A Framework for Designing Professional Development

In the years that followed the development of the original design framework, in the 1998 edition (see Figure 1.1), it has been heartening to see how extensively the framework has been used by professional developers to design programs and by researchers to analyze and describe professional development. Through these experiences, as well as developments in the field of professional development design and evaluation, we have arrived at some new thinking about professional development design that is reflected in a modified design framework. A major difference those familiar with the original design framework will notice is a tighter link among standards and a vision for student learning, analysis of student learning and other data, and professional development goals and plans. This change acknowledges the need to clearly connect professional development to student learning and, more particularly, to closing persistent achievement gaps between rich and poor and white and African American and Hispanic students. The change from the word reflect to the word evaluate was made for similar reasons. It signals the critical importance of rigorous evaluation of professional development both to inform redesign and to document the impact of professional development on student learning, teacher learning, teaching practice, and organizations. Reflection, we believe, is still a vital part of professional development design, informing the work not only after implementation but also during and before. Another change in the professional development landscape since the first edition of this book is that new and promising strategies for professional development have emerged and
caught our attention, including lesson study, curriculum alignment and instructional materials selection, and demonstration lessons, and are now included in an expanded description of professional learning strategies. Coaching and mentoring, identified as one strategy in the 1998 edition, are now treated as two different strategies.

These changes strengthen the framework for use as a guide to the process of designing and providing quality professional development. The framework emerged originally from collaborative reflection with outstanding professional developers about their programs for both mathematics and science teachers. These professional developers felt very strongly that what they had to offer were not “models” that others could admire and adopt. Their programs were more complex than that, combining elements of different models, evolving and changing over time. They emerged out of and were uniquely suited to their own particular goals and context.

Equally complex was the process they used to develop their programs. As professional development “designers,” they consciously drew on

**Figure 1.1.** Original Professional Development Design Framework

research and “practitioner wisdom” and were guided by their own passionate beliefs about the nature of mathematics and science and student and adult learning. They had a repertoire of strategies from which to choose. They grappled with challenging, critical issues related to the “big picture” of mathematics and science education reform. They analyzed student learning data and student work and studied their own unique contexts to deliberately set goals to improve student and teacher learning and classroom practice. They thought carefully about what approach would be best in a particular time and place to advance their goals. Drawing on all of these elements, they carefully crafted their goals and plans. Once implemented, their designs never stopped evolving. As they learned from their mistakes, as teachers developed, and as their contexts shifted, their programs changed as well. Finally, they evaluated their programs not just in terms of teacher satisfaction but also on the basis of whether teacher and student learning goals were met. For these “designers,” professional development was not about importing models or following formulas. It was a process of thoughtful, conscious decision making.

It is this process of decision making that we have attempted to capture, albeit greatly simplified, in Figure 1.2. At the center of the framework, illustrated in the rectangles connected with horizontal arrows, is a generic planning sequence, incorporating the following actions: committing to a vision and a set of standards, analyzing student learning data, goal setting, planning, doing, and evaluating. The circles above and below the planning sequence represent important inputs into the design process that can help professional developers make informed decisions. They cue designers to consider the extensive knowledge bases that can inform their work (knowledge and beliefs), to understand the unique features of their own context, to draw on a wide repertoire of professional development strategies, and to wrestle with critical issues that mathematics and science education reformers will encounter, regardless of their contexts.

The arrows from the input “bubbles” into the boxes in the center of the graphic indicate when in the planning sequence these inputs are most important to start to consider. For example, note that strategies are most important to consider after goals are clearly established. Otherwise, there is the danger of grabbing at strategies that may not align with your goals, meet student learning needs, or fit your context. Once an input feeds into the system, it is assumed that it will continue to inform all subsequent stages in the process. For example, knowledge and beliefs informs “commit to vision” and every subsequent step, including how the plan is designed, implemented, and evaluated. Context determines what kind of data you consider in the data analysis phase and what student, teacher, and organizational learning needs the goals should address. Plans are made and implemented based on a solid understanding of contextual factors such as available time, resources, leadership, and school culture and are evaluated, in part, by the
extent to which these and other context factors are positively impacted. Planners consider critical issues like equity, scaling up, and building capacity early on as they set goals and develop plans, and they continue to attend to them later as they are implementing and evaluating the program. Finally, in the design framework graphic, an arrow connects evaluation back to vision to illustrate how evaluating leads to rethinking the vision, plans, goals, and actions. The feedback loop also connects back to the inputs of context, critical issues, and strategies to reflect how inputs may change. For example, professional developers may unearth new critical issues, develop new knowledge as a result of their experience, identify the need for a different strategy, or document changes in context. Designs continue to evolve as professional developers learn from both their experiences and evaluation results.

The process mapped out in the design framework can be used to design both small- and large-scale professional development, from an individual school’s program to a statewide or national initiative. It can guide designs
that involve a single strategy such as a workshop or study group or a complex program, combining several strategies either simultaneously or over time. Whatever the grain size, the design framework provides a map for crafting professional development to achieve the desired goals for students and teachers. (See Chapter 7 for further discussion.)

The framework describes professional development design at its very best—an ideal to strive toward, rather than an accurate depiction of how it always happens or a lockstep prescription for how it should. Given limited resources, especially time, professional developers may not always have the luxury of giving their full attention to every input in the model. The professional developers who helped to develop the framework extracted its components from what they actually did and what they wished they had done better. With the benefit of hindsight, they helped to construct a tool that alerts planners to important bases to cover and pitfalls to avoid. For programs just being designed, planners can take advantage of the knowledge and experience of others who have preceded them down the path. If programs are already under way, the framework can stimulate reflection and refinement. Wherever planners are in their process, they can hone in on the parts of the framework that best serve their purposes, knowing that no planning process is perfect, and that even the “best laid plans” are subject to the whims and serendipity of change.

This chapter briefly describes each element of the design framework, using examples primarily from the Cambridge (Massachusetts) public school curriculum implementation initiative, to make the process come alive. Chapters 2, 3, 4, and 5 provide more detail on each of the major inputs into the design process. While the design framework looks rational and analytical, professional development design is more art than science. It is fueled by vision and passion; requires great skill, knowledge, and creativity; and continues to evolve as the designer strives for greater mastery—better results for students, teachers, and schools.

