Introduction

Writing the third edition of *Designing Professional Development for Teachers of Science and Mathematics* has given us a chance to reflect on our learning from colleagues, new research and literature, and our work with dedicated and thoughtful professional developers in the field who have been using the ideas in this book since the first edition.

The intention of this introduction is to make visible for you, the reader, our process of reflecting and revising. If you are familiar with the first and second editions, you can take this retrospective look with us. If you are new to the book, you will understand its evolution into this revised edition. In either case, you will know why we took on the work of revising *Designing Professional Development for Teachers of Science and Mathematics* and how it has changed.

WHAT HAS HAPPENED SINCE THE FIRST AND SECOND EDITIONS

Since 1998, we have been watching with a sense of wonder and delight how *Designing Professional Development for Teachers of Science and Mathematics* has taken on a life of its own. We are professional developers. As such, we knew that writing the book was only the beginning, the easy part, as Susan Loucks-Horsley would say. The hard part, the "real work," was getting it used well. For the past 11 years, we have been on the ground actively disseminating and engaging others with the ideas in *Designing*

Professional Development for Teachers of Science and Mathematics along with many colleagues and collaborators.

Even so, when we first put fingers to keyboards 11 years ago, we could never have anticipated how well the book would be used. We have seen dog-eared, sticky note–marked copies in the hands of professional developers all over the country, some of whom fondly refer to it as the "yellow book" or the "clouds book" because of the first edition's cover design. With equal gratification, we have worked elbow-to-elbow with professional developers who have made the principles and processes come to life in the purposeful and imaginative professional development designs they have created—designs that are paying off in powerful learning for teachers and their students.

A long list of products and research that built on and extended the original work resulted from the first edition. For example, *Teachers as Learners: A Multimedia Kit for Professional Development in Science and Mathematics* (Corwin, 2003) is a set of videos and learning activities that provide visual examples of powerful professional learning strategies based on those identified in the 1998 edition of this book. The WestEd authors are currently developing a science professional development simulation and accompanying learning modules, with support from the National Science Foundation, to bring the professional development design framework and conceptual ideas in the book to life in the form of an engaging set of materials.

One of our reasons for updating the earlier editions of the book was to collect and bring together in one place all that we have learned through many people's efforts to translate the principles, framework, and strategies of the first and second editions into practice and to deepen our understanding of professional development design through further research and new resources. The original editions evolved by synthesizing and codifying what outstanding and effective professional developers do when they design programs. This edition has the design work of more professional developers from which to draw. It is truly from the field, to the field.

In addition to what we have learned through work that grew directly out of the earlier editions, the field as a whole is advancing. With a wide-angle lens, we have observed some encouraging changes that have influenced our thinking and informed our revisions.

The knowledge bases about learning, teaching, the nature of science and mathematics, professional development, and educational change are growing. A veritable explosion of cognitive research has occurred since the first edition of this book, increasing our understanding about how children and adults construct knowledge in mathematics and science. More also is known about what constitutes and supports transformative learning for teachers and how to combine professional learning strategies to address a multiplicity of teachers' learning needs. We now better understand when and how professional

development improves practice and student learning. Reports and studies emerge almost daily (e.g., Blank, de las Alas, & Smith, 2008; Carnegie Corporation of New York, 2009; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009) that outline the current status of science and mathematics education and professional development and provide recommendations for continuous improvement. We are learning more and more about how professional learning communities support continuous improvement and their role in sustaining teachers' professional learning. Research is emerging on the impact of coaches and mentors on teachers' practice and the benefits generated through teacher induction programs. The knowledge base on evaluation of professional development programs, paired with ongoing monitoring, has influenced our thinking about the design framework and how designers collect data to improve programs. These developments and learnings are reflected throughout the chapters in the book, as well as in the professional development design framework itself.

