— INTRODUCTION —

WEATHERING THE STORM

ADOPTING STANDARDS-BASED MATHEMATICS IN UNCERTAIN TIMES

"What we call the beginning is often the end. And to make an end is to make a beginning. The end is where we start from."

T.S. Eliot

SAN DIEGO EPIPHANY

While waiting in San Diego to catch her plane home after a mathematics conference, a Minnesota math teacher watched the news on the television at her gate. The newscaster was reporting on California's state board of education's decision to return to "the basics" for teaching mathematics in public schools[1]. As she and her companion discussed the story it became clear to them that facts were "all mixed up" and that the story was filled with misinformation about the nature of standards-based mathematics.

Later, in May 1997, as high school juniors and seniors were arriving for their Prom, the math teacher approached me about her district's recently adopted standards-based math curriculum. Amid the flowers, music, formals and tuxedos, she recalled her trip to San Diego and said, "I came back from that trip realizing the fact that people's beliefs about math are not all the same. I saw what happened in California and it was clear that the same thing could happen here." This math teacher wanted to be sure to have parent support from the beginning of the district's mathematics pilot. She said in retrospect, "In California the districts did not communicate well; they did not communicate at all. The papers were full of misleading stories and facts taken out of context, and so I knew we needed to be proactive if we wanted to get anywhere with the curriculum here."

With the support of SciMath[MN], she asked me to bring my firm's communications background together with the district leadership's knowledge. The goal was to create a thoughtful process for involving parents and community members with the new curriculum. Her hope was to help the community understand the reasons the math curriculum needed to change, and share with them the potential of standard-based mathematics education. During the summer and fall, we assembled a small, representative group of advisors to work out a plan that the math committee then followed. From right after Labor Day through the middle of November, the district math teachers provided nine different opportunities to meet with parents and community members, involve them with the curriculum, listen to and answer questions. By the time eighth grade students were selecting their high school math courses in January, over 95% of incoming freshmen and their parents elected the new standards-based option over the traditional curriculum.

Not unlike the weather, schools are dynamic systems subject to the competing forces within which they operate. This is especially true in today's educational climate dominated as it is by the language of standards and accountability. The storminess that currently surrounds public schools results from a struggle between the assumptions of one educational era and the emerging expectations of another. Turmoil experienced by school leaders reflects the current state of transition— from a system focused on institutional education to one focused on student learning—and is felt at every level of the American political and educational systems (Elmore, 2000; Marshall, R. and Tucker, M., 1993).

While school districts across the country wrestle with implementing their respective state standards, the risks leadership confronts in today's often inclement educational climate can be most clearly seen in the debates about mathematics that have erupted on evening news reports and newspaper front pages. As public and political debate churns with sometimes irrational rhetoric, school leaders who are directly accountable for student achievement embark on the difficult task of bringing classroom instruction in line with the changing needs of students who will live and work in an interdependent, complex world (Battista, M., 1999; Becker, J. and Jacob, B., 2000; Mathews, D., 1996; Moses, R. and Cobb, C., 2001)[2]. Yet, as the math teacher's epiphany in the opening story indicates, this will be no small task. In the realm of mathematics education, early ventures along the journey to the adoption and implementation of standards-based curriculum materials have spawned confrontations that reveal with great specificity the larger discourse on education reform.

"…research evidence [that] is consistent and compelling concerns weaknesses in mathematical performance of U.S. students. State, national, and international assessments conducted over the past 30 years indicate that although U.S. students may not fare badly when asked to perform straightforward computational procedures, they tend to have a limited understanding of basic mathematical concepts.… In comparison with the curricula of countries achieving well on international comparisons, the U.S. elementary and middle school mathematics curriculum has been characterized as shallow, undemanding, and diffuse in content coverage."

Kilpatrick, J., Swafford, J., Findell, B. (Eds.) 2001, Adding it up, p. 3-4.