**KNOWLEDGE AND BELIEFS**

“How long did it take you to make that pot?” someone asked the potter. “A lifetime,” the potter replied.

—Source unknown

Skilled professional developers, like skilled artists, come to the task of designing professional development with knowledge that has evolved over many years of research and practice. Much is known about effective professional development for mathematics and science education, and more is being learned every day. Taking advantage of this knowledge can help
Designing Professional Development

Figure 1.3. Knowledge and Beliefs Supporting Effective Professional Development

planners jump-start their efforts, put them on solid footing, and avoid unnecessary and costly mistakes.

Five distinct, but related knowledge bases inform the work of professional developers. (See Figure 1.3.) First is what we know about learners and learning. An explosion of cognitive research in the past 20 years has resulted in a rich body of knowledge about learners and learning in general and in mathematics and science in particular (Bransford, Brown, & Cocking, 1999). A second knowledge base is what is known about teachers and teaching. Third is the nature of the disciplines of mathematics and science. Fourth are the principles of effective professional development. Last is the knowledge base about change and the change process. In Chapter 2, we argue that there is a growing consensus about what is known in each of these domains and summarize key principles. That is not to say that these principles constitute the final word but that there is a substantial body of evidence to support them. Professional development designers tap this reservoir of knowledge to inform the initial planning and whenever they face dilemmas that research has addressed. In the design framework (see Figure 1.2), knowledge and beliefs are delineated as an important input into every phase of design, from the initial vision to the evaluation.
For example, the Cambridge team planning its curriculum implementation program brought a wealth of knowledge and experience to the table. The science staff development teachers on the team had been practicing inquiry-based science in the classroom for years. Some members had been involved in urban school change and science education reform since the 1960s. They knew the research on effective professional development and change and have been living it for 30 years. Everyone was steeped in standards work, from their science education consultant, Karen Worth, who was involved in developing national science education standards, to the staff themselves, who had drawn heavily on national and state standards to develop their own curriculum frameworks. Even so, one of the first decisions the team made was to find out more about successful science systemic change efforts. Team members wanted to know who was doing what, where, and what was working. They were determined not to reinvent the wheel or go down the wrong path.

Guiding beliefs about each of the five knowledge bases are important inputs into the vision and goals that drive professional development planning. Beliefs are the ideas people are committed to. Sometimes called core values, fundamental choices, or mental models, beliefs shape one’s ways of perceiving and acting. Many researchers have found that organizations that are deeply committed to a clear set of beliefs and that act consistently with them experience the greatest success (Deal & Kennedy, 1982; Fritz, 1996; Peters & Waterman, 1982; Schwahn & Spady, 1998). As designers clarify and articulate their beliefs, these beliefs become the “conscience” of the program. They shape goals, drive decisions, create discomfort when violated, and stimulate ongoing critique.

This was certainly true for the Cambridge team members, who shared a strong belief in inquiry science for all students and a common image of what that meant. They knew why they were there—to see their vision of science learning enacted in their schools. These beliefs were reflected in the vision and goals for the program and helped to sustain leaders through the difficulties of implementation.

**CONTEXT**

There is no prescription for which designs are right for which situations—no “paint by numbers kit” for professional development. Skillful planners have one foot planted firmly in theory (knowledge and beliefs and vision) and the other in reality. As professional developers design their program, they are influenced by their vision of what science and mathematics teaching, learning, and professional development should look like, but they also carefully analyze and study their own context. (See Figure 1.4.)

They must know who the students are and what standards are in place for them. They need data about student performance, about performance
gaps between rich and poor, white and minority, boys and girls, and about practices that are contributing to these gaps. They also need to know about teachers and their knowledge and beliefs about teaching and learning as well as their learning needs as they relate to students’ learning needs. They rely on information about current curriculum, instruction, and assessment practices and about the culture of the organization. This information serves as the basis for professional development goals for students, teachers, teaching, and the organization and helps to ensure that professional development is linked with learning results. It is so crucial to the design process that the revised design framework (Figure 1.2) includes “analyze student learning and other data” as an essential step before arriving at goals for professional development. (See the section Analyze Student Learning and Other Data below.)

Other features of the context that are important to consider are organizational structures and leadership; national, state, and local policies; available resources such as time, money, and available expertise; the history of professional development; and parents and community. (See Chapter 3 for a fuller discussion of each of these.) Considering these factors helps
designers make better decisions as they plan, implement, and evaluate programs. Each of the cases discussed in this book (see Chapter 6), from Cambridge, Massachusetts, to the state of California, illustrates how different contexts influence the creation of very different programs. The design process entails filtering all of the other inputs—knowledge and beliefs, strategies, and critical issues—through one’s own context to arrive at the most appropriate approach for a given setting.

Context is complex, comprising many interconnected and dynamic influences. Some contextual factors were readily apparent to the professional developers and drove their designs from the outset. For example, in Cambridge, the design team knew that the schools had a history of autonomy, and, therefore, opted for a school-based strategy with liaisons from each school. Other context factors required more study and analysis. When the Cambridge team members surveyed curriculum practices, they learned that there was little continuity from grade to grade and that the quantity and quality of science being taught was uneven. Some teachers in kindergarten through sixth grade were not teaching science at all. This led them to a decision to start slowly, phasing in a few units of the new curriculum at a time. Still other context factors were overlooked entirely, in some cases, to the program’s peril, such as public perception of mathematics reform in the Mathematics Renaissance program in California. (See Chapter 6.)

CRITICAL ISSUES

As we looked at professional development programs throughout the country, we discovered some common issues that designers were facing. These issues seemed to be critical to the success of programs everywhere, regardless of the context (although context will heavily influence how they take shape): time for professional development, equity and diversity, professional culture, leadership, capacity building for sustainability, scaling up, and garnering public support. (See Figure 1.5.) Proactive planners anticipate these issues and begin grappling with them in the initial design phase. As the program is implemented, they keep these issues in the forefront, confronting obstacles and creating opportunities to better respond to these challenges. For example, during several years of implementing the new science curriculum in Cambridge, professional developers kept their focus on developing capacity by supporting building liaisons and district staff developers in moving along the continuum from novice to expert science educators and taking greater responsibility for leading the effort.