National, state, and local standards are more widely known and consulted as school districts shape their vision of teaching and learning. Since we first convened as a team of authors and collaborators in 1996, the National Council of Teachers of Mathematics (NCTM) standards were only three years old, and the National Research Council's (NRC) National Science Education Standards had just been published. "The 1990s," we wrote, "are certain to be known as the decade in which standards became commonplace among educators and policymakers in the United States" (Loucks-Horsley, Hewson, Love, & Stiles, 1998, p. 215). We were right; standards are now commonplace. Most states and many school districts have adopted standards, some more closely aligned with national standards than others. In fact, as we write this introduction, the Common Core State Standards Initiative, led by the National Governors Association and the Council of Chief State School Officers (CCSSO), has the commitment of 49 states and territories to develop common academic standards in mathematics and English language arts (CCSSO, 2009).

For the most part, today the debate has shifted from whether or not standards should guide mathematics and science education to how to implement them and how to ensure that they are met. There are many recent resources to help guide the efforts to implement the standards, including NCTM's *A Research Companion to Principles and Standards for School Mathematics* (2003a) and *Curriculum Focal Points for Prekindergarten Through Grade 8 Mathematics: A Quest for Coherence* (2006), new tools from the American Association for the Advancement of Science (AAAS) such as the two volumes of the *Atlas of Science Literacy* (2001, 2007), the work under development at the National Science Teachers Association (NSTA) on the Science Anchors project, as well as other publications supporting standards and

research-based mathematics and science education. The consensus that has been reached around standards sets the context for the other advances in the field we discuss below.

Professional development has become more purposeful and is being designed more often with the clear intention of improving student learning. While "hodgepodge" and "hit-and-run style" professional development are far from a thing of the past, we find more examples than we did 11 years ago of professional development that is being designed and implemented for the purpose of helping students to achieve standards. In these programs, goals for student learning are determined by studying standards and analyzing student learning data; student goals influence the purpose and content of professional development, which is tied to improving practice. Teachers have access to meaningful data and are better prepared to engage in data-driven dialogue processes to design instructional interventions to address their students' learning needs. Designers have become more intentional in their efforts to create teacher learning opportunities that align with their contexts and cultures. It has been especially gratifying for us to witness the design framework described in this book being widely used to stimulate dialogue about important inputs into the design process and to produce more thoughtful and powerful professional development programs. We have seen the design framework used to guide the development of programs of many grain sizes, from single institutes to complex multiyear programs.

Science and mathematics content and pedagogical content knowledge are playing a greater role in professional development programs. Another positive development has been a shift from providing teachers with opportunities to learn generic instructional strategies, such as cooperative learning, to designing professional development around the essential knowledge teachers need to teach the mathematics and science embodied in the standards. The national mandate to ensure a highly qualified teacher in every classroom has contributed to the progress made in helping teachers develop the in-depth science and mathematics content knowledge they need to improve student learning. We see more examples of professional development that engages teachers in understanding the content they teach, deepening their knowledge about how to teach this content in particular, and learning about ways that students think about and learn this content. For example, *Science Curriculum Topic Study* (Keeley, 2005) and *Mathematics Curriculum Topic Study* (Keeley & Rose, 2006) along with *A Leader's Guide to Science Curriculum Topic Study: Designs, Tools and Resources for Professional Learning* (Mundry, Keeley, & Landel, 2010) provide structured opportunities for teachers to "bridge the gap between standards and practice" by creating awareness of the mathematics and science content needed for basic adult literacy. These resources also provide opportunities to set goals for deepening content

knowledge in areas that are weak, for understanding what research suggests about teaching different science and mathematics topics, for becoming facile at identifying the recommended grade spans for teaching certain mathematics and science content, for becoming aware of common misconceptions students' hold and gain insight into how to spot them, and to better understand how science and mathematics ideas develop across grades K–12**.**

Research indicates that leadership for teaching and learning has a direct impact on student learning. Leadership is widely recognized as one of the most important factors in teacher and student learning. Schools and districts that are going somewhere—toward improved student learning—have effective leaders who behave in specific ways that impact success. Leithwood and his colleagues found that only classroom instruction has a greater impact on student learning than school leadership (Leithwood, Louis, Anderson, & Wahlstrom, 2004). In their meta-analysis of school leadership, Marzano, Waters, and McNulty (2005) reaffirm the link between leadership and student learning: "Our basic claim is that research over the 35 years provides strong guidance on specific leadership behaviors for school administrators and that those behaviors have well-documented effects on student achievement" (p. 7). Summing up decades of research in two words, Dennis Sparks (2005) says, "Leaders matter" (p. vii). We have seen many national, state, and local initiatives started in the last several years to develop the knowledge and abilities of leaders in district and school contexts, most relying on recent research to guide the content for the leaders' learning.