WISDOM WITHIN A DYNAMIC WORLD

PURPOSE AND CONTEXT

The purpose of this paper is not to review the merits of various views in the mathematics education debate, but to share insights from those who have adopted standards-based mathematics curriculum materials in harmony with the National Council of Teachers of Mathematics' (NCTM's) P*rinciples and Standards for School Mathematics (2000)* and Minnesota's Graduation Standards. Standards-based mathematics expects that *all* graduating students will have covered the equivalent of algebra II and geometry, and will have coursework in statistics-and-probability as well as discrete mathematics. As more and more districts across Minnesota and the country adopt these

new curriculum materials, there is practical value in learning from those who have already begun the journey along the bumpy road to implementation. SciMath[MN]'s interest in the study reflects its support for Minnesota's Graduation Standards through a comprehensive program of research, tools, technical assistance, teacher education and leadership, evaluation and communication. "Our goal is to provide vital support for standards, assessment and accountability, toward the goal of improved student learning and system reform" (SciMath[MN] Annual Report, 2000).

• **CHANGING TIMES, CHANGING NEEDS** The reasons to change the way mathematics is taught come down to increasing mathematical proficiency of all young people as they move into a world complicated by technology. Besides solving everyday problems of living and preparing for work and professional life in a knowledge driven era, children today will be expected to make important civic decisions that will require them to understand and interpret sophisticated data. Though national and state measures show Minnesota students performing well in mathematics, international tests suggest there is room for improvement. Not only do students lose ground as they proceed through school, but eighth grade coursework is less rigorous than in other industrial nations (SciMath[MN], *Minnesota K-12 Mathematics Frameworks,* 1998). Critics find the U.S. educational system out of sync with the economic needs today where 85% of all jobs will require two years of post secondary technical training and/or four years of higher education. Contrasting the U.S. method of mass producing low-skilled workers with Japan, Germany, Sweden, Singapore and other countries where education is linked to economic policy and a single integrated strategy, the critics recommend more stringent educational standards and improved teacher salaries (Bureau of Labor Statistics, 1991; Marshall, R., and Tucker, M., 1993; NRC (National Research Council), *Global Perspectives*, 1999; Schoen, H., Fey, F., Hirsch, C., Coxford, A., 1999).

• **RESEARCH ON LEARNING AND UNDERLYING BELIEFS** Current research on learning underlines the necessity of changing classroom practice to reflect new knowledge that children learn best when they are actively engaged, when their studies are connected to what they already know, and where they make sense of fundamental concepts that they can explain to others. Assumptions underpinning standards-based mathematics curricula include: the belief that all students can learn challenging mathematics and deserve the opportunity to do so; that mathematics standards align curriculum, instruction and assessment providing focus and coherence to K-12 instruction; and that learning mathematics is both a collaborative and active process that utilizes technology as a necessary tool (SciMath[MN], *Minnesota K-12 Mathematics*

"Achievement data indicate that the traditional teaching approaches are deficient and can be improved. It is curious that the current debate about the future of mathematics education in this country often is treated as a comparison between the traditional 'proven' approaches and the new 'experimental' approaches.... Presuming that traditional approaches have proven to be successful is ignoring the largest data base we have. The evidence indicates that the traditional curriculum and instructional methods in the United States are not serving our students well. The long-running experiment we have been conducting with traditional methods shows serious deficiencies and we should attend carefully to the research findings that are accumulating regarding alternative programs."

HIEBERT, J., 1999, RELATIONSHIP BETWEEN RESEARCH AND THE NCTM STANDARDS, P. 12.

Algebra, "once solely in place as gatekeeper for higher math and the priesthood who gained access to it, now is the gatekeeper for citizenship; and people who don't have it are like people who couldn't read and write in the Industrial Age."

ROBERT MOSES, 2000, RADICAL EQUATIONS, MATH LITERACY AND CIVIL RIGHTS

Framework, 1998; Kilpatrick, J., et al. (Eds.) 2001). Research confirms that "students learn what they have an opportunity to learn," which makes access to challenging mathematics a priority for all children. Until recently students have been taught simple calculation, mathematics terms and procedures, and that is what they learned. They are, however, unable to transfer what they have learned and cannot solve multi-step problems (Kilpatrick, J. et al. (Eds.) 2001). Because access to challenging mathematics opens the door to economic opportunity, educators and leaders question the practice of tracking children since it jeopardizes their opportunities. Robert Moses (2000) argues, "the most urgent social issue affecting poor people and people of color is economic access. In today's world, economic access and full citizenship depend crucially on math and science literacy." While many urban children lag behind their white counterparts for a variety of reasons, there is evidence that significant improved achievement in these populations results from access to a challenging course of study (Bracey, G., 1998; Roy Wilkins Center for Human Relation and Social Justice, 2000; Thompson, S., 2001).

