycle of failure needed to be broken, especially at the high school level. Admittedly, the skill level of the student population was low and their language needs were high, but these were not insurmountable problems given the history of strong community support in Harlandale. Pressure from the state, in terms of high-stakes standardized tests and the goal of "Algebra for All" in the 9th grade was also mounting. Too many students, essentially all of them Spanish-speaking, were falling behind. As a result, the district faced an achievement gap that could no longer be ignored.

Simply stated, it was a matter of educational equity. In hopes of getting new perspective on the issues confronting their region, a local team had applied to participate in the Equity in Mathematics Education Leadership Institute (EMELI). This group completed two years of intensive training through a series of residentially based workshops in California, designed and facilitated by Math Professor Julian Weissglass of UC Santa Barbara. Through EMELI, they gained a deeper understanding of some of the root causes of inequities in education, particularly in mathematics. Among the team members was Harlandale's District Math Coordinator, Jonnie Patranella. The EMELI team returned to their home districts with a renewed commitment to better serving the needs of *all* children and with skills that would help the group communicate an equity-based vision for change. It was also about this time that the Harlandale School District took up its equity mantra: "Excellence + Equity = Exemplary Education." Consensus was growing that bolstering academic achievement in Harlandale would be intrinsically linked to departing from the status quo, and this meant changing the pattern of low expectations that operated on the part of teachers, parents and students. This was

precisely the conclusion of the teachers at Harlandale who had decided to pilot *SIMMS: Integrated Mathematics*.

Support from Other Systemic Initiatives

Simultaneously, the work of the San Antonio Urban Systemic Initiative provided further support for Harlandale's reform agenda. The USI included seven school districts in the San Antonio area, Harlandale among them. The initiative aimed to support the improvement of math and science in grades K-12 across all seven participating districts. USI leaders viewed the use of innovative curricular materials – particularly those developed by NSF-funded programs – as a key reform strategy in both subject areas. As a result, leaders of the USI were providing many opportunities for teachers, schools and districts to become more familiar with some of these new materials. In addition, the USI offered financial assistance to any school that was willing to pilot and/or implement one of these programs.

Gaby McMillian had attended nearly every session offered by the USI for secondary math educators. She recalls that in the early sessions, most of the work centered on familiarizing teachers with the NCTM *Standards* and providing them with ideas for teaching Algebra differently. However, none of the secondary materials presented in the early years of the USI had the coherence of a full four-year, integrated program. As it turns out, the 1997-98 school year (the year prior to Robert Jaklich's arrival at Harlandale High School) was a math adoption year for the district. McMillian describes the selection process as "pure chaos." The district had instructed the committee to come up with a single textbook series for both high schools. People felt pressured to choose something that would address the state's new Algebra requirement. Even though the adoption committee tried to thoughtfully approach the task, they could not agree, and ultimately came up with nothing.

In the spring and summer of 1998, the USI offered a number of opportunities for high school teachers across all seven districts to learn about some of the newly published NSF math curricula. McMillian attended a workshop on *Core-Plus* and felt that this was definitely more along the lines of what she had envisioned for Harlandale. Knowing that there were four other like-minded programs available, she wanted to see more. Soon afterward, she had the chance to see *SIMMS*. McMillian says she knew the first time she picked up the *SIMMS* book that "this was it!" She enthusiastically brought her new discovery back to her department and district. Adoption seemed unlikely given the district's interest in finding a single secondary text. Nonetheless, the district Math Coordinator seized on McMillian's enthusiasm and offered to support training on the *SIMMS* curriculum with *SIMMS* funds if she could find a group of teachers to pilot the program at Harlandale High School during the upcoming school year.[8]

[8] At that point, no other high schools served by the San Antonio USI had indicated an interest in pursuing reform, meaning that of the budgeted $50,000 that had been set aside for high school support, none of the money had been used. In addition, Patranella had access to some Texas SSI funds that had been earmarked for a similar purpose.

Back at Harlandale, finding a few colleagues to join her in piloting *SIMMS* did not prove a difficult challenge. There were 19 teachers in the Math Department at Harlandale High School at the time, and due to high turnover among the faculty, about a third were fairly new to the department and to teaching. These teachers also tended to be the ones most interested in supporting their energetic Math Chair in trying the new program. In the end, all 19 members of the department agreed to attend two weeks of training before summer's end. In the fall, about half of Harlandale High School's entering 9th graders found themselves sitting in a *SIMMS* Level 1 course.

THE STORY

Although the full Harlandale Math Department willingly attended training in the summer of 1998, some wondered if all their efforts might be for naught. At the time, they were still waiting to get word on the assignment of their new principal. The more they learned about the new math pilot, the more the group understood that putting a program like *SIMMS* into place would require support beyond the Math Department. A reluctant principal could completely undermine the effort. However, one day during the training, a visitor came to observe – the visitor turned out to be Robert Jaklich. That was the first time he and Gaby McMillian had met. McMillian remembers trying to get a sense of where Jaklich stood on math reform in that initial meeting. And he, in turn, was trying to get a read on her level of commitment. Jaklich had been already been through the experience of implementing a reform-minded curriculum school-wide and he believed in it. Although they could not have known it in that moment, these were two people who felt very strongly about the identical educational issues – and together, they were a force to be reckoned with.

McMillian recalls that the *SIMMS* pilot year, 1998-1999, proved even more difficult than she had anticipated. In addition to the challenges of the new curriculum, which included new topics and a much more constructivist approach, she felt that the district office was sending mixed signals. While the Math Coordinator clearly supported her department's efforts, McMillian was less sure about other district leaders. Harlandale's other high school, McCollum, had also sent three teachers to the *SIMMS* pilot training that summer, but the staff there seemed quite hesitant to do anything more than try a single module or substitute a few activities from *SIMMS* into their traditional program. With the two high schools both theoretically "trying" the new program, district leaders seemed to take more of a "wait and see" approach. In the meantime, the district officially adopted a commercial textbook series for the high school level.

At Harlandale High School, a total of six teachers piloted the Level 1 program much more completely. Among those who opted not to pilot, a few were clearly opposed to making such a drastic change. Others liked the idea of the *SIMMS* curriculum, but felt that it was too much work and simply too time consuming, especially given the testing pressure from the state. Because she truly believed that this new program was what Harlandale students needed, McMillian pressed on. She tried to motivate her colleagues to do the same, by providing support within the department and encouraging them to collaborate whenever possible.

The physical structure of the mathematics office worked to their advantage. At Harlandale, teachers generally rove from room to room during the day rather than having their own individual classrooms. Most mathematics classes are clustered at one end of the building. Also in this area, one of the larger classrooms has been converted into a Math Department Office, a common space for all math staff to congregate when they are not teaching. In addition to encouraging dialogue and common planning for teachers, the arrangement also provides a place for students to come and get their questions answered – if not from their own teacher, then from one of the other math teachers. In the center of the math office is a large rectangular table. We were told that many teacher hours have been spent around this table deciphering the *SIMMS* curriculum – planning lessons, thinking about how to better meet the needs of students, solving new problems, working with graphing calculators, and sharing strategies for facilitating more and lecturing less.

Admittedly, progress was slow in the beginning. That first year, the Level 1 courses worked through less than half of the 16 modules. Despite the difficulties, nearly every teacher who piloted *SIMMS* reported liking the changes that they saw in their classroom and in their students as a result of the new program. The question was whether Harlandale had the critical mass to move towards school-wide implementation. Principal Robert Jaklich relied on the wisdom and experience of his Math Chair, saying that he would support whatever decision the department made. When McMillian told him that the majority of the department was prepared to go with *SIMMS* school-wide, Jaklich responded with a resounding, "Then *SIMMS* it is!" More than this, he put his math faculty on notice – informing them that all math teachers at Harlandale would ultimately be required to teach the new program and to participate in the training needed to do so. There would be no exceptions. The change would be a gradual one, but he advised anyone unwilling to abide by that policy to consider employment elsewhere.

Over the next four years, Harlandale would replace its traditional sequence (Pre-Algebra, Algebra, Geometry, Algebra II, and so on) with a collection of integrated courses based on the *SIMMS* instructional materials. The new offerings needed to successfully align with the state's testing practices and accommodate the school's existing schedule. The overall plan was to phase out elements of the traditional program as the new classes were offered and to completely remove any remedial offerings. Also implicit in this strategy was the phasing out of "how" mathematics had been taught for decades at Harlandale – meaning a move away from teacher-centered classroom practice. Through the implementation of *SIMMS*, the Harlandale Math Department believed they could provide a high-quality, rigorous, and learner-centered math program for all of their students – ultimately leading to higher math achievement school-wide.