The critical issues defy easy solutions. They are the “tough nuts” that professional developers work to crack as they design and provide learning experiences for teachers. Chapter 4 examines these issues in all of their
complexity, summarizing research, offering examples of best practice, and posing enduring, unresolved questions.

STRATEGIES FOR PROFESSIONAL LEARNING

After developing goals for the program, professional developers consider another important input, proven strategies for professional learning. Like classroom teachers, effective professional developers have a variety of strategies to draw on and skillfully select and combine to achieve their goals and to support change over time. Professional developers with such a repertoire to select from are in a much better position to come up with a strategy or combination of strategies to suit their purposes than designers who have only one move—the workshop. That is not to say that workshops cannot be effective. They can, if implemented well and linked to other strategies that sustain learning. The problem comes about when doing a workshop
becomes a knee-jerk reaction, not a conscious choice from among alternatives. With a repertoire of strategies, professional developers can design programs that embed professional learning into the daily lives of teachers. (See Figure 1.6.)

Chapter 5 describes 18 different teacher learning strategies clustered around six categories: aligning and implementing curriculum, collaborative structures, examining teaching and learning, immersion experiences, practicing teaching, and vehicles and mechanisms. (See Table 1.1.) These strategies are included in this book because they are robust examples of professional development in mathematics and science and are consistent with the principles of effective professional development discussed in Chapter 2. With each strategy, a set of key elements and implementation requirements is provided to assist planners in matching strategies to their own contexts and purposes. A professional development program can be made up of multiple strategies offered simultaneously to different groups of teachers to meet their different needs or accommodate varied learning styles. For example, novice teachers might benefit from an inquiry immersion
experience followed by mentoring. More expert teachers might follow up on the immersion experience with an action research project to study how students learn through inquiry. Different strategies can also be phased in over time, such as in Cambridge, where professional development evolved from workshops led by external experts to more teacher-directed study groups as teachers’ confidence and skill increased. Or strategies can be bundled together for the same group of teachers, like when a study group is facilitated by a university partner who also coaches study group members in the classroom. Rather than models, these 18 strategies are the palette from which professional developers can select and blend individual colors to give life and form to their professional development programs.

### TABLE 1.1 Eighteen Strategies for Professional Learning

<table>
<thead>
<tr>
<th>Category</th>
<th>Strategies</th>
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<tbody>
<tr>
<td>Aligning and implementing curriculum</td>
<td>• Curriculum alignment and instructional materials selection&lt;br&gt;• Curriculum implementation&lt;br&gt;• Curriculum replacement units</td>
</tr>
<tr>
<td>Collaborative structures</td>
<td>• Partnerships with scientists and mathematicians in business, industry, and universities&lt;br&gt;• Professional networks&lt;br&gt;• Study groups</td>
</tr>
<tr>
<td>Examining teaching and learning</td>
<td>• Action research&lt;br&gt;• Case discussions&lt;br&gt;• Examining student work and thinking, and scoring assessments&lt;br&gt;• Lesson study</td>
</tr>
<tr>
<td>Immersion experiences</td>
<td>• Immersion in inquiry in science and problem solving in mathematics&lt;br&gt;• Immersion into the world of scientists and mathematicians</td>
</tr>
<tr>
<td>Practicing teaching</td>
<td>• Coaching&lt;br&gt;• Demonstration lessons&lt;br&gt;• Mentoring</td>
</tr>
<tr>
<td>Vehicles and mechanisms</td>
<td>• Developing professional developers&lt;br&gt;• Technology for professional development&lt;br&gt;• Workshops, institutes, courses, and seminars</td>
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</table>
Figure 1.7. The Implementation Process: Commit to Vision and Standards ➔ Analyze Student Learning and Other Data ➔ Set Goals ➔ Plan ➔ Do ➔ Evaluate

THE IMPLEMENTATION PROCESS

The components of the framework described above—knowledge and beliefs, strategies, context, and critical issues—are important influences on the professional development design process. While taking these into account, the design process has a life of its own. It sometimes follows a logical sequence from committing to a vision, to analyzing student learning data, to goal setting, planning, doing, and evaluating. It often does not. Action can often help to clarify the vision or the goals, for example. But, eventually, in some fashion, the implementation of a professional development program, from its initial conception to its postmortem, unfolds over time. A brief look at each of the phases of the implementation (commit to vision and standards ➔ analyze student learning and other data ➔ set goals ➔ plan ➔ do ➔ evaluate) follows (see Figure 1.7).
Create a Structure

Before beginning, designers need a structure for ongoing professional development planning and decision making. Creating that structure involves asking the following questions: Who sits at the table? Who makes the decisions? Who has input into the decisions? What do decision makers need to know and be able to do to effectively carry out their roles? How do decisions get made? How will designers communicate with stakeholders and build support for the plan? In Cambridge, for example, it was very important to the design process that teachers were brought in from the very beginning. The Cambridge team also employed an outside expert and established a collaborative decision-making process.

COMMIT TO VISION AND STANDARDS

The reform of mathematics and science education rests firmly on a commitment to enhance the teaching and learning that is currently the norm in our nation’s classrooms. The new vision of mathematics and science teaching and learning, based on the standards developed by the National Council of Teachers of Mathematics (NCTM, 1989, 1991, 1995, 2000), the National Academy of Science’s National Research Council (NRC, 1996a), and the American Association for the Advancement of Science (AAAS, 1993), is one in which all students engage in inquiry into significant questions in science and investigate complex problems in mathematics in supportive, collegial communities. Students come to deeply understand important science and mathematics ideas and master complex skills and reasoning processes that are essential to scientific and mathematical literacy. To achieve this vision teachers also need new knowledge, skills, behaviors, and dispositions. Teachers need to have ownership in the new vision and feel competent to create appropriate learning environments for their students. This includes feeling secure in their knowledge of the content they will help their students learn.

