TABLE 3.9 Parents and Community

Questions to Consider	Data Sources	Resources
1. What are parents' and the community's interests and concerns about the science and mathematics education program?	Parent and community surveys, interviews, focus groups	*Effective Public Engagement* by the Public Agenda Foundation for the New Standards Project (phone: 1-888-361-6233) *Supporting Reform in Mathematics: A Public Relations Sourcebook,* National Council of Supervisors of Mathematics, 1997 (Web site: www. ncsm.org)
2. To what extent do parents, school board, and community members understand/support the national standards' vision of science and mathematics teaching, learning, and professional development?	Same as 1	
3. How effective is the organization's approach to public engagement? To what extent have they reached out to diverse cultural groups?	Same as 1	
4. How well prepared are teachers and administrators to communicate and work effectively with diverse parents and community members?	Teacher, administrator, and parent surveys; interviews; focus groups	
5. Where in the community can you find support for your mathematics and science education program and use this as a resource for professional development?	Contact and interview education and business alliances, community foundations, and university partners and faculty	

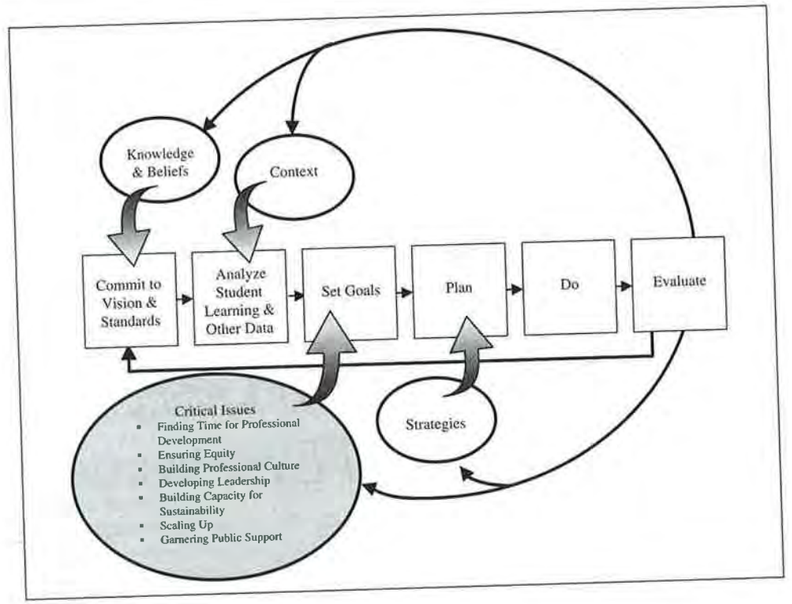
4

Critical Issues to Consider in Designing Professional Development

Seven critical issues need to be considered as one designs and provides professional development for teachers: finding time for professional development, ensuring equity, building a professional culture, developing leadership, building capacity for sustainability, scaling up, and garnering public support. (See Figure 4.1.) Readers who are familiar with the first edition of this book will notice the absence of two critical issues—evaluating professional development and supporting standards and frameworks. To emphasize the critical role of ongoing evaluation of professional development, we incorporated evaluation as one of the major steps in the design framework. Similarly, supporting standards and frameworks was incorporated into the design framework to show how important it is for professional development design to be driven by a vision of standards-based teaching and learning. (See Chapter 1 for a discussion of the stages of committing to a vision and standards and evaluation in the design framework.)

Each of the seven issues discussed in this chapter is important, and lack of attention to any one of them can ultimately doom a professional development initiative. As Susan Loucks-Horsley repeatedly warned when sharing the design framework with professional developers, "Ignore these at your own peril." The seven critical issues play an important role at different

Figure 4.1. Critical Issues Influencing Professional Development



stages in the life of a professional development program or initiative, but designers can be assured that each will influence the effectiveness of the program at some point. For this reason, it is important to consider each of them during the "set goals" stage in the design process and not only when the program or initiative is well under way. Anticipating that each issue will have an impact on the way in which the professional development program is implemented and sustained can enable designers to plan for ways to address each of them. For example, when setting goals and identifying specific learning outcomes to be achieved, it is imperative to consider the issue of finding time for professional learning. If designers intend to conduct collaborative study groups with grade-alike teachers during the school day, such a strategy will fail if policies and structures are not adjusted beforehand that provide the necessary time. In another example, inviting teachers to examine student work or engage in lesson study in a school in which isolation is the prevalent norm will meet with defeat if designers do not plan early to address ways to enhance the professional learning culture in the school.