Implementation Strategy

Harlandale High School operates on an accelerated block schedule with four classes per semester that meet for 90 minutes each day. In the fall of 1999, all incoming 9th graders were enrolled in the same math class – *SIMMS* Level 1 – which met for two semesters, the equivalent of two year-long courses as measured by instructional hours. In the fall of 2000, the same students were once again double-blocked for mathematics as sophomores. The practice of having 9th and 10th graders enroll in two semesters of mathematics each year continues to this day. Robert Jaklich refers to the strategy as Harlandale's "math-rich curriculum." The school has found that doubling the time that 9th and 10th graders spend in math classes provides an opportunity to better individualize instruction and to address academic issues in other areas, particularly technology and literacy, via mathematics. The result is a more level playing field for students during their junior and senior years. It is worth noting that the nature of the *SIMMS* curriculum – which places high demands on students in terms of communicating their ideas and using technology as a tool for mathematical exploration – makes it an ideal match for accomplishing these goals.

Regarding course load, teachers in the Math Department teach three out of four blocks each semester, leaving one 90-minute period available each day for planning. Since teachers do not have their own classrooms at Harlandale, most math teachers end up in the Math Department office during their "instructional planning period." Since the *SIMMS* implementation began, Gaby McMillian regularly distributes to all department members a list of who is teaching the same courses and who has planning time together – a fairly subtle hint that they should be taking advantage of the opportunity work together.

One of the characteristics of *SIMMS* that makes it unique among the five NSF-funded secondary mathematics curricula is that it consists of six levels or courses as opposed to four, providing multiple avenues of mathematics study, depending on students' future interests. The theory behind this program design is that *all* students will enroll in Level 1 in their first year and in Level 2 in their second year. In their third year, students with a strong interest in mathematics, or who plan to pursue a field in which considerable mathematics is a prerequisite, are advised take Level 4. Those who plan to pursue careers in the humanities or social sciences are advised to enroll in Level 3. The math topics are essentially the same, but the approach in Level 3 tends to involve more applications and modeling, while Level 4 includes more theory and derivation of algorithms. The same is true of Level 5 (aimed towards students who do *not* intend to pursue mathematics study beyond high school) and Level 6 (aimed towards students who do).

Harlandale strayed a bit from the typical *SIMMS* implementation strategy due to its double-semester math model for 9th and 10th graders. Only in the 9th grade do all students take the same the course. In practice, Harlandale's Level 1 courses actually consist of all Level 1 modules plus two modules from Level 2. After completing the Level 1 course, Harlandale students have two options: a Level 2/3 course or a Level 2/4 course. The differences in these offerings reflect the differences in Levels 3 and 4 described above.

According to the school's incremental implementation strategy, each Math Department member teaches a Level 1 course as their introduction to the new curriculum and prior to teaching any of the more advanced *SIMMS* courses. In preparation for teaching Level 1, each teacher must participate in two weeks of training during the summer before the course begins. The same is true for each new *SIMMS* course that a teacher takes on – another two weeks training specifically for that course is required beforehand. In the first year of implementation, designated *SIMMS* staff came to Harlandale and led the training. Over the course of implementation, members of Harlandale High School's pilot group have partnered with *SIMMS* staff to provide more of the training, not only for Harlandale teachers, but also for those at McCollum and other surrounding districts.

In addition to summer trainings, teachers at Harlandale High School have received considerable mid-year support as they attempt to implement *SIMMS*. Based on their prior experience with other improvement efforts in the San Antonio area, both Gaby McMillian and Jonnie Patranella, the Harlandale District Math Coordinator, knew that teachers would need more than summer training to successfully implement a program like *SIMMS*. Therefore, in addition to encouraging structures for site-based collaboration, they arranged for mid-year support that would bring *SIMMS* staff not just to Harlandale, but also directly into the classrooms of the implementing teachers. Twice a year, in the fall and in the spring, a team of *SIMMS* trainers would come to Harlandale for three days. They would spend Thursday and Friday in classrooms, observing and consulting with teachers. On Saturday, they would facilitate a day-long workshop grounded in the experience of the first two days. The mid-year sessions give teachers the opportunity to voice concerns and work through trouble spots with empathetic peers who have developed and/or taught the *SIMMS* curriculum. The three-day visits remind teachers that their work is part of a larger effort and that they are not alone in the challenges they face. Not surprisingly, teachers have found the mid-year workshops very helpful. According to one teacher, "There's just a lot of things that you don't know to ask in the summer. The school-year support for *SIMMS* happened just when I needed that little boost."

The table below chronicles the key events of the *SIMMS* implementation at Harlandale.

SIMMS Implementation at Harlandale High School
Calendar of Critical Events

Date	Activity	Notes
1996	State of Texas demands "Algebra for All" in 9th grade.	As a result, state no longer gives course credit for Pre-Algebra at high school level.
1996	Elementary teachers in Harlandale decide to implement TERC *Investigations*.	Implementation is a teacher-driven effort that meets with considerable success.
1997	Middle School teachers in Harlandale decide to implement the *Connected Math Program*.	Adoption built on the work of "The Algebra Project" – professional development for teachers in grades 4-8.
1997-1998	Math Adoption Year in the Harlandale School District – district leaders want a single textbook. McMillian reviews published copies of *Core-Plus* and *SIMMS* materials for the first time. She organizes a group from Harlandale High School (HHS) to pilot *SIMMS* in 1998-1999.	NSF materials were available for perusal at many of the USI meetings/workshops.
Summer 1998	All 19 member of Harlandale's Math Department receive training for *SIMMS* Level 1 (3 teachers from McCollum High School also participate); Robert Jaklich arrives at Harlandale High School and endorses the *SIMMS* pilot.	District Math Coordinator arranges USI for both training and textbooks related to the *SIMMS* pilot.
1998-1999	With ongoing support from Harlandale's District Math Coordinator and the new HHS Principal, McMillian and six other HHS teachers pilot the *SIMMS* materials.	USI provides funds for books; district and school provide funds for graphing calculators.
Summer of 1999	The HHS Math Department attends two weeks of further *SIMMS* training.	*SIMMS* staff come to Harlandale. Funding is provided by the USI.
1999-2000	Implementation of *SIMMS* begins; all 9th graders enroll in Level 1.	All Level 1 courses meet for 90 minutes/day.
Fall 1999 & Spring 2000	*SIMMS* staff return to Harlandale to offer mid-year, follow-up workshops for all teachers who are teaching the curriculum.	Funding is provided by the USI.
Summer 2000	Harlandale teachers participate in training for Level 1, Level 2/3 and Level 2/4 courses.	*SIMMS* staff come to Harlandale. Funding is provided by the USI.
2000-2001	Implementation of *SIMMS* continues. All 9th graders enroll in Level 1. All 10th grade enroll in a Level 2/3 or Level 2/4 course depending on their future interests.	All 9th and 10th grade mathematics courses meet for 90 minutes/day.
Fall 2000 & Spring 2001	*SIMMS* staff return to Harlandale to offer mid-year, follow-up workshops for all teachers implementing the curriculum.	Funding is provided by the USI.
Summer 2001	Summer training continues with a shift towards in-house providers.	USI ends.
2001-2002	Implementation of *SIMMS* continues with the offering of the Level 6 course and AP Statistics. HHS Math Department provides its own form of mid-year professional development, using the former *SIMMS* visits as a model.	A total of 76 students at HHS sit for the AP Statistics exam.

THE REAL WORK

Reflecting on the implementation process thus far, members of the Harlandale Math Department say that changing habits, those of teachers as well as students, has been arguably the most difficult challenge of implementing the *SIMMS* curriculum. Teachers try to lecture less and facilitate more. They work on honing their questioning strategies so that they can better guide students towards their own mathematical discoveries. Students, in turn, are trying to rely more on themselves and their peers when it comes to developing full understanding of a concept or solving a difficult mathematical problem – as opposed to asking their teacher to give them an explanation or demonstrate a solution. This shifting of roles can lead to frustration on the part of both teachers and students.

According to Gaby McMillian, garnering department-wide support for the program has been a significant implementation hurdle as well. Clearly, these challenges are connected. When it comes to high school mathematics, there is simply such a long-standing tradition of what is taught and how one teaches it. Breaking free from those old habits and getting every member of a department to see the value of doing so can seem nearly impossible. Despite these potential barriers, Harlandale seemed to be making headway when we visited in the spring of 2001.

The principal's strong endorsement for the program coupled with his willingness to back words with actions, particularly when it came to teacher hiring, proved to be a tremendous source of support. Although the state of Texas is currently suffering a math teacher shortage, Jaklich unabashedly counseled some of his experienced math staff to consider other options if they refused to buy in to the *SIMMS* implementation or to his larger equity-driven vision for improving learning conditions at Harlandale. He also refused to hire highly qualified math teachers who balked at the two weeks of required summer training. A few veteran teachers chose to leave the school as a result of the new direction the department was taking. A couple, we are told, actually ended up across town at McCollum High School, where *SIMMS* was also present, but where there was only minimal pressure to implement it.