For this to happen, teachers need opportunities for professional growth—ones in which they learn what they need to know to achieve this new vision, in ways that model how they can work with their students. The National Staff Development Council’s (2001b) professional development standards and the teaching standards and professional development standards in the NCTM and NRC documents clearly articulate a vision for science and mathematics teaching and professional development. Because it is difficult if not impossible to teach in ways that one has not learned, teachers also need opportunities to inquire into significant questions in science and to learn challenging mathematics and reflect on their own learning and teaching in supportive, collegial communities. What do classrooms look like in which the new vision of science and mathematics teaching and
learning, based on local, state, and national standards, is playing out? And, following from that question, what do professional development opportunities look like in which teachers learn in that way, and learn to teach in that way? In Resource A, we include vignettes that create images of alternatives to the dominant practices in both teaching and professional development.

The original design framework included “Supporting Standards and Frameworks Through Professional Development” as a critical issue, which was discussed in Chapter 6 of the first edition of this book. Our decision to incorporate commitment to vision and standards as the first essential step in the design framework reflects our new understanding that supporting standards is more than a critical issue to be considered; standards set the course for professional development. (See Figure 1.7.) Providing teachers with the knowledge and skills they need to help every student achieve high standards is the central purpose of professional development. Standards guide the selection of content for professional development, which helps teachers explore the “big ideas” of the disciplines and deepen their content knowledge. Standards themselves are often the subject of professional development, as teachers immerse themselves in studying what the standards mean and what their implications are for learning, teaching, schooling, and professional development. And standards serve as the foundation of the vision that inspires the professional development design process from beginning to end.

Dennis Sparks (1997) wrote, “It’s been said that someone who has a ‘why’ can endure any ‘how’; few things are more important to motivation than purpose that is regarded as profoundly and morally compelling” (pp. 24-25). The vision of learning, teaching, and professional development based on standards is the “why” of professional development design. It is the desire to reach the vision that motivates professional developers to create powerful learning opportunities for teachers. It is the tension between the vision and the current reality that fuels goal setting and planning, drives the desire to change, and gives meaning to the daily tasks of implementing professional development programs. And, as professional developers reflect on and evaluate their programs, they gauge how well the school community is moving closer to its vision and recommit to the future they want for students, teachers, and schools.

What actually happens in the phase “commit to vision and standards” of the design process? How does a school community solidify its commitment to a vision and a set of standards for science and mathematics reform? Many educators have experienced the process of developing a vision as a meaningless exercise of putting words on paper that are either promptly ignored, written and embraced by only a few, or so general as to inspire no one. Because the vision for science and mathematics reform is rooted in deeply held beliefs and assumptions, developing a truly shared and compelling vision is a complex and long-term process. Notice in the design framework that an important input to the vision is knowledge and beliefs—
the knowledge bases about teaching, learning, the nature of science and mathematics, professional development, and change. It is important that the vision statements are written based on shared knowledge, not shared ignorance, and that school staff take the time to study relevant research and national standards and supporting documents. Without exception, the professional developers who worked on this book reported drawing on these knowledge bases to formulate the purpose, guiding principles, and core outcomes for their work.

A recent example in one author’s experience is a kindergarten through Grade 12 mathematics committee in Turner, Maine, that began its curriculum development project with a yearlong study of *Principles and Standards for School Mathematics* (NCTM, 2000). Committee members read and discussed each content strand, solved mathematics problems together related to that strand, provided similar problems to their students, and studied the student work together. In this case, the professional development design had as its goal building teachers’ knowledge of national standards and strengthening their commitment to a different kind of classroom.

Richard DuFour and Robert Eaker (1998) offer another strategy for building collective ownership of a vision and set of commitments based on using data. First, staff paint a picture of the current conditions of the school using a variety of data, including student achievement, behavior, participation data, satisfaction surveys, and staff activities. Then they answer the question, “If, within the next five years, you achieve everything you

<table>
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<tr>
<th>TABLE 1.2 Questions to Consider in Committing to a Vision and Standards</th>
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<tbody>
<tr>
<td>1. What is our vision for science and mathematics teaching and learning?</td>
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<tr>
<td>2. What do students need to know and be able to do in mathematics and science?</td>
</tr>
<tr>
<td>3. How will we know they have gained this knowledge?</td>
</tr>
<tr>
<td>4. What will we do if they do not gain this knowledge?</td>
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<tr>
<td>5. What do classrooms in which this new vision is playing out look like?</td>
</tr>
<tr>
<td>6. What do teachers need to know and be able to do if students are to achieve these standards?</td>
</tr>
<tr>
<td>7. What is our vision for teachers’ learning?</td>
</tr>
<tr>
<td>8. What does professional development in which this new vision is playing out look like?</td>
</tr>
<tr>
<td>9. What kind of organization do we need to be to support this vision of science and mathematics teaching, learning, and professional development?</td>
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</tbody>
</table>
describe in your vision, what changes would you expect to see in the data?” (DuFour, 2000, p. 72). “When a faculty begins to struggle with that question,” says DuFour, “they begin to develop the results orientation of a learning community.”

Creating opportunities for constructive dialogue around the questions in Table 1.2 can also contribute to developing a shared vision for science and mathematics reform. The vignettes with reflective questions in Resource A may act as a catalyst to this dialogue.

Although a shared vision is essential for a productive learning community, this does not mean that professional development cannot proceed until the entire school community is united around a common vision. Michael Fullan (1993) reminds us that “vision emerges from, more than it precedes, action” (p. 28) and that “ready, fire, aim” may be a more productive sequence (p. 31). Ready implies that professional development design starts with some notion of purpose, especially for those designing the effort, but does not bog down in perfecting the shared vision. Fire is implementing the professional development program. It is through doing, learning, reflecting, and applying new knowledge and skills that the vision is clarified. Aim, according to Fullan, is crystallizing new beliefs and clarifying and strengthening the sense of shared purpose. While commitment to vision and high standards for all students come first in the sequence of the design framework, this phase is in fact iterative and interactive with all other phases of the process.