THE ENDURING CHALLENGES OF PROFESSIONAL DEVELOPMENT

As noted earlier in this introduction and explored in-depth in Chapter 2, there is widespread consensus regarding what constitutes effective professional learning: It is directly aligned with student learning needs; is intensive, ongoing, and connected to practice; focuses on the teaching and learning of specific academic content; is connected to other school initiatives; provides time and opportunities for teachers to collaborate and build strong working relationships; and is continuously monitored and evaluated. Despite the improvements made in teachers' professional learning that reflect what is known about effective professional development, the challenges are greater than ever.

Of paramount importance is raising the performance of all students in mathematics and science and closing achievement gaps that exist between rich and poor, and students of color and White and Asian students. Given that future innovation, global finance, and our very standard of living depend on mathematics and science knowledge, our students' unacceptable performance

in these subjects constitutes nothing short of a national crisis. The report from the National Commission on Mathematics and Science Teaching for the 21st Century (2000; also known as the Glenn Commission), aptly named *Before It's Too Late,* states:

> Our children are not just losing the ability to respond to the challenges already presented by the 21st century but to its potential as well. We are failing to capture the interest of our youth for scientific and mathematical ideas. We are not instructing them to the level of competence they will need to live their lives and work at their jobs productively. Perhaps worst of all, we are not challenging their imaginations deeply enough. (pp. 4–5)

Most alarming are gaps in performance that exist between rich and poor students, and students of color and White and Asian students, which, after a decade of investment in systemic reform, are maddeningly persistent. The challenge we face is to make breakthroughs in educating an increasingly diverse student population with different histories and cultural perspectives, experiences and expectations, and styles and approaches to learning and organizing information—"before it's too late."

Enhanced Goals for Student Learning

According to the Glenn Commission, "Students' grasp of science as a process of discovery, of mathematics as the language of scientific reasoning is often formulaic, fragile, or absent altogether" (National Commission on Mathematics and Science Teaching for the 21st Century, 2000, p. 10). Moving students beyond superficial understanding requires a fundamental shift in the goals that school communities embrace for their diverse students: goals proposed in national standards that focus on deep understanding, inquiry, and problem solving rather than on acquisition of facts; application of knowledge across subject areas; collaboration among learners; and alternatives to traditional assessment that measure progress of individuals in relation to new learning goals while providing accountability for the effectiveness of teaching and schools.

Ongoing, Sustained, Collaborative Learning Beyond Workshops and Institutes

Although many schools throughout the country have implemented structures and processes that focus on teachers' collaborative learning, 90% of U.S. teachers have participated in professional learning consisting primarily

of short-term conferences or workshops (Wei et al., 2009). Too often, teachers are not provided with time or opportunities to observe in each other's classrooms, engage in sustained learning with mentors and coaches, or convene in small groups to reflect on practice. Many schools have embraced the tenets of professional learning communities (PLCs) and embedded the processes of continuous improvement within their cultures. However, many other schools have latched onto such an approach with minimal attention to changing mind-sets or cultures, reflected in such statements as "we are doing PLCs." In addition, we know from research that a substantial amount of time (typically, 50 or more hours) of professional development is needed before teachers make substantial changes in their practices, but most professional development opportunities are of much shorter duration (Wei et al., 2009). This suggests that districts and schools continue to view teachers' professional learning as independent, disconnected workshops, rather than interconnected, sequential learning experiences.