Another implementation issue that often surfaces in other districts did not arise in Harlandale – namely the role of parents and their critique of a mathematics program that looks quite different from what they recall learning in high school. It appears that the strong parent support for schools that is associated with the cultural traditions of Harlandale's student body also operated in favor of implementing *SIMMS*. One of the math teachers, who is also a Harlandale graduate, explained the situation this way:

> *You know, these are pretty traditional families – it's part of the culture. They go to church. They raise their children to respect their elders. You even hear kids calling their parents "Ma'am" and "Sir." And the parents trust the schools. They view the teachers as experts and professionals. So, when we decide to try a new math program, the parents support us because they believe we know our stuff. They don't question or pass judgment. They trust us to do what's right for their kids. Besides, it's not like the old way was working out too well.*

Walking the halls of Harlandale High School, we witnessed this notion of students displaying deference to adults with regularity. From the moment we approached the front door, students stopped to hold the door, "After you, Ma'am." Repeatedly, we heard students addressing their teachers as "Ma'am" and "Sir." These gestures of respect flowed from teachers to students as well: "Tell me, Ms. Gonzalez, what are your thoughts on this?" Also, implicit in the implementation of *SIMMS* was the teachers' belief that students at Harlandale were much smarter and more capable than many adults had given them credit for being in the past.

Degree of Implementation

When we visited Harlandale High School in the spring of 2001, we observed more than half of the department teach math lessons, the majority of which took place in *SIMMS* classes. The teachers we met represented a variety of ages and backgrounds, but the majority were quite new to teaching. About half of the department had been teaching three years or less, and more than half did not hold math degrees. The regional teacher shortage combined with the high turnover rate among Harlandale's math staff has resulted in most of the recent hires being in the early years of their career. For example, Harlandale hired five new math teachers for the 2000-2001 school year and of these, three were first-year teachers. However, it is important to note that during the hiring process Harlandale High School also turned away a highly qualified, state-certified secondary math teacher because that person's philosophy of teaching and views about students did not align with what the school, and in particular its Math Department, are trying to accomplish.

In Harlandale classrooms, we observed teachers at various stages of the implementation process. depending on their enthusiasm for the curriculum, their teaching experience, and their openness to modifying their own practice. Nearly all teachers seemed to be working to create more opportunities for students to collaborate and communicate about mathematics. Structurally, this was not an easy task since nearly every classroom was equipped with desks – the one-piece variety in which a small writing surface is connected to the seat. Still, teachers regularly had students working in pairs or small groups. In the one classroom that was equipped with tables rather than desks, we noted that the students were noticeably more accustomed to group work – laying out their papers so that the group could readily compare results, consulting each other on calculator steps, and making sure that the group did not leave any of its members behind.

Arguably more than with any of the other NSF-funded high school curricula, technology plays a significant role in the *SIMMS* curriculum. The availability of a graphing calculator is essential when implementing this program. We saw Texas Instruments graphing calculators in all *SIMMS* classes that we observed. However, graphing calculators were absent from the non-*SIMMS* classes that we visited (due to the year-by-year implementation process, 11th and 12th graders were still taking courses in the standard high school sequence when we visited). The calculators that students used at Harlandale tended to be TI-83's, as opposed to the TI-92's promoted by the *SIMMS* developers. As we understand it, the TI-83's calculators simply proved to be a more

readily available and affordable option. The school and the district provided funding for the calculators.

Another commonality that surfaced across the classrooms we visited at Harlandale was the strong rapport that teachers had with their students. Those who could speak Spanish clearly had a valuable tool for connecting to the Harlandale student clientele and they used it. Some were particularly playful in their approach. We heard this exchange in a 10th grade class taught by a teacher of Hispanic descent.

Teacher: OK, my little calabazitas, 9 weeks to go, man. Today we are going to be working with measures of central tendency. Can anyone tell me what we mean by that?
Hands go up; teacher calls on female student.
Student: Yeah, things like mean, median, and mode.
Teacher: That's right, and who can tell me what these things mean? How are they the same? And how are they different?
Hands go up; teacher calls on female student.
Student: Well, they all tell you something about the data. Like the mean is just the average and the median is the middle point.
Teacher: Good … good … OK, I want you to practice what you know with some data that relates to us … I'm going to go around the room and have each person give me their height.
Teacher does this and generates list of 21 heights, his own included. Students are then instructed to move into pairs and to work with a partner in calculating measures of central tendency. This takes about 15 minutes.
Teacher: So what did you find out?
Student offers: We're short, man.
Students laugh.
Teacher: Yeah, no kidding. I'm not even an outlier.
More laughter.
Teacher: I want to ask you some more questions.
Teacher proceeds to ask a mix of open and closed questions. Students seem confident with the material. After a few minutes, he wraps up this portion of the discussion.
Teacher: So the sum of the relative frequencies is ….?
[Teacher writes at the board, "SUM (relative frequencies) = "]
Class: One! *(in unison)*
Teacher: That's right, it's the whole enchilada. Is everyone all right with that? (pause) OK, then I need a volunteer to read…

Due to the language issues of many students at Harlandale, teachers told us that they often have students read aloud both in their small groups and as a whole class. We also saw teachers asking students to give Spanish translations of some problems. But most important, we observed that teachers refused to water-down the content or vocabulary simply because so many of their students were English language learners. Instead, they found multiple ways for students to access the underlying rigor of the material.

Understandably, the transition to *SIMMS* is also causing students to change their approach to learning. Sitting passively in a math classroom is no longer an option. Many classes contain episodes of direct instruction, but students take careful notes because they know that the information will prove valuable when they are working with their peers in

small groups. Still, some have a hard time thinking for themselves. Midway through a Level 2/4 class, as students were growing frustrated with a difficult problem, we heard one teacher exclaim, "You all just want to be spoon-fed and let me remind you that I won't do it." The students moan and groan. The teachers struggle not to give in. Together they work through the difficult spots. What students and teachers gain from both the process and the end results keeps everyone coming back for more.

By the end of the second year of implementation, the Harlandale teachers using *SIMMS* felt confident that essentially all 10th graders were prepared to sit for both their state "end-of-course" exam in "Algebra" and their state high school exit exam. Of the 19 members of the department, only one remained highly critical of the *SIMMS* approach to mathematics. The remaining teachers fell into two groups – those who had fully embraced the program and those who were still getting acquainted with it. The ratio of experienced *SIMMS* teachers to inexperienced *SIMMS* teachers was roughly 2:1.

Enabling Factors

Every educational context offers supports and barriers when it comes to implementing an innovative program such as *SIMMS*. Through our work in other schools and districts, we have found that the high school mathematics context is particularly vulnerable to the effects of these external factors. For that reason, we feel it is important to restate the conditions that have contributed to a successful implementation process in Harlandale.

First, this is a small district with high needs students and a trusting parent community. Those who initiated the change in curriculum felt compelled to do so. Although Harlandale is not exactly an urban district, it has reaped the benefits of being part of the San Antonio region, where educators at many levels of the system have shown an interest in using curricular change as the leading edge of their improvement effort. Through the San Antonio USI, Harlandale has had access to multiple sources of additional support that enabled piloting of the new textbooks and professional development for teachers. In addition, the overall district climate and mission made for strong administrative support that included the superintendent, the math coordinator, and the Harlandale High School's principal. Particularly the support of Harlandale's principal – a person willing to hire and fire based on his beliefs – is a rarity in the high school setting. Finally, the flexibility of the *SIMMS* curriculum (with its different six levels as opposed to four courses) combined with the program's emphasis on technology and language made it possible for the high school to address multiple achievement issues via significant change in one subject area. Proceeding down the reform path has not been without issue, but the benefits have outweighed the difficulties, and so far, there has been no turning back.

AS TIME GOES ON

In the fall of 2002, change was afoot in Harlandale, but the *SIMMS* curriculum remained in place at the high school. As department chair, Gaby McMillian continued to lead the school's math reform effort and the incremental implementation of the new program. In 2002-2003, the department's math offerings included courses from Level 1 to Level 6, as well as AP Statistics and AP Calculus. The school also had some exciting data to report. For example, during the previous spring, 76 Harlandale students had taken the AP Statistics exam. Of these, 30 students were sophomores who had been propelled forward in their math studies by Harlandale's double-blocking policy for 9th and 10th graders.

Four years into the implementation, some of the early supports for the program were absent. The San Antonio USI had come to an end. The District Math Coordinator, Jonnie Patranella, had retired. In addition, Harlandale's Principal Robert Jaklich had moved to the district office, taking his equity message and hiring criteria to the position of Executive Director for Personnel. However, Harlandale's new principal, Patricia Ramirez, was proving to be another strong supporter of the *SIMMS* curriculum at Harlandale High School – different in style from Jaklich, but quite similar in beliefs and message.