**ANALYZE STUDENT LEARNING AND OTHER DATA**

In this phase of the professional development design process, analyze student learning and other data, professional developers take stock of their reality as they explore the gap between the current and the desired state and set targets for improvement. (See Figure 1.7.) When a school community has a shared commitment to high standards for all students, it is better prepared to take an honest look at student learning data and is more likely to experience dissatisfaction with results that fall short of its commitments, rather than complacency, resignation, or defensiveness. The purpose of analyzing student learning and other data is to identify specific targets for improving student learning that will determine the goals for teacher learning and form the basis for a professional development program clearly focused on results for students. When designing professional development for a local school or district, it is crucial that the professional development plan is linked with school or district goals for improving mathematics and science learning.

Most important in this phase, professional developers examine multiple sources of student learning data to determine what essential knowledge and skills students are and are not learning and what performance gaps exist between rich and poor, white and minority, and boys and girls. Data
analysis can begin with readily available data such as state and district assessments, including both standards-based and norm-referenced test results. These assessments, however, do not provide adequate evidence of achievement of all the knowledge, skills, and dispositions that local communities may value and that national standards and many state and local standards call for, such as mathematical reasoning, problem solving, and communication, inquiry skills, or in-depth understanding of important mathematical and scientific concepts.

An important part of enacting a vision based on standards is putting into place a comprehensive local assessment system that complements high-stakes tests with assessments tied to local standards and curriculum and includes performance tasks, portfolios, and scoring and examination of student work as well as short-answer and multiple-choice tests. For example, schools or districts implementing standards-based curriculum can use assessments that are part of the program, such as in the Fresno (California) Unified School District, where teachers administer assessments from their FOSS units, which are collected and analyzed by the district (Love, 2002). In addition to classroom and school or district local assessments, common assessments administered periodically by teachers who teach the same grade level or course can provide teachers with timely and relevant feedback on the extent to which students are mastering agreed-on standards (DuFour & Eaker, 1998; Love, 2002; Schmoker, 2002). Figure 1.8 illustrates the dynamic interplay among different parts of a comprehensive assessment system.

By using multiple measures, professional developers verify their hunches about student learning needs with more than one data source. Goals for professional development are not arbitrary or based on individuals’ pet issues but instead are grounded in the needs that are showing up consistently in the data. Another advantage of using both classroom and common-grade-level assessments along with state and district assessments to target needs is that teachers become actively involved themselves in data analysis and data-driven dialogue. A professional learning experience in itself, the process of collecting and analyzing student learning data, using assessments that are aligned with their curriculum, increases teachers’ ownership of student learning problems. When teachers embrace the problems, they are more willing participants in the professional development programs designed to solve them. They also become active agents in testing
out new instructional strategies and monitoring progress toward improvement (DuFour & Eaker, 1998; Love, 2002).

**Digging Deeper Into Student Learning Data**

It is important not only to use multiple assessments of student learning but also to go beyond superficial analyses of summary or aggregate reports to derive the maximum value for goal setting. Figure 1.9 illustrates a process for digging deeply into state and local assessment results to gain a fuller picture of how students are performing in relation to the standards set by the school community. The process begins with examining aggregate or summary reports. These reports provide the headlines such as, overall, what percentage of students met standards in mathematics or science (on standards-based assessments) or what percentage of students are at or above the 50th percentile (on norm-referenced assessments).

They also reveal trends over time, such as progress in increasing the percentage of students who meet standards. To explore performance gaps, professional developers need to go beyond the aggregate or summary reports to examine disaggregated results, results separated out by subgroups such as students receiving lunch assistance and those not, racial groups, language groups, and boys and girls.
Digging deeper into the data in this way enables professional developers to uncover achievement gaps so that equity issues take center stage in the professional development plan. Often schools do not even recognize that they have race, economic, or cultural performance gaps until they examine disaggregated data. By uncovering these gaps, professional developers can direct attention to improving the achievement of specific groups of students who are not learning well. Their designs may include opportunities for teachers to better understand the racial and cultural backgrounds of their students and challenge educators’ beliefs, practices, and policies that act as obstacles to poor and minority students achieving standards.

The next level of analysis is examining cluster or strand and item-level data. This kind of analysis requires looking at how students performed on content clusters or strands such as number sense or geometry and on particular test items. By getting inside the actual items, analyzing what knowledge and skills the assessment items were actually measuring and looking for patterns in correct and incorrect answers, planners gain a much better sense of what mathematics and science knowledge and skills students are struggling with as well as what vocabulary and test-taking skills they may be lacking. This enables professional developers to pinpoint needs more precisely, not just, for example, at mathematics problem solving in general, but at specific aspects of problem solving that are most challenging for
students. Finally, examining student work often proves to be the most fruitful data source, providing rich insights into students’ thinking, as the following example illustrates.

“Our mathematics department meets weekly,” explained a teacher at City On A Hill. “There are two meetings a year where we don’t look at student work.” The team uses a process for examining work that begins with defining a clear purpose for looking at the work. They always do the mathematics task themselves and share their strategies before digging into the student work. Then they closely examine pieces of work the teachers bring, first making observations, then drawing inferences and identifying questions for further investigation.

For the past two years, they focused on this question: Why are our students doing so poorly on the open-response problems on the state mathematics assessment when we do these kinds of problems regularly as part of our Interactive Mathematics Program? As they studied student work and thinking over time, they identified some key reasons. First, there was some basic mathematics vocabulary the students did not have. Second, teachers were hovering too much over the students in the classroom, explaining the problem to them, breaking it down, coaching them step-by-step. So even though the students were familiar with mathematics problem solving, they did not have enough independent practice. Teachers worked on these areas and over a two-year period quadrupled students’ average score on open-ended questions. This example illustrates how careful analysis of student work led to a clear focus for improvement and how examining student work is in itself a powerful professional learning strategy. (See Chapter 7 for more on City On A Hill and see Chapter 3, Table 3.1, for questions to consider, data sources, and resources for investigating students and student learning.)