STUDY FOCUS

The combined experience represented in this case study of four Minnesota school districts, who were early adopters of standards-based mathematics curricula, has both practical and theoretical value. It is not a comparison among district strategies, but a compilation of their experience as they reflect on the events related to their local adoption process. On the practical side, the lessons gleaned from participant accounts represent common patterns found in the way district leaders described what they learned as they moved along their own adoption and implementation journeys. The study asks, *What did these leaders learn during their implementations? How do they suggest other districts attend to the work of improving student achievement in mathematics amid a political storm that clouds and even distorts the issues?*

On a more theoretical note, though the report is organized by stages in the adoption/implementation process, it does not see these as separate steps. Rather, given the unique situations each district faced, the report suggests that leadership's role in improving student learning involves an ever widening engagement with the "publics"who make up their district education system—parents, teachers, and community leaders. At every stage of their mathematics adoptions, and with each of these interest groups, district leadership found new challenges and some surprises. In the paradoxes of each situation, the possibilities for resolving the contradictions became apparent by examining leadership in the context of learning itself:

• **RECONCILING COMMON SENSE EXPECTATIONS FOR STUDENT MATHEMATICS EDUCATION WITH LOYALTY TO FAILING TRADITIONAL MODELS** In the first section of this study district leaders report examining the climate found in their respective communities. They assembled representative school and community members to help frame criteria that would move the decision about which mathematics curriculum materials to adopt. While districts reported varying levels of parent/community participation on their math curriculum committees, parents' hopes for their children's mathematics classes bore remarkable resemblance to current descriptions of mathematical proficiency (see sidebar, Kilpatrick, J. et al, 2001). From study participants' collective experience it appears that attention to an authentic process was critical to long term success and that, through well framed questions, their leadership offered legitimate channels for collective decision making (Capra, F. 1996; Deal, T., and Peterson, K., 1999; Heifetz, 1994; Mathews, D., 1996).

The failure of a traditional model has been well documented[3]. Research indicates that students' mathematical knowledge under traditional instruction is both fragile and fleeting. As Hiebert (1999) writes, the traditional approach to solving problems is to teach students a procedure and then assign problems to practice the procedure. Problems are seen merely as applications of already mastered procedures. "The best evidence suggests that if students have memorized procedures and practiced them a lot, it is difficult for them to go back and understand them later"(p.14-15). Traditional methods lack understanding of both the essence of mathematics and the research on how students learn. Alternatively, standards-based models are based on the theory that procedures can be learned *as* students solve problems. They build directly on the skills and knowledge students bring, provide situations where students both invent and practice problem solving, and they ask students to explain their solutions. (Battista, M., 1999; Hiebert, J., 1999; SciMath[MN], *Minnesota K-12 Mathematics Framework*, 1998; NCTM, 2000).

• **ADJUSTING LONG HELD NORMS OF TEACHER-CULTURE TO NEW DEMANDS FOR STUDENT ACHIEVEMENT AND ACCOUNTABILITY** Part two shows that, from district to district, there were different levels of teacher-readiness regarding national and state standards. In addition, openness to new curriculum materials among staff varied by age, gender and grade level[4]. The importance of understanding the role of local cultural norms along with examination of best practices paved the way for some districts to win teacher support for standards-based mathematics (Elmore, R., 2000, Stigler, J. and Hiebert, J., 1998). Attention to professional development refocused teacher attention on their professional responsibility to student learning (Darling-Hammond, L., 1997; Loucks-Horsley, S., Hewson, P., Love, N., Stiles, K., 1998).

"The problem is no longer so much teaching better mathematics as it is teaching mathematics better....The trouble with [the competing] claims is not so much that one is true and the other false; it is that both are incomplete. They fail to capture the complexity of mathematics, of learning and of teaching."