During the summer of 2003, despite the scarcity of funding for professional development in the district, Harlandale High School remained committed to offering sufficient training and support for teachers of the *SIMMS* curriculum. Local staff were facilitating the two-week summer workshops, a more cost-effective option than bringing in *SIMMS* trainers from out-of-state. The Math Department continued to arrange substitutes for mid-year in-class support through the use of on-site peer partners (an experienced *SIMMS* teacher with a less-experienced *SIMMS* teacher).

Looking back on all that her department has accomplished since the fall of 1998, Gaby McMillian told us that in her mind, the 3rd and 4th years were the most difficult of all.

> *The first two years basically run on excitement. It's also the enthusiastic people who teach it in the beginning. But the more you replace, the more you bite into the resistance. And those people who thought they might be able to avoid the whole thing find out that it just keeps coming. They just can't hide anymore.*

In Harlandale, the last of the most reluctant teachers proved to be those with some lingering doubt about the ability of Harlandale students to successfully rise to the challenge of a rigorous curriculum like *SIMMS*. Those teachers either retired or moved on; a number of them actually transferred to the district's other high school. Meanwhile, each successive Harlandale graduating class has mathematically achieved as much or more than the class before it. McMillian says this is because every year both teachers and students get better – incrementally improving their styles of teaching and learning. The school has also continued its practice of double blocking in mathematics for all 9th

and 10th graders. Some students still use the extra math classes as an opportunity to catch up with their peers, but the majority use Harlandale's "math-rich curriculum" to propel themselves forward in the high school curriculum. The strategy originally used to bring students up to the overall level of the state now helps them achieve at a mathematical level far beyond the expectations of the state.

♦♦♦♦♦

When we spoke to Gaby McMillian in the fall of 2002, she continued to relish the success of *SIMMS* and expressed every confidence that it would continue. She planned to remain at Harlandale until she could be certain that the program would have a life beyond her presence. From the beginning, McMillian has been personally involved in every phase and nuance of the implementation. She has carefully and diligently nurtured the program along recognizing, quite wisely, that in the world of math reform, "You can't let up. You can't ever let up." However, McMillian also shared her growing weariness as a result of the constant effort required to keep the program afloat. Every year, the parents of the incoming 9th graders needed to be re-educated. New teachers required hours of training and support before they could take on any of the *SIMMS* courses. Battles at the district level over budget and creating a unified curriculum raged on.

In the spring of 2003, Gaby McMillian was offered a regional consulting position that would enable her to support other schools in San Antonio interested in pursuing the path of reform. She chose to leave Harlandale High School at the end of the 2002-2003 year. Others left with her. In fact, by spring 2004, only two of the teachers involved in the original *SIMMS* implementation remained on campus. While Harlandale High School continues to offer only *SIMMS* and AP mathematics courses, teachers tell us that the program has been under attack in the absence of its most committed advocate. One of the biggest challenges at this point is the district administration's desire to have one, and only one, textbook series for both high schools. With the Math Department at McCollum adamantly opposed to an integrated program of any kind, the future of *SIMMS* at Harlandale High School seems questionable. Still, we are told that a committed and vocal group of faculty, who can make a strong case for why *SIMMS* works with Harlandale students and who have the achievement data to support their claims, might force a compromise. That story, however, remains to be told.

CHAPTER 6

SUMMARY OF FINDINGS

When this study began, our intention was to document the difficult, sometimes controversial, effort involved in successfully implementing one of the COMPASS affiliated curricula. We traveled to the selected sites to immerse ourselves in their work and described in detail what we encountered. We followed the stories through telephone interviews and email for at least another year, sometimes longer. However, as time went on and the reality unfolded, the work of implementing these programs proved to be far from over, and ultimately, even more challenging than we had anticipated. At the writing of this manuscript, two of our sites had chosen to discontinue use of their NSF-funded programs. One had selected another COMPASS curriculum to use as a replacement; the other site had opted for a new direction entirely. It is now clearer than ever to the members of our research team that high fidelity implementation of these curricula is not a trivial matter – not for a school, and certainly not for a district.

This study raises new questions for us as researchers and for others engaged in the business of improving high school mathematics education. The stories, we believe, have much to teach about using these curricula specifically and about the nature of high school mathematics reform more broadly. The experiences of the five sites also point to basic issues about how to define the success or failure of a curriculum implementation effort. As we all know, the implementation of an innovative curriculum serves as but one factor in shaping the behavior of a highly complex education system. We, therefore, face the task of ascertaining the value-added of curriculum-based improvement efforts such as these. The current tendency is to view the implementation effort as either a success or a failure, all or nothing, depending on the extent of implementation and its sustainability. However, such a stance now seems entirely too limited.

High school mathematics programs like the five involved in the stories studied here require much more on the part of teachers and students, as well as schools and districts, than a traditional textbook adoption. They make demands on the entire system that raise the bar for the overall quality of mathematics education in a school or district. And when, often for political reasons, a program is dismantled, we find evidence in these stories that the implementation process itself, combined with the experience of teaching and learning with such an innovative program, leaves a lasting legacy. In short, the people and institutions in the places we studied are changed by the implementation process – to the point that even if the program is no longer present, many of the beliefs and practices associated with it remain. All of this is a powerful reminder of the extent to which the implementation of COMPASS curricula involves much more than the purchase of a set of new textbooks.

The discussion that follows is organized around four critical themes that emerged over the course of our work both in the field and during the data analysis phase. They are as follows:

- Differences Between These Implementation Stories and Other Efforts to Improve High School Mathematics Education
- Commonalities Across the Implementation Stories
- The Effect of Implementation on Classroom Practice
- Interactive Dimensions of the Implementation Effort

We provide a detailed discussion of each theme below, referencing examples from all five of the stories as evidence. The chapter concludes with a few final thoughts about new and deeper questions raised by these stories, prospective areas of future research, and a re-conceptualization of curriculum-driven mathematics reform at the secondary level.

Differences Between These Implementation Stories and Other Efforts to Improve High School Mathematics Education

In prior studies of secondary mathematics curricular decision-making, members of our research team have examined school and district readiness to implement innovative curricula similar to the COMPASS curricula (Inverness Research Associates, 2000; Inverness Research Associates, 2003). Perhaps surprisingly, the findings from these studies indicate that the majority of schools and districts in the US are relatively satisfied with their secondary mathematics programs. Moreover, among those who express dissatisfaction and a clear desire to change, most would not choose to do so by completely reworking their course offerings; instead, they envision more of an incremental strategy, infusing new activities into the existing curriculum. Thus, the intense desire for change and the willingness to experiment with a radical change in approach sets COMPASS implementers apart from their counterparts from the outset.

The schools and districts we studied represent five places that wanted, for many different reasons, to improve math education in a deep and profound fashion. They intentionally chose to make significant changes, such as completely reworking their course offerings, rather than pursuing a path of incremental change that so often characterizes improvement efforts in mathematics education.

There are times when schools and districts take on system-wide approaches to reform, but such efforts are generally driven by standards and accountability measures, not by curriculum. Whenever a new curriculum is implemented, the process always takes place within the existing norms, expectations and culture of the district, school and department. Since it is not likely that a new curricula will immediately trump existing culture, prevailing norms and culture of a district, school, or department almost always

prove to have a greater influence on teachers and administrators than the new program. In many respects, introducing a new curriculum is somewhat analogous to introducing a new organism into an ecosystem – at best a process of accommodation and assimilation begins to take place. For this reason, our five implementation stories are very much stories of accommodation and assimilation, and they tell us a great deal about how systems – namely schools and districts – respond to innovation. In many respects, our analysis of the five stories proves to be a study of the interaction of curriculum and place.

Of the many factors that distinguish these implementation stories from other improvement efforts, we focus here on three aspects that we believe are the most critical. They include: the overriding *motivation* for the reform, professional *connections and relationships* to others doing similar work, and the *duration* of the curricular reform effort. We discuss each of these ideas independently.

Motivation

In our stories, people's *motivation* for implementing the COMPASS programs runs deeper than simply updating the math curriculum or raising test scores. Those who spearheaded these implementation efforts want to do more than simply upgrade their offerings. They want to make high-quality mathematics teaching and learning accessible to more students – ultimately to *all* students. They view mathematics as a key gatekeeper in the high school experience – one that is critical in determining students' future career options and choices. But mathematics is also a gatekeeper within the school. It is a domain that can readily harbor embedded equity issues and sustain status quo cultural norms within a given building. In our stories, the implementation leaders want to use math reform as a way to get beyond the status quo and to promote powerful cultural changes in education. Therefore, their motivation in choosing one of the COMPASS curricula extends beyond the adoption of a better mathematics textbook. Instead, they see the curriculum as a kind of "Trojan horse," initiating a process that will itself further the achievement of other broader and deeper goals.