**Opportunities-to-Learn Data/Data About Practice**

Underlying performance gaps are often inadequate opportunities for particular student groups, particularly racial and language minorities and poor students, to learn a rigorous mathematics and science curriculum. A study by Weiss, Banilower, McMahon, and Smith (2001) found that ability grouping was still widely practiced in mathematics and science and that classes labeled low ability are more likely to contain a high proportion of minority students. Another study by Weiss, Matti, and Smith (1994, as cited in Weiss, 1997) found that students in low-ability classes had fewer opportunities to do inquiry-based science or write about reasoning when solving mathematical problems. Professional development programs should be geared not just to closing achievement gaps but also to closing opportunities-to-learn gaps. In this phase of the design process, professional developers can also use data about course enrollment, special program placement, teachers’ qualifications, and curriculum, instruction, and assessment practices to uncover what practices may be preventing
some students from achieving standards (Love, 2002). (See also Table 3.3 in Chapter 3.)

Complementing data about student achievement and opportunities to learn are data about teachers’ needs. What knowledge and skills do teachers need if students are going to reach specific standards? These can be assessed through surveys, classroom observations, interviews, and content assessments. (See Table 3.2 in Chapter 3.) Finally, professional developers will want to consider data about the school, district, or organization that helps them assess the quality of leadership, the strength of the professional learning community, and the capacity of the organization to implement and sustain mathematics and science reform. (See Tables 3.4 and 3.5 in Chapter 3.)

When designing professional development programs not for individual schools or districts but for teachers from many different schools and districts or for large-scale state or national programs, professional developers can draw on state-level data and national data from sources such as the National Assessment of Educational Progress (NAEP) and from the Third International Mathematics and Science Study (TIMSS) to identify trends in student learning, achievement gaps, and classroom practice. Whether using local, state, national, or international data, professional developers ground their design in data about student learning, opportunities to learn, and classroom practice to ensure that their programs focus on critical areas of need for student and teacher learning.

SET GOALS

Rigorous analysis of student learning and other data sets the stage for setting goals for the professional development program. (See Figure 1.7.) If the vision describes the desired future and the data analysis describes the current reality, goals are the benchmarks or milestones to assess progress toward the vision. “Vision may inspire, but goals foster immediate accountability,” says Richard DuFour and Robert Eaker (1998), who liken goals to the “ports of call on the journey toward improvement” (p. 203). A few clear, concrete, and attainable goals motivate, energize, and focus professional development and school improvement. On the other hand, according to Michael Schmoker (1999), the absence of explicit learning goals is “the most striking, self-defeating, contradictory characteristic of schools and our efforts to improve them” (p. 23). If professional development is to be linked to gains in student achievement, four kinds of goals are relevant: goals for student learning; goals for teacher learning; goals for teaching practice; and goals for the organization. The following were the broad goals for the curriculum implementation program in Cambridge:

- To improve science learning for all kindergarten through Grade 9 students in the Cambridge public schools (student learning)
• To implement an inquiry-based, modular science curriculum throughout the district (teaching practice)
• To build teacher leadership and expertise within the system (teacher learning)
• To develop a structure that would permanently sustain the science program (organization)

The driving force behind a professional development program is a small number of specific, attainable, and measurable student learning goals. Learning goals, according to Schmoker (2002), should target the lowest-scoring subjects or courses and target specific standards where achievement is low. For example, a professional development program might target students’ understanding of fractions, decimals, and percentages or problem solving in mathematics, as in the example from City On A Hill above. Improvement efforts can bog down with long laundry lists of goals or vague or overly ambitious goals. As designers set goals for student learning, they tap into knowledge about teaching and learning and the nature of mathematics and science treated explicitly in the national and some state standards. In Cambridge, planners developed a conceptual framework for science in the elementary years, based on state and national standards, which eventually led to the selection of the curriculum they implemented. In addition, setting goals for students involves analyzing students’ needs and confronting disparities in achievement between boys and girls or among racial or cultural groups. It is essential that goals for student learning specifically address closing achievement gaps and expanding learning opportunities to all students.

Goals for teachers flow directly out of goals for students. If students are going to develop a set of understandings, skills, and predispositions, then what do teachers need to know and be able to do to realize those outcomes for students? Learning goals for teachers are also informed by referring to the standards, as well as data about teacher performance, knowledge and skills, needs, and supports available. Planners in Cambridge considered what knowledge and skills, professional development, and structural support teachers needed to successfully implement the new science curriculum.

Professional development that is linked to improving student learning should also set goals for teacher practice. How will teachers translate the new knowledge and skills they are gaining into classroom practice? In the
Cambridge example, the goal was for teachers to implement the new science curriculum as intended by the curriculum developers.

Professional development goals can also encompass goals for the organization, such as the development of leadership or the strengthening of the learning community. In Cambridge, for example, a goal was to put in place a structure that would sustain the implementation of the science program. This goal reflected the designers’ attention to the critical issues of sustainability and professional culture as well as their knowledge and beliefs about effective professional development and change. These are important inputs into goal setting as are contextual factors such as the history of professional development, the resources available, and local, state, and national policies. In Cambridge, the decision to focus on leadership development early on in the program arose in part because resources limited reaching every teacher. Knowledge of context helps designers formulate goals that are realistic, attainable, and forward moving. “You want to both be realistic and push the system at the same time,” explained Karen Worth.

Clarifying clear and worthwhile outcomes for student learning, teacher learning, teaching, and the organization not only brings focus and coherence to the professional development program but also lays the groundwork for future program evaluation. An important part of the goal-setting process, according to Thomas Guskey (2000), is to consider how goals will be assessed and what evidence will be used to determine if goals are met.

PLAN

Once goals are set, planners begin to sketch out their design. All of the other inputs described above—critical issues, context, knowledge and beliefs, and strategies—are strong influences in the planning phase. (See Figure 1.7.) Planners scan their context, unearthing important factors to consider as they tailor their program to their own circumstances and review the student learning and other data they have collected to connect plans to goals. This is when they may decide they need more information about learning, teaching, mathematics or science, professional development, and change. Having a research-based vision of what effective programs can look like can also generate some ideas for their plans. (See the profiles in Enhancing Program Quality in Mathematics and Science by Kaser and Bourexis, 1999, for one source.) Learning about other similar districts’ plans can also be helpful.