"MATHEMATICAL PROFICIENCY as we see it has five strands:

- *CONCEPTUAL UNDERSTANDING*—comprehension of mathematical concepts, operation and relations
- *PROCEDURAL FLUENCY*—skill in carrying out procedures flexibly, accurately, efficiently and appropriately
- *STRATEGIC COMPETENCE*—ability to formulate, represent, and solve mathematical problems
- *ADAPTIVE REASONING*—capacity for logical thought, reflection, explanation, and justification
- *PRODUCTIVE DISPOSITIONS*—habitual inclination to see mathematics as sensible, useful and worthwhile, coupled with a belief in diligence and one's own efficacy."

KILPATRICK, J., SWAFFORD, J., FINDELL, B. (EDS.) 2001, ADDING IT UP, P. IX.

Learning is basically sense making. Through an interplay of experience, memory and imagination, human beings create a picture of how the world works. Learning is not a passive activity, but the active process of interpreting information and constructing knowledge (National Research Council, 2000; Langer, S., 1942; Dewey, J., 1935; Bruner, J., 1990). As opposed to simply giving back information, knowledge creation involves higher levels of thinking characterized as "scientific constructivism"—a well researched theory that describes fundamental mental processes such as abstraction (the ability to select, coordinate, combine and record in memory), and reflection (the ability to consciously replay facets of experience and employ them in subsequent abstractions and reflections). In the context of mathematics education, what we gain from this theory is a picture of mathematical learning that becomes meaningful as individuals move through phases of action, reflection and abstraction "in a way that enables them to integrate related abstractions into ever more sophisticated mental models" (Battista, M., 1999, p. 429).

• **CREATING A COHERENT INSTRUCTIONAL LEADERSHIP MODEL FOR INCREASINGLY COMPLEX SCHOOLS AND INVOLVED PARENTS** The third section describes how principals handled the ambiguity of transition by recasting their relationship with teachers and parents. Given the multiple demands on today's schools, principals used strategies that realigned their leadership roles with new instructional expectations and that included parents' need to understand and help their children with the new curriculum. Holding all to the agreed upon goals, principals oriented staff and parents toward student mathematical proficiency in multiple efforts to strengthen relationships that support student learning and so reduce the stress of transition.

In dynamic systems the role of leadership looks less and less like the authoritarian visionary model from simpler times. Given the uncertainty today's educational leaders face, an adaptive model of leadership holds greater promise. The adaptive leader helps people face current challenges in light of their beliefs; the work is less about decision making and more about bringing forward the right questions (Heifetz, 1994, p. 276). To put a sharper edge on it, Drath and Palus (1994) describe leadership in terms of sense-making: "Whenever people are doing something together for any period of time extended enough to form a community, we can usefully think of the striving to make things make sense, to create meaning out of that experience, as the process of leadership" (p. 25). Aspects of this adaptive, meaning-making model of leadership are present in the recommendations offered by those who participated in this

study, even as they describe the "white water" conditions within which they worked (Briggs, J. and Peat, F.D., 1999; Stacey, R., 1992; Vaill, P., 1991).

• ALIGNING COMPETING DEMANDS FROM COMMUNITY LEADERS, LEGISLATORS AND PARENTS WITH A COMMON VISION FOR STUDENT LEARNING Finally, in the fourth section, district leaders describe an alignment of community understanding with the district goals and beliefs that grew out of multiple conversations with local leaders and parents about mathematics instruction. In addition, districts used policy requirements to implement Minnesota Graduation Standards as an impetus to focus limited resources and energy in a reexamination of student learning. The standards-based mathematics curriculum materials they chose modeled instructional methods that increased understanding of standards-based learning across multiple disciplines. At a time when public education is challenged on multiple fronts, support from a districts' various publics takes on added urgency. School leaders need to engage the whole system in a focused effort on student learning.