Not only does the curriculum serve a broader reform agenda; but the opposite is also true. That is, the wider base of support for equity-related reform can provide valuable capital for getting through some of the rougher parts of the mathematics implementation – a situation we encountered both at Harlandale and Bald Knob High School. However, the desire for greater equity and the goal of math for ***all*** students can also raise the ire of parents of traditionally high-achieving students, especially those bound for four-year colleges. In describing this group, one teacher quoted a parent as saying, "If it's good enough for all children then it can't be good enough for my child" – a perspective that we heard about when visiting both Ranum and Bellevue.

Connections and Relationships

The implementers of COMPASS curricula told us that they attribute the development of their larger, more programmatic vision in mathematics to their *connections and relationships* to others engaged in similar work. COMPASS curricula are instantiations of a larger vision that is associated with the professional world of mathematics education, specifically the NCTM *Standards*. The connections that math

leaders had with other NSF projects, and with schools and districts pursuing similar goals, proved critically important in nourishing their own efforts. In our stories, we saw NSF's systemic initiatives playing such a role in Bald Knob, Harlandale, and Bellevue. At Ranum, participation in a national curriculum network with a number of local partners provided the key supportive connections. In Boston and Bellevue, leadership on the state level, with respect to standards and assessment, helped connect the local reform effort to a much larger improvement initiative. In every instance, connections and relationships with other reformers put the work of curriculum implementation in a larger context, creating increased leverage and providing a broader base of support for local change.

Duration of the Effort

Having companions in the work is particularly helpful due to the scope and duration that these implementation efforts require. According to the data collected by COMPASS and Inverness Research Associates, the time span of a successful curriculum implementation effort is generally five to seven years. It takes at least that much time to garner administrative support, get the Math Department on board, phase in the four years of courses, train teachers, work with counselors, educate parents, and help students acclimate to the new program. In short, implementing one of these programs is long-term, stay-the-course work.

We found that the time scale of implementation does not align well with that of school systems that tend to run on seven-year adoption cycles. By the time the implementation is taking hold, the district is likely to be adopting a new program. And it is fair to say that the lifetime of curriculum implementation is not well matched with the lifetimes of other key system processes – such as the revision of district standards, school turnover, and superintendent changes. The bottom line is that, in the end, all five of our stories prove to be examples of reform-minded leaders – an array of teachers, department chairs, principals, and superintendents – pushing on parameters of what the system traditionally finds acceptable in order to make their vision of mathematics teaching and learning a reality.

Commonalities Across the Implementation Stories

The five NSF-funded high school mathematics curricula are each quite unique. And the five sites we chose to study were purposefully selected to differ from each other. However, in our five implementation stories, the nature and extent of the changes that these innovative programs demand prove to be more similar than different. It is, therefore, not entirely surprising that our stories share a number of common elements. In what follows we describe those commonalities that appeared in most if not all sites:

- *All sites had a student performance issue that mathematics leaders hoped the new curriculum would help them better address.*

The achievement issues were certainly not the same across the five stories. However, each site had a student population that they were targeting with this reform and a sense of how they would measure improvement. Ranum teachers, for example, wanted more students to take more years of mathematics, with students pursuing coursework beyond the required level. Bellevue wanted to get more students to the AP level, but they were also concerned about supporting low-performing students and improving overall district results on the new Washington state assessment. Math leaders in Boston wanted *Math Connections* to bring all students to the level of their peers in the exam schools, and also wanted to improve district performance on the new state assessments. Bald Knob wanted to better address the needs of "low-performers" as well as students in the "middle-range" as measured by the state assessment and course enrollment. Harlandale's goals included most of the above with an explicit desire to use mathematics as a vehicle for improving student performance in literacy and technology.

- *Teachers knew of and felt an obligation to address the NCTM Standards in their classroom and school.*

Each of the sites we studied were places where teachers were members of professional organizations and engaged in regular professional development. Teachers understood the challenges posed by the NCTM *Standards* and, even if not all of them agreed with the selection of the COMPASS curriculum, they understood that the purpose of the new curriculum was to improve their teaching and, consequently, the performance of their students. At each site, there was also a smaller group of teachers that had become convinced of the need to improve the quality of mathematics instruction and had embraced the NCTM *Standards* as the direction they wanted to pursue. These teachers had become quite committed to a professional vision of mathematics teaching that was more student-centered and less didactic, more grounded in real world applications and less focused on symbol manipulation devoid of context. Inherent is this vision was a deep belief in the capacity of all students to learn rigorous and relevant mathematics.

- *All stories involved a core leadership group that included administrators as well as teachers.*

Again, while the nature of the administrative support varied from one site to the next, at the outset, all could count on someone at the administrative level to publicly endorse and support the reform effort. In Bellevue and Boston, the Superintendents played this role. At Ranum and Harlandale High School, it was the principal. In Bald Knob, it was a combination of the two, although neither was as avid a supporter as the people we met at the other sites. In addition, the core group always included teachers and often included the mathematics department chair. All were people with significant educational experience who simply believed that the traditional curriculum and pedagogy had failed too many students for too long. Dissatisfied with status quo of the high school mathematics classroom, change for this group was seen as a necessity, not a luxury.

- *Due to the timing of their implementation, each site established a connection with the national community involved in Standards-based mathematics education – and most important, with the developers of their curriculum.*

While not "pilot sites," all of the schools and districts we studied were among the earliest sites in the nation to implement the COMPASS curricula. As a result, the curriculum developers associated with each program had a particular interest in learning about and supporting their work. Because there were still so few schools and districts implementing these programs at the time, each of our sites had regular direct contact with someone on the curriculum development staff for their program. Many teachers participated, at least at the beginning of the implementation effort, in professional development facilitated by the developers themselves. And many received professional development training at a fraction of the regular cost.

- *As these early implementers proceeded with their work and the status quo began to change, they encountered the political side of reforming mathematics education.*

Despite the number of teachers, students, and parents who welcomed the changes associated with the new curriculum, there were others who remained unconvinced that this was the best direction for their school or district. Some teachers struggled with some of the new content and recommended pedagogy. Some students balked at seemingly having the rules of the game changed this late in their schooling career and at being asked to take more responsibility for their own learning. Parents questioned whether colleges would value the new courses as much as traditional offerings like Algebra and Geometry. Leaders of the reform efforts found that the work of educating others about the new curriculum was an ongoing task. Each year, they faced new students, new parents, and new teachers – not to mention those still doubtful from the year before. In addition, at the turn of the new millennium, there was growing political controversy surrounding the use of non-traditional mathematics curricula, especially at the secondary level. While mathematics was not a political issue in most of the places we visited, it generally became one as the wheels of implementation were set in motion. In a few cases, these political tensions proved to truly threaten the new program.

- *All flourished initially only to face significant challenges in their 3rd or 4th year, in some cases with the program being removed completely.*

Each of these implementation efforts were able to document early on that the curriculum was enhancing the math program in their schools and districts – either by producing results in terms of test scores (Ranum, Bald Knob, Bellevue, and Harlandale) or by showing that the new curriculum was better aligned with the state exam and therefore afforded better chances of success with mandatory testing (Bellevue and Boston). Some of the sites also boasted higher numbers of students sitting for Advanced Placement exams, especially in Statistics (Bellevue and Harlandale). Still, all of the sites also admitted that their most difficult challenges came well into the implementation process – most often during the 3rd or 4th year. They offered multiple explanations for this phenomenon. First, it is the 3rd and 4th year texts that pose the greatest challenge for teachers with respect to content knowledge. Second, by the 3rd or 4th year, whether a school is using a COMPASS program exclusively or a parallel track model with two

different programs, the schedule dictates that most teachers must now teach the new curriculum; those who may have been trying to avoid it can no longer do so. Third, the novelty of the program begins to wear off at this point, even among advocates – it is no longer experimental or temporary, but established – and therefore, a bit more difficult to promote. Finally, due to the high turnover among math teachers at the high school level, this is also the time when systems begin to lose the teachers and administrators who started the program – meaning schools and districts that must make new hires and arrange for their training. Without continuity of staff, leadership, or vision, a new program is once again at risk.

The Effect of Implementation on Classroom Practice

This study not only tried to document the dynamics of implementing an innovative curriculum but also to understand the degree of fidelity involved in that implementation. The COMPASS curricula embody a different vision of teaching and learning – and therefore, a different vision of classroom practice, interactions, and culture. Consequently, in addition to documenting how schools and districts implemented their curriculum of choice, we also wanted to get some sense of what that implementation actually looked like in the classroom setting. We wanted to experience the distinction between the adopted curriculum, as intended by the developers, and the actualized curriculum that results as teachers and students use any given program in a real classroom. The desire was to better understand and be able to articulate the process of accommodation and assimilation that necessarily takes place as this new organism is introduced into the ecosystem.

