

# Introduction

## Linking Research and Practice in Mathematics Education

Over the past two decades, numerous initiatives have encouraged partnerships among researchers and mathematics education professionals (e.g., teachers, specialists, math coordinators, and so on). The National Council of Teachers of Mathematics (NCTM) has recently implemented a strategically focused initiative on linking research and practice (Heid et al. 2006). Many of these types of initiatives and related position papers aim to develop coherent, interdependent, research-and-practice strategies. What forms have these research-and-practice activities taken? What lessons have been learned from these collaborations? This volume examines both these questions.

Examining these questions first requires recounting some history. The annals of research have traditionally linked with efforts to understand better the quality factors associated with curriculum, instruction, and learning conditions. The story of the research enterprise in the field of mathematics education, however—particularly concerning building bridges to the school leadership and educational policy communities—can be described as *evolving*. In fact, mathematics education's focuses as a field were, for many years, very specified and largely decoupled: some scholars focused on learning, whereas others examined teaching or curriculum. However, practitioners have to negotiate multiple influences on students' mathematical proficiencies. In contrast, Romberg and Carpenter (1986) argued the need in mathematics education for a combined, synthesized concept of two distinct areas of research—research on teaching and research on learning. Their review implied that separating these two areas works against establishing a well-informed understanding of the developmental processes associated with mathematical competency.

Research on learning suggests that the cognitive demand of mathematical tasks links to students' understandings and skills. It follows that the aim to support learning associates with curriculum choices and teachers' action. Mathematical tasks are embedded in instructional materials that link to curriculum management tools. These tools are interpreted and implemented to varying degrees by teachers who have a range of talents and understandings. Research on teaching, however, indicates that teachers with high expectations, who provide help and support, positively influence students' outcomes. High expectations include furnishing developmentally

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appropriate and cognitively demanding mathematical tasks. The interdependence among teaching, learning, and curriculum as part of the design of an effective instructional regime appears greatly significant to aims to link research and practice. Yet, recognizing that significance is only one step in the strategy to create the link.

A basic understanding of the school environment suggests that school leaders are central to the design, maintenance, and improvement of instructional practice. Rowan (1995) called for a research agenda that linked learning, teaching, and educational administration. In his opinion, this bridge would address a criticism of research on educational administration—more specifically, that scholarship in the field of educational administration has failed to address issues of teaching and learning in schools. Although he directed his message largely to colleagues in educational administration, he could have as easily aimed it at the mathematics education community. Mathematics education's idea of a robust research-and-development effort that examines important links among teaching, learning, and leadership was underdeveloped. Fortunately, this void in the literature has not been ignored. Stein and Nelson (2003) argued that leadership content knowledge is a missing paradigm in education research. They described leadership content knowledge as a knowledge of school subjects (e.g., mathematics) and of how students learn the content. Stein and Nelson's analysis implicitly stated that leaders require a sound understanding of teaching, learning, curriculum, and other factors influencing students' skill development and understanding. A National Research Council report (Elmore and Rothman 1999, p. 3) made this argument explicitly:

The theory of action behind an education improvement system relies on information and responsibility. Everyone in the system—students, parents, teachers, administrators, and policy makers at every level—needs high-quality information about the quality of instruction and student performance. At the same time, everyone needs to be responsible for fulfilling his or her role improving results. The key is transparency: everyone should know what is expected, what they will be measured on, and what results imply for what they should do next.

This report focused largely on building accountability and assessment systems to support standards-based reform. Henig and colleagues (1999) warned that many accountability models almost exclusively rely on test scores, mechanically, to identify successful and unsuccessful schools. They noted that this approach encourages centralized authorities to design and implement reforms but does little to make those reforms work. We submit that important parts of a system's capacity are (1) developing sustained engagement among school professionals, researchers, and policymakers and (2) making crucial factors influencing students' outcomes in mathematics central to the collaborative process. Focusing strictly on students' outcomes is not enough. Understanding, and intervening on, factors that influence students' understanding and skills in mathematics are vitally important, too. One strategy for intervening is to bridge the research-and-practice divide by forming alliances that include both scholars and practitioners. This kind of alliance has great potential, but it also has a problem; no grand theories or how-to books focus on building sustained, research-based practice in mathematics on a scale that would make a difference. Enter the colleagues who were invited to participate in this book.