Professional Development That Is Directly Connected to Teaching Practices

Although there have been changes in the extent to which professional development is driven by students' learning needs, there has not been concurrent improvement in focusing those learning experiences on what teachers do in their classrooms. We have seen teachers engaged in meaningful exploration of their teaching practices, but too often, this is not prevalent in schools. For example, teachers report that much of the professional development available to them is not useful (Wei et al., 2009, p. 92), implying that their learning is disconnected from their practice. This aspect of teachers' learning frequently appears on federal, state, and organizational reports as a recommendation for improvement, as is the case with the 2009 Carnegie Corporation of New York's report:

> Cease support for professional development in science and math that is disconnected from teaching practices in schools; replace with investment in strategic and coherent collaborative offerings that link coherent, sustained professional learning, rich in relevant science and math content, to direct changes in instruction in schools. (p. 9)

Professional Learning That Is Facilitated by High-Quality Professional Developers and Teacher Leaders

In an economic environment where districts and schools are eliminating structured, off-site "professional development days," it is increasingly critical

to develop school-based capacity for facilitation of teacher learning within the school day and culture. However, developing facilitators of teacher learning is often left by the wayside, with facilitators who either receive little or no professional learning of their own, or are "pressed into service before they are fully prepared for their roles" (Banilower, Boyd, Pasley, & Weiss, 2006, p. 86). With coaching and mentoring gaining popularity in many districts, it is equally important to develop the knowledge, skills, and abilities of these facilitators of adult learning and to provide them with ongoing, sustained opportunities to reflect on and make improvements in their practice. Research is beginning to demonstrate the impact of teacher-to-teacher learning approaches, and it is imperative to ensure that these leaders are afforded the same quality professional development that they offer to other teachers.

These are not easy problems to solve; they are systemic and reflect the wide gap between what we know about effective professional development and what actually happens in practice. It was our sense of urgency about closing that gap that led us to write the first edition of this book. The fact that many of the same challenges persist indicates that our original purpose for the book has yet to be fulfilled and is more urgent than ever. Our hope is that providing designers with updated guidance on what we know to be effective in professional development will continue to move the field closer to narrowing the gap between what we know and what we do in schools to support the teaching and learning of science and mathematics.

CARRYING ON SUSAN LOUCKS-HORSLEY'S WORK

Our commitment to contributing to improvements in the field of professional development relates to another of our reasons for undertaking the third edition revisions: to carry forward the work of our close friend, mentor, and coauthor, Susan Loucks-Horsley, who died in a tragic accident in 2000. *Designing Professional Development for Teachers of Science and Mathematics* was Susan's vision. In her usual generous way, she brought collaborators into the process so that we could learn with her. Learning was Susan's passion—students' learning, teachers' learning, her colleagues' learning, and her own continuous growth. The project grew out of her commitment to create "thick and rich descriptions of robust professional development" that could transform old notions of what she called cafeteria-style or hit-and-run professional development. She led the project with extraordinary clarity of thinking and purpose, yet surprised us with her eagerness to listen and learn from us. Susan did more than write about collegial learning; she created it wherever she went. When anyone would call *Designing Professional Development* Susan Loucks-Horsley's book, she was

quick to correct them, saying, "It is *our* book." Benjamin Disraeli said that the mark of a truly great person was not just someone who gave her gifts, but someone who brought out the gifts in others. Because Susan brought out our gifts, we produced this new edition—"*our* book"—as our gift to her.

In describing the central idea for *Designing Professional Development for Teachers of Science and Mathematics,* Susan Loucks-Horsley used the simile of a bridge. She wrote, "A bridge, like professional development, is a critical link between where one is and where one wants to be" (1999, p. 2). We find her simile apt in several ways. Susan was herself a bridge builder—building bridges between the research and practitioners, between the professional development and the science and mathematics education communities, and between educators and scientists and mathematics. She intended for *Designing Professional Development for Teachers of Science and Mathematics* to build strong bridges as well.

The book's organizing principle is that professional development is a complex design undertaking. Susan wrote: "Each bridge requires careful design that considers its purpose, who will use it, the conditions that exist at its anchor points (beginning, midway, and end), and the resources required to construct it" (1999, p. 2). In part, *Designing Professional Development* is a practical manual for bridge building. While there is consensus about the characteristics of effective professional development, there is still a prevalent gap between knowledge and practice. The book, like Susan's life, bridges research and practice by providing rich descriptions of effective programs constructed in various contexts addressing common challenges in unique ways. By carrying on her work, we as Susan's coauthors and friends serve as a bridge, connecting our readers to her prodigious legacy and profound vision.