Before summarizing our findings with respect to classrooms and the nature of instruction in the schools we visited, it is important to review some of the expectations for classroom quality and culture that the COMPASS developers generally associate with their curricula. As alluded to earlier, all of these programs were designed to place students more purposefully at the center of classroom activity. The intention is that teachers play more of a facilitator role – meaning that they lecture less and listen more, creating regular and rich opportunities for students to explore and discuss the mathematics they are learning. In terms of mathematics content, these programs include new topics, change the sequence of old ones, and demand a level of conceptual understanding not required of teachers or students in the past. Rather than teachers explaining finite problem-solving techniques and students practicing them in a rote fashion, the expectation is that students work with one another to solve complex problems that lead to the discovery, introduction, or utilization of mathematical algorithms, concepts, or results. The development of mathematical ideas also grows out of a context – for example, students learn that the concept of slope is much more than a definition such as "the change in y over the change in x" and that a linear function represents many more situations than those connected with slope and y-intercept. In this way, the algorithms, concepts, and results are embedded in a process of inquiry and the classroom ideally becomes a community of learners.

Development of the COMPASS programs also expect that classrooms using their curricula will physically look different than a traditional high school mathematics

classroom. The students' seats will be arranged to facilitate communication between students, rather than in traditional rows. Students will have direct access to technology, either graphing calculators or computers with appropriate software, to facilitate their mathematics explorations. The classroom will contain additional tools for developing conjectures, collecting data, and engaging in hands-on discovery – such as patterns blocks, Geoboards, tape measures, stop watches, and so on. It goes without saying that one would also expect to see student work that reflects the classroom environment and experiences described thus far – for example, students would be expected to write about their problem solving strategies and solution methods as opposed to completing traditional problem sets.

Common Attributes

When our research team observed mathematics lessons as part of this study, we encountered a wide range of quality and practices. Some classrooms clearly evidenced the vision of the curriculum developers and the NCTM *Standards*, others less so. However, across all of the classrooms, we encountered many common practices that reflect an intention to shift the nature of teacher and learning and to move it towards what we would call a more reform-minded vision of instruction. Below is a list of the qualities we found in nearly every classroom we visited.

- Student seating consisted of either tables or clusters of desks arranged to support cooperative learning and increased opportunities for student discourse.
- Technology (usually in the form of TI graphing calculators) was regularly present, although not always in use.
- Teachers were trying, with varying degrees of success, to play more of a facilitator's role.
- Mathematics content was rigorous and challenging, often involving statistics.
- Students were given opportunities to articulate and present mathematical ideas to their peers either in small groups or at the front of the room.
- Students were working to solve lengthy, challenging problems as opposed to series of short exercises.
- Student discourse and questions tended to involve content more than procedure.

The Welch Model

Despite notable departures from traditional practice, nearly all the classrooms we observed also evidenced a longstanding structure of the high school mathematics lesson that appears very difficult to change, even with professional development and materials that encourage an alternative. It is an organizational pattern for lessons that most will find highly familiar:

STEP 1: Students arrive and are asked to complete a "warm-up" problem or some other brief task aimed at getting the class settled and started. (optional)
STEP 2: The class reviews the previous night's homework and any relevant questions.
STEP 3: Teacher introduces and/or students discuss the new material.
STEP 4: Teacher gives the next assignment.

STEP 5: Students begin their assignment while teacher roves. (optional)

Our research team has come to refer to this structure as the "Welch model," based on the findings of another educational researcher, Wayne Welch, more than 25 years ago. Welch conducted an in-depth study of science education that took him into many high school mathematics classrooms. He found:

> *In all math classes that I visited, the sequence of activities was the same. First, answers were given for the previous day's assignment. The more difficult problems were worked on by the teacher or the students at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and the problems assigned for the next day. The remainder of the class was devoted to working on homework while the teacher moved around the room answering questions. The most noticeable thing about math classes was the repetition of this routine.* (Welch, 1978)

From what we have experienced in this study and other projects involving high school mathematics classroom observation, the Welch pattern remains strong to this day. Only a few of the high mathematics lessons we viewed strayed significantly from this pattern; the ritual structure of classroom lessons clearly trumps the curriculum that is present – a finding that surprised many of the COMPASS curriculum developers.

Quality of Instruction

While far from perfect, as a group, the lessons observed for this study were effective and generally of high quality, with only a few exceptions. These exceptions occurred most frequently in situations where teachers had received little or no professional development related to the curriculum. Nonetheless, across all of the lessons, we recognized areas where teachers would benefit from additional professional support. These included: further developing their questioning skills, more carefully designing cooperative learning tasks, integrating technology so that it supports rather than dominates the lesson, and making decisions about when adaptation of the curriculum is or is not appropriate.

Each classroom reminded us anew of just how difficult it is make the kind of change supported by the COMPASS Implementation Center. With respect to content and pedagogy, the COMPASS curricula demand much more on the part of teachers and students than traditional programs, a phenomenon confirmed by studies such as TIMSS. They also call into question some of the tried and true practices associated with secondary mathematics teaching, the "Welch model" being one example. Adapting materials is another. Traditionally, high school teachers are accustomed to pulling from a variety of resources and adapting textbooks to meet their needs. Not surprisingly, during our classroom observations, we saw people trying to adapt the COMPASS curricula to their context. However, the very nature of these programs makes them less suited to such practices. They have been carefully written and the activities crafted so that they purposefully build on one another. The developers' hope and intention is that teachers will use them as designed, at least initially. Our sense is that without faithful and thorough implementation it is actually quite difficult to see the full potential of these programs. And according to our experience, this takes considerable time and effort – more than most of the teachers in our study had yet taken when we visited them. Still,

there were some that had achieved such high fidelity implementation and it was in these classrooms that we saw the richest lessons.

In the end, our research team concluded that the mere presence of these curricula did indeed raise the quality of the mathematics lessons but that the overall picture was more mixed. The implementation effort clearly makes classrooms look different and has the potential to deeply enrich the mathematics content. However, putting the new program in place involves, in practice, a process of accommodation and assimilation. The system accommodates the innovation within existing structures. Likewise, teachers and students assimilate the new curriculum into the norms of their classroom. In any given context, it is impossible to adhere completely to the new program as designed and envisioned by the developers. The pressure to default back into the known, the tried and true, is simply too great. However, we also see how these programs serve as a constant force of stretch and pull on the systems that choose them, leading to a broader vision of mathematics education and increased capacities to make that vision a reality – in short, an easing of the gridlock that is high school mathematics.

Interactive Dimensions of the Implementation Effort

Over the course of our work, we have encountered a set of what we call "interactive dimensions" that we now associate with the implementation of programs like the COMPASS curricula. These are capacities that the implementation not only needs to succeed but that it also generates over the course of the effort – in other words, these are capacities that the curriculum implementation demands and simultaneously creates. We have identified six such elements that we discuss in more detail below. The list is not exhaustive, but includes: multi-level leadership, programmatic vision, professional supports, teacher beliefs, classroom culture, and attention to community and context.

Multi-Level Leadership: Real and sustained leadership at multiple levels of the implementation process not only shepherds, but also safeguards the effort.

In the places where the implementation is most successful, even if it is only at the outset, we see a core group of critical leadership coming together that includes: *curricular leadership* (people with a vision of the kind of mathematics they want students to learn), *instructional leadership* (people who believe that traditional pedagogy needs to change), and *administrative leadership* (generally a principal and/or a superintendent who are willing to publicly endorse the implementation effort). The members of this core leadership group are spread across the individual mathematics departments, the schools at large, and district administrations. We acknowledge that school systems rarely generate such a committed team of leaders without first collectively recognizing the need or cultivating the will required to implement one of these programs. However, once the effort has begun, new leaders surface and are fostered via the additional professional development opportunities the implementation affords.

Programmatic Vision: All constituents involved in the implementation process, from district administrators to members of the parent community, need to share an

understanding of why the change is important and what benefits will come from the effort in the long run.

Due to the long-term nature of the implementation process associated with one of the COMPASS curricula and the system-wide change that the effort demands, there needs to be a shared and concrete vision of what the program should look like when it is fully implemented. Implementation leaders must first work together to articulate this vision among themselves and then collaborate with others to modify and create ownership for that vision. Ideally, this vision evolves and deepens over the course of the implementation effort, involving all that come into contact with the new program, including students. This kind of programmatic vision is also at the heart of the community education effort associated with successfully putting an innovative curriculum in place and maintaining it over a number of years. According to our study, communicating such a vision generally proves to be a constant task due to an ever-changing student clientele and the high rate of turnover in schools. However, as the program becomes established and begins to succeed, the facts reinforce the vision, in particular the notion that *all* students can learn rigorous mathematics.