The chapters in this book offer (1) insights into the role research can play in supporting and improving school mathematics and (2) specific examples of that role, while raising questions that are valuable for the mathematics education community. NCTM has sponsored the develop-

ment of two handbooks aimed to serve the research community. We do not intend to replicate these two documents. Instead, our goals are (1) to illustrate where strategic partnerships have linked research findings to the design of practice and programmatic endeavors and (2), in many instances, to illustrate generating evidence to guide both educational decision making and routines modification related to school mathematics.

Beginning with James P. Spillane, several authors in this volume examine how research can influence practice, policy, and leadership in mathematics teaching and learning. Like the other authors of the first five chapters, Spillane demonstrates how tool development is an important aspect of the research-and-practice integration process. Drawing on theoretical and empirical research in distributed cognition and sociocultural activity theory, he describes a hypotheses-generating research-and-development (R & D) effort. That effort is part of the Distributed Leadership Studies (DLS), where knowledge of the *how* of leading and managing is driving the R & D program. Spillane states the four major components of DLS: (1) designing and validating research or diagnostic instruments for gathering policy relevant data, (2) analyzing leadership and management arrangements in schools, (3) engaging district policymakers and school practitioners with research findings related to their own schools, and (4) designing curriculum modules that engage school personnel distributively in diagnosis and design. Three examples of DLS collaborations illustrate the resulting research-to-practice interactions.

In chapter 2, “Surveys of Enacted Curriculum and the Council of Chief State School Officers Collaborative,” Andrew Porter and Jennifer McMaken explain the value of the Surveys of Enacted Curriculum as a part of a practical, reliable reporting tool focused on instructional practice and content being taught in classrooms. The chapter describes a collaboration among the Wisconsin Center for Educational Research, the Council of Chief State School Officers, state education agencies, and service provider organizations. This collaboration helps state agencies and local school districts implement data-collection procedures and reporting tools that generate evidence on how instructional practice and content align with required mathematics standards and assessments of students’ learning. The collaboration also provides professional development to state and local educators on uses of enacted curriculum data as part of decision making in instructional improvement.

In chapter 3, “The Role of Tools in Bridging Research and Practice in an Instructional Improvement Effort,” Mary Kay Stein, Jennifer Russell, and Margaret Schwann Smith depict a collaborative project involving university-based researchers and a grades 6–10 public school. The project examined the role of technology-enhanced lesson planning in guiding schoolwide improvement. They argue that school districts will not realize the promise of tools as supports for large-scale, research-based improvement without proper attention to teachers’ learning and organizational reinforcement. They define tools as artifacts (e.g., curriculum materials, computer-based programs, observation protocols, and rubrics) that apply insights from scholarship directly and readily to practice. The authors describe how tools can be embedded in a project-based research effort, where insights generated from the collaboration both influence the research literature and link to teachers’ planning, enactment, and reflection. Also, they demonstrate how to align lesson-planning routines with the work of school leadership. The preliminary findings from this project are promising.

In chapter 4, “Building Bridges between Research and the Worlds of Policy and Practice:

Lessons Learned from PROM/SE,” William H. Schmidt paints a picture of how reports consisting of modified instrumentation from the Third International Mathematics and Science Study supported the development of capacity-building activities and intervention design. The chapter looks into how research guided policy decisions at various levels of the educational system—school, district, and state. Schmidt voices a warning common throughout the volume: he argues that the collaboration level required to generate meaningful research-and-practice exchanges is difficult when resistance threatens the process. He offers several important lessons learned from collaborations with scores of school districts.

In chapter 5, “Teachers’ Use of Standards-Based Instructional Materials: Partnering to Research Urban Mathematics Education Reform,” Karen D. King passes on lessons that emerged from a project designed to study how middle grades teachers use standards-based mathematics instructional materials in a reform effort in an urban school district. Like the authors of the first four chapters, King is intent on discovering the nature and quality of the instructional realities that teachers encounter in implementing the materials. In studying survey results, including information gleaned from the Surveys of Enacted Curriculum (see Porter and McMaken 2010); she found that teachers’ actions diverged significantly from those the district envisioned and articulated in the curriculum pacing guide. The chapter concludes with observations and cautions for those interested in research, policy, and practice concerning collaborations.

In chapter 6, “Examining What We Know for Sure: Tracking in Middle Grades Mathematics,” Lee V. Stiff, Janet L. Johnson, and Patrick Akos recount research findings from an effort to document the influence of curriculum differentiation practices and policies on opportunity to learn and students’ related outcomes. The authors used a variety of methodological approaches and data sources to guide a partnership of counselors, mathematics teachers, and administrators. The findings reflect unintended consequences of existing placement policy and educators’ decision making. The implications for traditionally underserved students are significant.