Planning is also the time to revisit and clarify the beliefs that underlie the program. Critical issues enter in, as planners consider how to confront challenges like scaling up or building leadership. And, finally, during planning, professional developers think strategically about which strategy or combination of strategies to employ, much like a skillful teacher selects from a repertoire of instructional strategies.

The design framework has been used to plan short-term and long-term and small- and large-scale programs. Planners for small-scale and short-
term efforts pick and choose among the contextual factors, critical issues, and knowledge and beliefs that are most relevant for their initiative but can still use the design framework to be more thoughtful and deliberate about their planning. For example, staff members at Biological Sciences Curriculum Study (BSCS) use the design framework to plan institutes, which are part of their National Academy for Curriculum Leadership. For a small-scale, shorter-term effort such as one institute, they do not consider every context factor but think carefully about the most relevant ones, especially about the participants’ backgrounds and their learning needs. Since they are working with high school teachers in district teams who are implementing standards-based high school curriculum, they consider participants’ need to plan during the institute; planning time is hard to come by once the teams return to their districts. To make the planning time as productive as possible, they have participants bring their own student achievement data to the institute, which they analyze and use to guide the goals for the curriculum selection process and subsequent professional development. Based on selective inputs and their goals for a particular institute session, they plan to use a mix of strategies. For example, participants are engaged in an immersion in inquiry experience both to increase the participants’ science content knowledge and for staff to model a professional development strategy to be implemented in the teams’ districts. Participants also engage in examining student work during the institutes to enable them to effectively select instructional materials. Whether large scale or small scale, short term or long term, professional developers draw on the most relevant inputs into the design process to craft a plan that will soon be put to the test of implementation—the “do” phase of the design process.

**DO**

Having made the best decisions they can, designers move from “sketching” to “painting”—the actual implementation of their plan. (See Figure 1.7.) In this phase, they draw on their skills as change facilitators and knowledge about implementation and the change process (e.g., Fullan, 1991, 2001; Hall & Hord, 2001; Loucks-Horsley et al., 1990). For fundamental change to happen, teachers need to experiment with new behavior and gain new understandings, and that takes time. They will move through predictable developmental stages in how they feel and how they are using new approaches. Frequently, things get worse before they get better, as teachers experience what Fullan (1991) calls the “implementation dip.” And, despite professional developers’ best efforts to “manage” change, it is, by nature, unpredictable. Often the best that can be done is to expect the unexpected and problem solve along the way. Taking these and other important principles of change into consideration can help prevent the all too common failure of professional development programs at this stage in the process.
Despite the “best laid plans,” it is impossible to predict how the initial design will work. As the action unfolds, designers discover what works and what doesn’t. Like artists stepping back from the canvas and examining their work from different perspectives, professional developers continuously monitor their plan, using a variety of data sources. They ask questions such as: Is this working? Are we moving toward our goals of improved student learning in mathematics and science? Are we meeting participants’ needs? Is our program, in fact, a good match with our context? What conditions, if any, have changed, and how should we respond? What critical issues do we need to address now? Sometimes their reflection is enhanced by interested “visitors” (sometimes called “critical friends”) who sensitize professional developers to important aspects of their programs seen from different perspectives.

Based on this feedback, planners often go back to the drawing board. It is rare that an entire program is carried out exactly as planned. As the examples in this book will illustrate, the most successful programs do not start out with flawless designs. They begin with a sound idea that then goes through many revisions and continues to evolve. Programs change over time both because planners figure out a better way and because conditions change, sometimes as a direct result of the professional development program. For example, as teacher leaders in Cambridge became more self-assured and experienced, they wanted fewer workshops and more self-directed study groups. Professional development changed the culture, which in turn created the conditions for a different strategy. There is a live interplay between context and implementation.

None of the inputs, in fact, remains static over time. The knowledge base about learning, teaching, the nature of mathematics and science, professional development, and the change process is constantly growing. As professional developers learn from their experiences, they become active contributors to the knowledge base, as the professional developers featured in this book have. And, as their needs and interests change, they look to research for new ideas. Beliefs change, too. Seeing the impact of their work, professional developers begin to think differently about students, teachers, their disciplines, professional development, and change. Critical issues are just as dynamic. Experience may lead designers to consider new issues or gain deeper understandings of the ones they have grappled with. Far from linear or lockstep, implementing professional development is recursive and usually messy, demanding flexibility and continuous learning throughout the process.

**EVALUATE**

An essential but often overlooked or underutilized part of the professional development design process is evaluation. (See Figure 1.7.) Professional
development opportunities are designed for a wide variety of purposes. It is the role of evaluation to determine whether and in what ways they are successful.

Fulfilling that role, however, is rarely easy for several reasons. First, regardless of the purpose of a given program, people typically jump to measure what is easiest: satisfaction of participants. Because of this norm it is difficult to get people to think more broadly about outcomes and measures. Second, there is increasing demand to assess the value of professional development based on the achievement of the students of those teachers who participate. This demand is well founded, given the large investment of resources that has been made in professional development and the critical need to improve student learning and close achievement gaps. The challenge here is not to expect student learning outcomes prematurely, before the professional development program has been fully implemented and teacher learning and change in practice have been well supported over time. Nonetheless, it is important that professional developers broaden the valued outcomes for in-depth, long-term professional development to include change in classroom practice and in student learning results. Finally, evaluation needs attention because it is underutilized as a valuable learning experience for professional developers, participants, and others. Reflection on evaluation results, as they are being gathered as well as when synthesized, is an important contributor to continuous improvement. There are several questions that professional developers can ask themselves that may help them address the challenges of evaluation of their programs and initiatives.

- What are the goals or desired outcomes?
- How do you assess the accomplishment of the outcomes?
- How do you acknowledge and evaluate how a professional development initiative and its participants change over time?
- How do you take advantage of evaluation as a learning experience in itself?

What are the goals or desired outcomes of the program or initiative?