Professional Supports: Adequately supporting the realization of any of the COMPASS programs requires professional development for players at all levels of the system and throughout the implementation process.

While teachers need content training to feel confident with challenging programs like the COMPASS curricula, the professional development that supports high fidelity implementation goes well beyond content. It is a sustained and cumulative set of experiences that grounds teachers in the vision that underlies the new programs – providing multiple opportunities over time for them to buy in to the underlying motivation for the reform as well as the technical aspects of achieving it. All administrators, but especially principals, need to thoroughly understand the anticipated changes to course offerings and classroom instruction. They also need to be informed about potential community criticism and conflict that can arise over the course of implementation and prepare themselves to respond accordingly. Ideally, the professional development plan will provide activities for all staff – math and non-math – including special ed teachers, counselors, principals, site-level administrators, and district-level administrators (even if the implementation involves only a single school site). Although teachers and administrators do not always see the need for the professional development at the outset of the implementation, as the work continues, they tend to want more instead of less. The more they learn, the more they realize all that they have yet to learn.

Teacher Beliefs: Day-to-day implementers of COMPASS curricula need to value and cultivate an understanding of mathematics that goes beyond skills.

Teachers who successfully use these programs in their classroom ultimately possess or develop a conception of mathematics as a discipline that differs from that of most American adults. They recognize that mathematics is a dynamic and highly relevant field in which new ideas continue to be discovered on a regular basis. They understand that mathematics is much more about interpreting the world than it is about performing arithmetic or manipulating symbols. They model particular mathematical habits of mind

– a love of inquiry, a curiosity in grappling with the unknown, an appreciation for multiple correct answers and numerous pathways to the same answer. They believe that they must foster similar attributes among their students, knowing that productive citizenship in the 21st century demands more than reading, writing, and arithmetic – it requires critical thinking and true mathematical literacy. Some teachers possess these beliefs before their school or district adopts one of the COMPASS curricula, and successful implementation can cultivate such values in those teachers who do not.

> Classroom Culture: In order for these curricula to truly thrive and grow, a particular classroom culture must exist.

In the highest quality lessons that we observed for this study, teachers had cultivated a culture of rigor and respect that one does not generally associate with the traditional high school learning environment. These were classrooms in which teachers and students had moved beyond what we call "going through the motions of reform." They seemed to understand that using cooperative group work and requiring student presentations is only a first step. If these activities are not carefully structured and if students do not approach them with the appropriate attitude, then the lessons fall flat. The most successful COMPASS classrooms that we observed had as their foundation strong relationships between students and teachers, engaging mathematical discussions and activities, an inherent respect for learning and the learner, and a balanced stance towards knowledge and authority. In short, they were learning communities comprised of both teachers and students – places where it was safe to question, to challenge each other, to make a mistake, and to steer the lesson in a direction that the teacher might not have originally intended. Again, when such conditions are pre-existing, an innovative curriculum like one of the COMPASS programs has fertile ground to become faithfully and fully implemented. In other cases, thoughtful and conscientious implementation of the new program can encourage teachers to take a fresh look at their classrooms and the kind of learning environment that they want to create.

> Attention to Community and Context: Although community education is often among the last details that implementers attend to, it is often the first to threaten their work.

In all of the schools and districts in this study, we encountered people who told us they initially did not pay great attention to involving the community in their vision, educating constituents about the direction they hoped to take, or thinking about issues unique to their context. However, they either quickly developed the skills and strategies for doing

so, or else they experienced serious erosion of the implementation effort. Of all the interactive dimensions we have identified, this appears to be the one that school and district leaders had the greatest tendency to underestimate – ironically, it is also the one that proved to most critically impact their progress. In each of these stories, we encountered teachers and administrators struggling to move from a state of "internal commitment," which occurs in the hearts and minds of teachers and administrators, to one of "external commitment," which occurs outside of the school itself (Fullan, 2001). The farther they proceeded with the implementation, the more pivotal this issue became – and therefore, the more skilled and savvy the implementers needed to be in order to safeguard their fledgling programs.

FINAL THOUGHTS

In summarizing our work with the five implementation sites portrayed here, it is important to go back to the beginning, to recall the origins of these curricula and the motivations for their development. We need to remember that in comparison to other textbooks on the market, these programs represent a truly radical approach to secondary mathematics education. They represent what some would call "pure vision:" a revolutionary attempt to completely redesign the high school math experience according to the vision laid out in the original NCTM *Standards*.

When implemented, all of the COMPASS curricula pose major challenges to the system by:

- increasing demands on teachers with respect to learning new content and changing classroom practice
- encouraging students to view mathematics differently and to play a more active role in their own learning
- providing an alternative to the long-standing tradition of high school mathematics
- taking the public risk of pursuing something different from the status quo
- facing the social justice challenge of providing an empowering mathematics education for all students that is both rigorous and relevant

The tension created by these challenges can be resolved in different ways. In some cases, the system pulls back and rejects the curriculum. In others, the system meets the new program half-way, each making some sort of compromise, resulting in an assimilation of the program into existing structures and practice. In still others, the system fully embraces the program and engages in a process of accommodation, making the changes that are necessary for it to become established and grow.

The strain that these programs put on the systems that adopt them begs the question: why did the National Science Foundation fund the development of these curricula in the first place? While we do not know for sure, we can speculate about some of the reasons behind the NSF decision to invest in creating these programs. For example, was the goal a "proof of concept," establishing that it is indeed possible to re-design the high school mathematics experience? This probably was one of the initial goals and one that the curricula have in fact achieved. However, once created, was the goal to achieve a national market share for these curricula? Or perhaps the goal was to achieve institutionalized and sustained implementation among a more limited group of schools and districts?

While an early goal may have been national market share, prior research conducted by Inverness Research indicates that this remains unlikely (St. John, et. al., 2000). The curricula are simply too cutting-edge and therefore, not aimed at attracting a large market share. And how about the less lofty goal of getting them institutionalized, i.e., adopted and sustained in a few places? Even this may be unrealistic in the present era of limited economic resources and high stakes accountability. Under stress, which

we know is high with these programs, there are strong pressures on the system to revert back to default state. The truth is, even when they succeed, these programs are still out in front of the rest of the math education field – one that is ever-changing and essentially unstable. Even traditional curricula are not sustained; every seven years a new book is adopted. Therefore, the belief that these curricula are going to be institutionalized and sustained over an extended period of time is probably not realistic.

Rather than judging these curricula by their staying power, we believe we need to re-conceptualize the goal of such innovative programs. Ultimately, these curricula are communicated via textbooks. Time passes, publication dates get stale, and districts face a new adoption cycle. As programs, they can not be expected to remain in place indefinitely. However, they can serve as vehicles by which schools and classroom experience profound change. Therefore, rather than institutionalization or sustainability, the goal should be to introduce a challenge that encourages growth – to provide impetus for building capacity beyond the status quo – to move people, schools, and districts beyond where they were prior to implementation.

The experience of documenting the COMPASS implementation stories further convinces us that the degree of success of the NSF-funded high school mathematics curricula should not be determined by the number of years that a particular program remains in place, but by the extent to which the process of implementing such an innovative curriculum may have actually altered the system –resulting in greater capacities to support teachers, to serve students, and to communicate with families than existed before. We would like to suggest that the difficult work required to implement one of these challenging programs leaves behind some legacies – small changes for lots of people and big changes for a few.

These legacies suggest to us that the COMPASS curricula, by stretching the field and enhancing the sophistication of the system, actually have the power to begin easing the gridlock of high school mathematics education. By contributing to the growth of individuals, classrooms, schools, and districts, they bolster the system's capacity. By seeing curriculum implementation as a means, rather than an end, we may be able to understand and evaluate the investment made in such curricula more accurately.

Also, we end these final thoughts by saying that implementation efforts such as the ones we studied here afford a unique research opportunity – namely, a chance to study the forces that limit the improvement of high school mathematics. The famed detective, Mike Hammer, once wrote that if you really want to understand how a machine works, you should throw a wrench into it and watch what happens. These curricula are very much like wrenches in the ongoing machine of high school mathematics teaching. What

is it about high school mathematics that makes it so reform-resistant? And what will it take to truly change the status quo? This project is a first step in understanding these questions and using an implementation effort to study the underlying dynamics that define the high school gridlock phenomenon. We hope that the work of those who attempt high fidelity implementation of the COMPASS curricula will continue to be studied and to help provide valuable lessons that can help us all better understand the high school gridlock. We strongly believe that the opportunities for applied research afforded by the implementation of these curricula should be seen and valued. For if nothing else, this study confirms the complexity and difficulty of engineering real improvement in the quality of instruction within our nation's schools.