PURPOSE OF THE BOOK

The book is intended to help professional developers construct strong bridges—between theory and practice, professional development and mathematics and science education, and the current and desired state of teaching and learning these subjects. It brings together in one place a rich discussion of the practices and issues of professional development for mathematics and science education. It is at once a "primer" on principles of effective professional development and a conversation among experienced professional developers about ways they address the many barriers to creating programs that emulate those principles. The book gets inside the thinking of designers, illuminating their purposes, strategies, triumphs, and failures.

The idea behind this book—and the professional development project at the National Institute for Science Education that produced it—evolved as

experienced professional developers examined their practice. The purpose of the book as originally conceived was to offer a few distinct and robust models of professional development, ones that provided alternatives to traditional formats such as inservice workshops. As we examined the "models" in use by each of the project's collaborators, we realized that, rather than offering distinctly different approaches, each program or initiative was a unique combination of professional development strategies whose choice was influenced by the professional learning goals and the particular context—and those strategies changed over time as learning occurred, goals and context changed, and various issues developed. We determined that professional development, like teaching, is about decision making—designing optimal learning opportunities tailored to the unique situation. Rather than offering a few models for professional developers to adopt or adapt, we could instead provide guidance about professional development design. Drawing on research, the literature, and the wisdom of experienced professional developers, we could offer multiple "best practices" to assist professional developers in designing and strengthening their programs. More specifically, this book is designed to

- offer a framework to assist professional developers in considering key inputs and combining strategies uniquely tailored for their contexts and their particular goals in improving science and mathematics teaching and learning;
- summarize key knowledge, such as the characteristics of effective professional development for teachers of science and mathematics, that informs professional development design;
- provide guidance on how to assess one's context to prepare to design professional development;
- discuss critical issues that cut across professional development programs and initiatives and ways these issues can be addressed;
- describe different strategies for professional learning that go beyond the most common workshops and institutes;
- provide examples of how elements of the design framework were used to create real-life professional development initiatives for teachers of mathematics and science; and
- offer references and resources for further exploration and inquiry.

CHANGES IN THE THIRD EDITION

This third edition of the book *Designing Professional Development for Teachers of Science and Mathematics* reflects new ideas and updates and

expands the core concepts presented in the first and second editions. The discussion of the professional development design framework in Chapter 1 reflects the authors' deeper understanding of the relationship and interaction among the implementation processes and the inputs into designing professional development. We also expanded the discussion of the role of evaluation on impact and the continuous cycle of reflection and revision. We have updated the design framework graphic to emphasize where the different professional development inputs are most influential as well as to emphasize that reflection and revision are ongoing and that evaluation focuses on understanding the results that are achieved.

A core idea we continue to build on in this edition is the idea that professional developers should have a basic understanding of research findings that influence their work. In Chapter 2, we update the discussion of knowledge and beliefs, including recent research, and how they influence the professional development program, and the actions of professional development designers. In Chapter 5, we added a new professional development strategy, curriculum topic study, that is focused on helping teachers learn and apply knowledge from research and standards.

Over the past several years, we have learned even more about the importance of understanding the context for the professional development, and Chapter 3 discusses the context factors that influence professional development, with a new emphasis on practical approaches for assessing your own context in relationship to each factor.

A major message in the other editions of the book was the need to shift professional development from one-time workshops and institutes to more ongoing and job-embedded professional learning. In the past decade, many educators have made this shift and are working in continuously improving learning organizations in which teachers expand their expertise and work with colleagues to share best practice in an ongoing way. In this edition of the book, we expand on this message and include more on the role of professional development in building professional cultures that support and sustain ongoing improvement and the use of best practice. For example, Chapter 4 includes a discussion of the critical issues that influence professional development, with an emphasis on building leadership and cultures that sustain learning. Chapter 5 provides more guidance about professional development strategies with an emphasis on their purposes, intended outcomes, and ways in which to combine strategies to address diverse contextual needs and provide an array of different experiences tied to teachers' and students' learning needs. Chapter 6 is updated to reflect our original collaborators' cases and includes discussions of how their thinking and programs have evolved over time.