In chapter 7, “Mathematics Education, Language Policy, and English Language Learners,” Marta Civil looks closely into the complex world of language ideology and the opportunity to learn mathematics. She uses evidence gathered by the Center for the Mathematics Education of Latinos/as (CEMELA). Relying on sociocultural approaches and qualitative data, Civil explores mathematics placement policy and parents’ perceptions of their children’s mathematics education. Civil also describes classroom conversations between teachers and students, which offer a glimpse into the intricate relationship between language and mathematics learning. Guided by her research, Civil posits that Arizona’s language policy has in some instances negatively influenced mathematics discourse and learning. She recommends a better integration of research, policy, and practice to deal with that negative influence.

In chapter 8, “Elementary Mathematics Specialists: A Merger of Policy, Practice, and Research,” Patricia F. Campbell communicates details about a Virginia collaborative project involving four universities and five school districts organized to develop coursework with two aims. The first aim was to produce an integrated academic experience where mathematics content and pedagogical content knowledge were central to the coursework pathway. The second aim was to develop a coherent leadership-coaching experience where the courses shaped the participants’ (e.g., in-service teachers) understanding of current research on mathematics teaching and learning and supported their growth as change agents or coaches. In tandem, the proj-

ect's aims were part of a concerted human capital development strategy focused on the production of elementary mathematics specialists charged to support the improvement of mathematics teaching and learning in school settings. Research was a part of the collaborative's core activities. For example, the coursework development process relied on fundamental understandings gleaned from scholarship in education and related literatures. Also, the collaborative's efforts included a randomized control trial designed to evaluate the effect of mathematics specialists on students' achievement and teachers' beliefs. The research findings influenced legislative and regulatory discussions as well as local school policy developments. (For further reading on the development of mathematics instructional specialists, see Martin et al. 2010.)

In chapter 9, "Transforming East Alabama Mathematics (TEAM-Math): Promoting Systemic Change in Schools and Universities," W. Gary Martin, Marilyn E. Strutchens, Stephan Stuckwisch, and Mohammed Qazi convey essential elements of their National Science Foundation-funded math and science partnership (MSP) located in east Alabama. The MSP, referred to as TEAM-Math, included two universities and fourteen school districts. Research guided the design of the partnership's leadership model, professional development activities, and community and parental engagement strategies. Research by two authors of other chapters in this volume (Campbell 2010; Spillane 2010) shaped the MSP's conceptual underpinnings. TEAM-Math borrowed from the research study of Campbell and colleagues (2003) regarding the effectiveness of mathematics specialists as school-based supports. In addition, Spillane's (2000) distributed leadership model guided the thinking associated with TEAM-Math's organizational structure. Preliminary TEAM-Math findings suggest the partnership is moving toward the development of important lessons related to teachers' quality and students' learning.

In chapter 10, "The SCALE Project: Field Notes on a Mathematics Reform Effort," Terrence Millar and Mathew D. Felton chronicle more than decade of collaborative work organized to improve grades K–16 mathematics education. One major focus of their remarks is the cultural and institutional challenges associated with multiorganizational partnerships as well as internal institutional dilemmas. Their chapter is a reminder that collaboration as a process is worthy of study, especially if linking research and practice in mathematics education is an important objective. Collaborations are not natural acts; instead, the process includes difficult decisions, compromise, and communication strategies. Using an insider lens, the authors share lessons learned from years of partnership work. The lessons discussed in this chapter are relevant, because all this book's chapters involve some form of collaboration or partnership.

Finally, "Reflection" by William F. Tate offers a few concluding remarks about the future of research-and-practice collaborations in mathematics education. He argues that research-and-practice collaborations should be a standard regime in movements to improve mathematics teaching and learning.

A Cypriot proverb states, "We must convince by reason, not prescribe by tradition." The chapters in this book describe efforts to bring reason to the mathematics education field by way of purposeful links between disciplined inquiry and practice. As a collective, the authors raise questions about why so many colleagues are comfortable with traditional practice in mathematics education. Moreover, the chapters offer various research and practice pathways to disrupt tradition in mathematics education. Why disrupt tradition? Although tradition brings a level of security, it also can foster stagnation and decline. This book aims, where appropriate, to disrupt

traditional customs, folkways, and thinking by providing instances of pathways that make serious attempts to promote mutually informing, disciplined inquiry and practice in mathematics education.

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