Authentic standards aim at systemically deepening teaching and learning and, as a reform strategy, are fundamentally concerned with issues of access[5]. Based on years of research into the nature of learning, authentic standards policies hold high expectations for all students and provide substantial support to learners, teachers and schools. Because large numbers of children today do not receive a quality education, the issues of providing all students with high levels of instruction are less about economics and more about moral responsibility and the long term consequences for society and democracy. The challenge of standards is to translate the successes seen in a few innovative programs into a widespread national norm. To do that there needs to be specific improvement in the calibre of instructional content and professional practice. But that improvement cannot occur unless school systems and policy makers focus their energy and resources on education's central concern — improving instruction in order to improve learning for every student. Authentic standards require a school governance organized around a public accountability model that assesses student performance with a variety of tools (Elmore, R., 2000; Darling Hammond, L., 1997; Thompson, S., 2001).

"It is the combination of test-based reform in the name of standards, and the wholesale backlash that such practice provokes, that is placing the authentic standards movement in peril. Not only in the general media, but also in specialized education media, one can see that the world between proponents and opponents of high-stakes testing tends to define the entire standards movement in such a way that its actual nature and potential, which some school districts are beginning to demonstrate, gets buried under an avalanche of rhetoric."

THOMPSON, S., 2001, *AUTHENTIC STANDARDS MOVEMENTS AND ITS EVIL TWIN*, KAPPAN, P. 359.

UNCERTAIN TIMES

CONDUCT OF THE STUDY

Typical of qualitative research, this case study emerged from earlier work. In some sense its beginning coincided with documenting the 1997 communications plan prepared in cooperation with one school district and that resulted in SciMath^{MN}'s

Math Makes Sense (1998)[6], an overview for parents and community members of the influences and benefits of standards-based mathematics. From additional documentation of community outreach efforts on behalf of standards-based mathematics, it became evident that learning from school districts in the midst of adopting new curriculum materials for mathematics would be helpful in understanding *What makes these adoptions different? What strategies contribute to a successful implementation?* and *What obstacles stand in the way?* To answer these questions, in the spring of 2000 leaders from four Minnesota school districts were invited to share their insights as they reflected on their own process.

The participating districts differed in size, structure and geography and, though all were early adopters of the new materials, they were at varying stages of their respective implementations. The two largest districts implemented a standards-based mathematics program in grades 6-12 first, and two years later, began the implementation in grades K-5. One of the smaller districts was struggling with declining enrollment while the other was growing rapidly. Eight leaders from district centers (including five superintendents and curriculum directors), seven principals, and ten teachers were interviewed. Combined with comments from parents and community members taken during observations of parent math nights and curriculum advisory council meetings, the study participants paint a multi-faceted image of the complex, interdependent influence beliefs about the nature of learning and the meaning of mathematics have on decisions. Besides the cross validation implied through comparing the experience of various districts and the perspectives within these districts, this report has been submitted for both participant and peer review.

"'Living in truth' is the simple (though not always easily achieved) course of opening ourselves up to uncertainty, discovering the edge between our individuality and the universal, and acting from that discovery. This is the real power of the powerless."

Briggs and Peat, 1999, Seven Life Lessons of Chaos, p. 44.

AUDIENCE AND ASSUMPTIONS

This report is intended for anyone who plays a central role in shaping the original mathematics adoption process, and then those who lead the study and research, the actual adoption, the staff development and the implementation phases of the process. The case study is intended to spark discussion around the organizing concepts that connect leadership and learning: What makes an authentic process? How do districts increase teacher capacity? What does building leadership look like today? and How does systemic change occur in practical, everyday circumstances? The case study examines our assumption that support for standards-based mathematics programs depends less on the curriculum materials chosen, and more on how they are chosen, how implemented, how supported and how communicated within the system. In the end, because the

curriculum exists within the system, implementation of standards-based mathematics reveal the faults within the system itself.

The account that follows represents the collective wisdom of all four participating districts. Again, it is not a comparison among district strategies, but a compilation of their experience. Besides the rhetorical storm featured in media outlets, leaders reported facing a variety of other challenges at every level of the system. While participant responses to the challenges they encountered have practical value to other school leaders, they also shed light on the emerging contours of school leadership today. In their commitment to implementing standards-based mathematics, participants in this study supported national and state standards for mathematics education. Minnesota's Graduation Standards, while fraught with its own implementation struggles, represents the ideals of authentic standards and provided the necessary impetus for several districts to bring standards-based mathematics into their classrooms. Their work moved them into the realms of adaptive leadership.