THE AUDIENCE FOR THIS BOOK

The primary audience for this book is professional developers: those who design, conduct, and support professional development for practicing teachers of mathematics and science and those learning to do so through coursework, mentoring, and collegial support groups. Our focus is at the *inservice* level, although many of the ideas presented in the book can be used to redesign preservice teacher education programs. These professional developers are found in schools (as teacher leaders, advisers, mentors, coaches, administrators, members of leadership teams); school district offices (as curriculum supervisors, coordinators, staff developers); intermediate and state agencies; colleges and universities in faculties of education, science, and mathematics; professional associations, such as the National Science Teachers Association (NSTA) and the National Council of Teachers of Mathematics (NCTM), and their affiliated leadership organizations; state and federally funded projects and initiatives, such as those focused on teacher enhancement, systemic reform, and materials development, funded by the National Science Foundation, the U.S. Department of Education, and individual states; independent training and development firms; museums and other informal education organizations; and research labs and other organizations. There are several secondary audiences for the book: funders, sponsors, evaluators, policymakers, and mathematics and science teachers in their roles as consumers of professional development. All should find this book useful as it depicts best practices and how critical issues can be dealt with within different contexts.

ORGANIZATION OF THE BOOK

Chapter 1, A Framework for Designing Professional Development, introduces the design orientation of this book. This chapter discusses why, with the wide variety of professional development goals and contexts in which they are pursued, it is most fruitful to think of professional development as a dynamic decision-making process rather than as a static set of models. The design framework, which can be used to design new programs or analyze and improve existing programs, is described. Driving the process is a commitment to a vision for students and their learning and analysis of student learning and other data to set specific goals for professional development. These goals serve as the basis for implementing and evaluating the program and continuously reflecting on changes and refining the professional development. Inputs of knowledge and beliefs, context factors, and critical issues influence the professional development

design process and inform the design of the overall program. Each subsequent chapter delves more deeply into each of the inputs.

Chapter 2, Knowledge and Beliefs Supporting Effective Professional Development, describes what is currently known about learning, teaching, the nature of science and mathematics, adult learning and professional development, and the change process—knowledge that forms the foundation for a professional development initiative.

Chapter 3, Context Factors Influencing Professional Development, discusses several factors within local contexts that influence the design and nature of professional development, including the nature of the students and teachers (their needs, backgrounds, abilities, motivations, etc.); current curriculum, instruction, and assessment practices including the learning environment; the nature of the organizational culture and importance of developing professional culture; the critical role of leadership for professional development; national, state, and local policies that constrain or support professional learning; resources that are available to support professional development; and the role of families and communities in supporting, as well as contributing to, science and mathematics education and professional development. How differences in these dimensions influence design and implementation of professional development is illustrated by a variety of examples from different contexts.

Chapter 4, Critical Issues to Consider in Designing Professional Development, discusses seven issues that need to be addressed in professional development initiatives if they are to be effective and successful over time. These issues include building capacity for sustainability, making time for professional development, developing leadership, ensuring equity, building a professional learning culture, garnering public support, and scaling up. Each of the issues is defined and illustrated (what it is and why it is an issue), the existing literature is cited, and questions and actions are suggested for professional developers to consider as they grapple with these issues.

Chapter 5, Strategies for Professional Learning, describes 16 strategies that are widely used for professional development of mathematics and science educators. They are grouped into four clusters based on their primary purposes and focus: immersion in content, standards, and research; examining teaching and learning; aligning and implementing curriculum; and professional development structures. Each strategy is described according to its key elements and intended outcomes, and we explore how the strategy can be combined with other strategies to create a coherent program, as well as how the strategy lends itself to developing leadership and some of the issues to consider when selecting the strategy. Examples of each strategy in action are provided via a vignette, with resources suggested to guide designers to learn more.