Professional developers typically have a wide range of goals, but they are often not skilled at articulating them as outcomes. What would you see if you were successful? What would have changed for whom? It is easier to think of activities than accomplishments, for example, conducting a summer institute and a series of follow-up problem-solving sessions is often cited as a goal, rather than teachers using inquiry-based strategies in their classrooms. The range of possible outcomes is quite large: development of new abilities (knowledge, skills, strategies, dispositions) by a variety of people (teachers, students, administrators) and organizations (depart-
ments, teams, schools, districts) in a variety of areas (teaching, leadership, change management). Being clear about desired outcomes, articulating what they would look like if they were present, not only lays important groundwork for evaluation but also results in a more focused and purposeful program.

How do you assess the accomplishment of the program’s outcomes?

Evaluation helps collect evidence of the extent to which a program’s aims have been met. Although paper and pencil in the hands of the participants in professional development have traditionally been the tool of choice in evaluation, a wide range of instruments and sources of information are preferable. Evidence from interviews, observations, product (e.g., lesson plan) analysis, performance tasks, focus groups—all can contribute evidence. Teachers, students, colleagues, administrators, scientists and mathematicians—all can be sources of information about the outcomes of a professional learning experience. Obviously there are trade-offs for every instrument and source of information, for example, in cost, time, degree of self-report, or amount of inference required (Guskey, 2000). These are all considered in designing an evaluation keyed to a particular purpose, audience, and budget.

The National Science Foundation has funded many local school districts to reform the teaching of mathematics and science throughout their systems. Horizon Research, Inc. developed and is supporting the use of evaluation instruments so that each of these projects does not have to create its own, and so data can be aggregated across projects. The framework for data collection includes such outcomes as the quality of the professional development activities; extent of teacher involvement in the activities; changes in teacher attitudes and beliefs; changes in science and mathematics curriculum, instruction, and assessment; nature of the culture or context for teaching; and the sustainability of the professional development system (Horizon Research, 2001).

How do you acknowledge and then evaluate how a professional development initiative and its participants change over time?

The impact of professional learning activities looks different at different times. This is why it is foolhardy to either expect or focus on measuring student learning when teachers have just begun to learn and experiment with new ideas and strategies. Well-designed evaluations unfold with expectations for change. For example, one might focus on measuring participants’ satisfaction and whether they are developing basic understanding early in a program; change in classroom behavior and in the professional culture midway; and then on various kinds of student change, beginning with attitudes and evolving to demonstrating new, deeper understandings of concepts.
To address this issue, evaluators have used concepts and tools of the Concerns-Based Adoption Model (Hall & Hord, 2001) to answer questions about the implementation of changes in mathematics and science education (Loucks-Horsley et al., 1990; Pratt & Loucks-Horsley, 1993). Three kinds of questions can be asked: How do teachers’ concerns about the new program or teaching strategy change over time? How does their use of the new program or teaching strategy change over time? To what extent do teachers implement the critical components of the new program or teaching strategy over time? Two developmental scales—Stages of Concern (assessed using paper-and-pencil instruments) and Levels of Use (assessed through a focused interview procedure)—provide criteria for assessing progress along the change continuum. Components of the program or strategy can also be defined and assessed using a combination of interview and observation; the different “configurations” that the program components take on in different classrooms can then be represented and monitored over time.

After sufficient time has elapsed for teacher change to result in improvement in student learning, students are an appropriate focus for professional development evaluation. A unique evaluation scheme was used by the Mathematics Renaissance (see Chapter 6) in its final and fifth year to evaluate the impact on students of the professional development it provided to middle school teachers throughout the state of California. As part of TIMSS, hundreds of hours of classroom instruction have been videotaped in mathematics classrooms throughout the United States (U.S. Department of Education, 1996), which have been compared to those of classrooms in Japan and Germany using a very sophisticated coding and analysis procedure. Videotapes of classrooms of teachers participating in Mathematics Renaissance professional development were made, and similarly coded and analyzed. They were compared with a sample of the TIMSS tapes of U.S. classrooms to address the question, “Do students of Mathematics Renaissance teachers have a greater opportunity to develop the kinds of mathematical understandings, skills, and attitudes called for in the NCTM Standards and the California Mathematics Framework, than do students of teachers not involved in Mathematics Renaissance?”

Another resource for evaluating professional development comes from Thomas Guskey’s (2000) book Evaluating Professional Development. Guskey identifies five critical levels of professional development evaluation ranging from simple to more complex. Each level builds on the one before it.

- Level 1: Participants’ reaction
- Level 2: Participants’ learning
- Level 3: Organizational support and change
- Level 4: Participants’ use of new knowledge and skills
- Level 5: Student learning outcomes
For each level, Guskey lays out what questions are addressed, what information will be gathered through which evaluation methods, what is measured or assessed, and how the information will be used.

How do you take advantage of evaluation as a learning experience in and of itself?

Increasingly, evaluators are becoming partners with professional developers in a commitment to continuous improvement of programs and their results. Involvement is the key word here, through such activities as

- Engaging program staff as well as participants in specifying and discussing desired outcomes and identifying and prioritizing evaluation questions
- Involving staff and participants in the design or review of instruments or procedures for assessing outcomes
- Sharing responsibility with staff and participants for collecting data
- Engaging staff in analyzing and interpreting data
- Sharing responsibility for reporting learning from evaluation with a variety of audiences using a variety of formats

Each of these activities can contribute to staff and participant understanding of their own learning and that of others; of a variety of methods to assess important learning outcomes as well as interpret information gathered; of ways to specify and then to investigate the answers to important questions; and of how to communicate to a variety of audiences and develop arguments for new ways of acting.

A DISCLAIMER AND A PITCH

The design framework presented above is not perfect. It creates artificial distinctions among components like critical issues and context, which are far more interconnected than separate circles depict. It simplifies an enormously complex process. And it may miss important feedback loops and connections. With that disclaimer, allow us to advocate strongly for the use of a design framework such as this to guide professional development. Since the publication of the first edition of this book in 1998, we have seen the design framework lead to more purposeful and reflective professional development designs. Its use helps professional developers make conscious choices and resist the quick-fix approach. We are more convinced than ever that only through thoughtful and careful design, based on sound principles and strategies, can professional development be elevated from its current state.