Winning support for ambitious educational goals has proven to require more than technical know-how from Minnesota's school leaders. As living, complex organizations, schools, like other dynamic systems, are subject to the principles of change and require leaders with adaptive skills. School leaders who successfully bring their districts forward are able to create arenas where all stakeholders examine their thinking about education in light of the changing needs of children and society. Because beliefs about learning and the meaning of mathematics lie at the heart of any standards-based mathematics adoption, implementation of these new curriculum materials require district leaders to engage various publics at the point where their interests naturally intersect with the work of schools, and to do so on multiple occasions. The following pages describe what this engagement means and the time and effort required to weather the storm surrounding the way we teach and how our children learn mathematics.

While technical leadership involves the routine work many associate with management, an adaptive leader "has to engage people in facing the challenge, adjusting their values, changing perspectives and developing new habits of behavior....The adaptive demands of our society requires leadership that takes responsibility without waiting for revelation or request. One may lead, perhaps with no more than a question in hand."

Heifetz, R., 1994, Leadership Without Easy Answers, p. 276.

END NOTES: WEATHERING THE STORM

1. The article, *The Politics of California Mathematics: The Anti-Reform of 1997-1999* (Becker, J. and Jacob, W., 2000), gives readers a detailed account of a campaign to associate low scores in mathematics with standards-based curriculum materials. The authors note that not only did the argument "ignore the compelling evidence that drill-and-practice classrooms have short-changed students for decades....for the most part, today's students with unacceptable scores have *not* experienced the reformed mathematics curriculum materials. In California, the claim that the 1992 framework had failed its elementary students was widespread by early 1995, in spite of the fact that the curriculum materials aligned with the frameworks would not be available to teachers until the fall of that same year." The authors reported that concerns about the "failed reform" led legislators to reverse themselves and adopt a back-to-basics instructional model similar to the one that had failed students in the past.

2. The book *Thinking for a Living; Education and the Wealth of Nations* (1993) provides a well researched account of emergence of the Carnegie credit system of education tat the beginning of the century a system designed to produce low-skilled workers for the nation's emerging factory economy . The authors address the mismatch between an education system designed for another era and the need today for an integrated learning system that prepares all students for increasingly complex work environments and civic responsibilities.

3. In testimony to Minnesota's House Education Policy Committee on January 23, 2001, prepared by Linda Baer, Chancellor of Academic Affairs, MNSCU, and Joanne Mckay, Dean of the College of Education, St. Cloud State University, the two academic executives reported that in 1999 only 17.9% of freshmen were judged ready to start college level mathematics (college algebra and above) in the community colleges, and only 37.8 % in the MNSCU university system. Data from the University of Minnesota 2000-2001 Course Summary from February 27, 2001, indicates that of 7,003 freshmen enrolled, 872 are enrolled in no-credit math courses in the General College, and 3,246 are enrolled in math below the level of calculus in IT.

4. In a 1998 survey of teachers, Minnesota Council of Teachers of Mathematics (MCTM) learned that elementary teachers appear to be more supportive of reform efforts and to have a more positive outlook on Minnesota's Graduation Standards than their secondary counterparts. In the Twin Cities metro area, the need and support for reform was higher than elsewhere (p. 4).

5. Scott Thompson's (2001) article draws a distinction between "test based" standards (otherwise known as high stakes testing), and "authentic standards" which are fundamentally concerned with access to challenging learning opportunities. Authentic standards reject the sorting typical in factory-style education, and insist that all students be held to high expectations, and receive the same high levels of support. The confusion caused by two such opposite approaches to student learning are confounded by calling both systems "standards." Minnesota's Graduation Standards embody authentic standards as described in this article and as represented by NCTM's *Principles and Standards for School Mathematics (2000).*

6. SciMath^{MN} has a number of helpful resources available for districts in the planning and or implementation stages of adopting standards-based curriculum materials. See their web site: www.scimathmn.org.