Chapter 6, The Design Framework in Action, illustrates how the different parts of the design framework influenced the decisions and professional development designs in five settings. The five settings are summarized as cases of professional development, written by the book's original collaborators: Hubert Dyasi and Rebecca Dyasi of City College of New York; Susan Friel of the University of North Carolina at Chapel Hill; Judy Mumme of the Mathematics Renaissance at WestEd; Cary Sneider of the Museum of Science, Boston; and Karen Worth of the Educational Development Center (EDC) and Melanie Barron of the Cambridge (Massachusetts) public schools. These cases are referred to throughout the book.

HOW TO USE THIS BOOK

There are a variety of ways this book can be used. The design framework itself, introduced in Chapter 1 and discussed with illustrations in Chapter 6, can be used by professional developers to design new programs or improve current programs. Beginning with these chapters will immerse the reader immediately into the dynamic world of decision making about professional development. An alternative is reading the chapters sequentially, in which case different inputs into professional development programs are introduced one by one—the knowledge base, context, critical issues, and strategies—combining increasingly more considerations about professional development design by the time the actual planning and implementation process is illustrated in Chapter 6. Another alternative, one that may be more immediately helpful to professional development planners, is to review the section in Chapter 2 on the knowledge base in professional development and then to turn to Chapter 5, which describes each of the 16 strategies and suggests under what circumstances they might be best used. Because professional development is a complex and dynamic process, we believe that each chapter has something new to offer the reader, but the order in which chapters are read is not critical.

VALUES SHARED BY THE AUTHORS

Early in framing the first edition of this book, we realized that what we were creating was based very much on our shared beliefs and that a book by another set of authors might read quite differently. Therefore, we decided it was important to be explicit about our beliefs, as a form of "truth in packaging." Readers who share these beliefs should find the contents quite compatible; we hope that those who do not will be challenged to consider an

alternative perspective and direction and its value in their work. The values that underlie this book include the following:

1. *Professional development experiences need to have students and their learning at their core.* And by that we mean every student. Science and mathematics education reforms and the national standards on which they are based share a common commitment to learning for all, not the privileged or talented few. This not only implies a whole new perspective on the content that students should learn but also the teaching and learning strategies that need to be employed by their teachers (especially ways of knowing what students know). We believe that, given the scarcity of resources, including time, for teacher learning, all those resources must be focused on learning and developing the best means for reaching every student.

2. *Excellent science and mathematics teachers have a very special and unique kind of knowledge that needs to be developed through their professional learning experiences.* Pedagogical content knowledge, that is, knowing how to teach specific scientific and mathematical concepts and principles to children at different developmental levels, is the unique province of teachers and must be the focus of professional development. Knowledge of content, although critical, is not enough, nor is knowledge of general pedagogy. There is something more to professional development for science and mathematics teachers than generic professional development opportunities are able to offer.

3. *Principles that guide the reform of student learning should also guide professional learning for educators.* Professional development opportunities need to "walk their talk." People teach as they are taught, so engaging in active learning, focusing on fewer ideas more deeply, and learning collaboratively—all of these principles—must characterize learning opportunities for adults.

4. *Teachers as leaders exert a powerful force for school improvement.* In roles such as coaches, mentors, professional development facilitators, instructional specialists, and content or grade-level team leaders, teacher leaders benefit schools by increasing expertise in teaching and learning, strengthening collaborative cultures and internal accountability, and building capacity. Through the development of their own expertise in leading adult learning, teacher leaders also increase their own sense of professionalism and empowerment.

5. *Professional development must both align with and support system-based changes that promote student learning.* Professional development has long suffered from separation from other critical components of education, with the common result that new strategies and ideas are not implemented. While professional development cannot be expected to cure all the ills of the system, it can support changes in such areas as standards, assessment, and curriculum, creating a culture and capacity for continuous improvement so critical to facing current and future challenges.

With these values explicit, the reader is now invited to explore a new direction for professional development for mathematics and science**.** We hope that you will, as we have in revising this edition, see with fresh eyes the possibilities for powerful professional learning.