APPENDIX A

Curriculum Development Summaries

- **Application Reform in Secondary Education (ARISE)**
  Mathematics: Modeling Our World (W.H. Freeman and Co.)

The ARISE project came out of the COMAP tradition. For more than two decades, COMAP has produced dozens of applications-based replacement units for mathematics teachers. The program produced through ARISE reflect these COMAP roots. It is a four-year curriculum with a strong focus on developing mathematical ideas through real-world contexts and problem solving.

- **Core-Plus Mathematics Project (CPMP)**
  Contemporary Mathematics in Context (Glencoe/McGraw-Hill)

The *Core-Plus* curriculum, also a four-year program, was developed at Western Michigan University in Kalamazoo. All four courses feature interwoven strands of algebra and functions, statistics and probability, geometry and trigonometry, and discrete mathematics that build upon the theme of *mathematics as sense-making*. *Core-Plus* wants schools and districts to have the training and support needed to successfully implement their curriculum. They offer regional Users Conferences for mathematics teachers as well as Leadership Conferences for administrators to learn more about the program and the issues surrounding implementation.

- **Interactive Mathematics Project (IMP)**
  Interactive Mathematics Program (Key Curriculum Press)

A committed group of California teachers and mathematics faculty from San Francisco State University took the lead in designing the 4-year *IMP* curriculum, playing an integral role in writing as well as testing the materials from start to finish. A defining feature of the *IMP* materials is the organization of each unit around a central problem of practical and mathematical consequence. Thoroughly addressing the complex problem requires students to make use of many mathematical ideas simultaneously. Another hallmark of *IMP* is the program's commitment to supporting teachers through professional development. There are 13 regional *IMP* centers in the US and Canada that together create a wide-reaching network of support for *IMP* teachers.

- **MATH Connections Project**
  MATH Connections: A Secondary Mathematics Core Curriculum
  (It's About Time Publishing)

The MATH Connections Project was the only one of the five curriculum development grants awarded to a group with a private sector affiliation, the Connecticut Business and Industry Association (CBIA) Education Foundation. The textbook series that resulted is a three-year program designed to be a core curriculum for all students. Each of the three years is organized around a general theme: Year One - Data, Numbers, and Patterns; Year Two - Shapes in Space, and Year Three - Mathematical Models.

- **Systemic Initiative for Montana Mathematics and Science Project (*SIMMS*)**
  Integrated Mathematics: A Modeling Approach Using Technology
  (Kendall/Hunt Publishing)

The *SIMMS* project began as part of the Montana State Systemic Initiative in 1991. The Montana Council of Teachers of Mathematics applied for the SSI and as a result, project leaders estimate that most high school math teachers who taught in Montana during the 1990s have been involved with *SIMMS* in some way. Among the five curriculum projects, *SIMMS* has a reputation for having the most extensive technology connections and applications. It is also the only set of materials that is divided into six different levels or courses that are multiple, four-year paths that students might take according to their success in the earlier courses and their post-secondary aspirations.

APPENDIX B

Data Collection

In selecting our five sites, each of the five COMPASS satellite directors was asked to create a short list of three to five schools and/or districts that they viewed as likely candidates for our research. We asked them to provide as diverse a list as possible and that they give us a brief summary of their reasons for nominating each site. The guidelines we gave satellite directors for creating their lists were as follows:

- Choose sites that were preferably in their third year of implementation
- Choose sites where the curriculum had been successful, but where the implementers had also encountered a particular issue (examples include: an unsupportive administrator, teacher resistance, or criticism from parents)
- Omit "best cases" or any early pilot sites that had been involved in field testing materials prior to publication
- Choose sites where the curriculum seemed likely to remain for the next two years

Once we had received a list from each satellite director, we began conducting preliminary interviews with contacts at the various sites in order to determine our final set of five – one for each of the five curriculum projects covering a wide range of contexts – including urban, rural, and suburban schools; low-income and high-income student populations; English language learners; low-achievers and high achievers. Our goal from the outset was to tell true and journalistic stories about the sites we studied, meaning that we would use the real names of the places we went and the people we met. We shared these intentions with our contacts at each of the sites before they agreed to participate in the study. Not one declined to participate for reasons of confidentiality. We also discussed with each contact our plans for data collection. Ideally, the documentation of each implementation story included the following research tasks:

- extensive and multiple interviews with the site contacts
- at least one interview with the curriculum satellite director recommending the site
- a site visit of one to two days involving a team of three researchers who worked individually to conduct the following activities:
    - multiple classroom observations at each implementation grade level
    - interviews and/or focus groups with teachers
    - interviews and/or focus groups with students
    - individual interview with the department chair
    - individual interview with the high school principal
    - individual interviews with district leaders (for example: Superintendent, Assistant Superintendent for Curriculum and Instruction, Math Supervisor, and so on)
- review of documents (for example: district website, course catalogues, school and district mission statements, math department teaching schedules, course

enrollment data, student test scores, etc.) before, during, and after the site visit
- follow-up telephone interviews with site contact after six months to one year

While the specifics of the data collection varied somewhat from one location to the next, mostly due to the different sizes of the schools and districts, all of the core tasks listed above were completed for each of the sites.

REFERENCES

ARC Center. (2002). *The ARC Center Tri-State Achievement Study.* Lexington, MA: COMAP.

Ball, D.L., & Cohen, D.K. (1996). Reform by the book: What it is – or might be – the role of curricular materials in learning and instructional reform? *Educational Researcher*, 25(9), pp. 6-8.

Dewey, J. (1926). *Democracy and education.* New York: MacMillan.

Dewey, J. (1929). *The quest for certainty.* New York: MacMillan.

Ferrini-Mundy, J., Graham, K., Johnson, L., Mills, G. (Eds.). (1998). *Making change in mathematics education: Learning from the field.* Reston, VA: National Council of Teachers of Mathematics.

Fullan, M. (2001). *Leading in a culture of change.* San Francisco, CA: Jossey-Bass.

Hiebert, J., Carpenter, T.P., Fennema, E., Fuson, K., Human, P., Murray, H., Oliver, A., and Wearne, D. Problem solving as a basis for reform in curriculum and instruction: The case of mathematics. *Educational Researcher, 25*(4), 12-21.

Husen, T. (1967). *International study of achievement in mathematics.* New York: Wiley Press.

McKnight, C.C., Crosswhite, F.J., Dossey, J.A., Kifer, E., Swafford, J.O., Travers, K.J., and Cooney, T.J. (1987). *The underachieving curriculum: Assessing U.S. school mathematics from an international perspective.* Champaign, IL: Stipes.

McLaughlin, M.W., & Talbert, J.E. (2001). *Professional communities and the work of high school teaching.* Chicago, IL: The University of Chicago Press.

National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1994). *Voices of change in mathematics education.* Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education.* Washington, DC: National Academy Press.

Reys, R.E. (2001). Curricular controversy in the math wars: A battle without winners. *Phi Delta Kappan*, (83)3, 255-258.

Schmidt, W.H., McKnight, C.C., & Raizen, S.A. (1997). *A splintered vision: An investigation of US science and mathematics education, Executive summary.* Norwell, MA: Kluwer Academic Publishers.

Secada, W.G., Fennema, E. & Adajian, L.B. (Eds.). (1995). *New directions for equity in mathematics education.* New York: Cambridge University Press.

Stigler, J.W. and Hiebert, J. (1999). *The teaching gap.* New York, NY: The Free Press.

St. John, H.M., Fuller, K.A., Houghton, N., Huntwork, D., & Tambe, P. (2000). *High School Mathematics Curricular Decision-Making: A National Study Of How Schools And Districts Select And Implement New Curricula.* Inverness, CA: Inverness Research Associates.

Trafton, P.R., Reys, B.J., & Wasman, D.G. (2001). Standards-based mathematics curricular materials: A phrase in search of a definition. *Phi Delta Kappan,* 83(3), pp. 259-264.

Valverde, G.A., Bianchi, L.J., Wolfe, R.G., Schmidt, W.H., & Houang, R.T. (2002). *According to the book: Using TIMSS to investigate the translation of policy to practice through the world of textbooks.* Hingham, MA: Kluwer Academic Publishers.

Weiss, I.R., Pasley, J.D., Smith, P.S., Banilower, E.R., Heck, D.J. (2003). *Looking inside the classroom: A study of K-12 mathematics and science education in the United States.* Chapel Hill, NC: Horizon Research.

Welch, W. (1978) Science education in Urbanville: A case study. *Case studies in Science education.* Urbana, IL: University of Illinois.