This chapter discusses each of the seven critical issues and recognizes that entire books have been written on each. The intent of this chapter is to raise the awareness level of professional development designers to ensure

that the issues are not ignored and to suggest questions for professional developers to ask themselves as they design or reflect on their programs.

FINDING TIME FOR PROFESSIONAL DEVELOPMENT

It is clear that, for science and mathematics professional development to be effective, experiences for teachers must occur over time, provide ample time for in-depth investigations and reflection, and incorporate opportunities for continuous learning. (See Figure 4.1.) Finding adequate quality time to effectively carry out professional development programs or initiatives is a challenge faced by every professional developer. In fact, time has emerged as one of the key issues in virtually every analysis of school change appearing in the past decade (Fullan & Miles; 1992; Garet et al., 1999; Little, 1993; Loucks-Horsley et al., 1987; Loucks-Horsley, Stiles, & Hewson, 1996; National Council of Teachers of Mathematics [NCTM], 2000; National Research Council [NRC], 1996a; Sparks, 1994). The issue, however, is not just *finding* time but assessing how time is used, allocated, and distributed throughout the school day and throughout the academic year. Simply finding more time does not ensure more effective professional development opportunities for teachers. It is critical to use the time that is available in creative and unique ways to provide diverse learning opportunities for teachers. As the National Partnership for Excellence and Accountability in Teaching (2000) notes, "The one major reason for failure of schoolwide change models is the lack of teacher time focused on the right things. Districts actually may be providing sufficient support and time for professional development, but the results are less than desired because the time is not used well" (p. 11).

FINDING TIME FOR PROFESSIONAL DEVELOPMENT

- **How do you find ways to make more effective use of the time currently available within the school calendar for ongoing teacher learning?**
- **How can you work toward influencing state policies and public perceptions that support professional development?**

One challenge educators face is overcoming the traditional ways in which teachers, administrators, and the public view how time is spent in schools. Most schools are organized around the value—whether explicitly or implicitly acknowledged—that the most worthwhile use of time in schools is spent in direct contact with students. Although student learning *is* the most valuable outcome of schools, teachers' professional development greatly contributes to that learning. Until the view of learning for all,

including teachers and students, changes, educators will continue to bemoan the fact that "there isn't enough time!" As Tom Guskey (1999) notes, "If the additional time for professional development is to yield truly meaningful improvements, we must ensure that time is used wisely, efficiently, and effectively. This will require deep and profound changes in the organizational culture of most schools and in the perspectives of educators who work within them" (p. 11).

Advocating for quality time for teacher learning in schools is the responsibility of all educators. Fortunately, there is mounting evidence and research to support educators in their efforts to promote professional development embedded within the school day and the life of teachers. It will take devoted time to address the reforms in science and mathematics professional development and student learning being heralded by national standards. It cannot happen in one-shot workshops, during three professional development inservice days a year, or by attending several seminars that are disconnected from each other in their content and focus. As discussed in Chapter 2, the idea of building new understandings through active engagement in a variety of experiences over time, and doing so with others in supportive learning environments, is critical for effective professional development.

National standards are not the only impetus for moving the reform of professional development forward; the relationship between time and learning, for both teachers and students, was reviewed in depth by a nine-member commission of the National Education Commission on Time and Learning. The resulting report, *Prisoners of Time*, clearly stated that time for professional development is

> urgently needed—not as a frill or an add-on, but as a major aspect of the agreement between teachers and districts. They [teachers] need time to read professional journals, interact with their colleagues, and watch outstanding teachers demonstrate new strategies. (National Education Commission on Time and Learning, 1994, p. 36)

Almost ten years later, time for high-quality professional development continues to be a barrier. For example, the recent report from the National Commission on Mathematics and Science Teaching for the 21st Century (2000) supports and reconfirms the essential need for schools and districts to allocate time and institutionalize structures that support teacher learning. The report noted:

> Many people erroneously believe that teachers are not working unless they are standing in front of a classroom. In fact, preparation time, individual study time, as well as time for peer contact and joint lesson planning, are vital sources of both competence and enrichment for all teachers. But teachers are granted precious little time for any of these activities. Equally rare are extended periods of time set aside for teachers to have challenging educational experiences of their own. Everyone connected with and touched by the U.S. education system is responsible for changing the character of professional development and its impact. The place to begin improving mathematics and science teaching is with a *system* that promotes high-quality professional development opportunities for all teachers. (pp. 24-25)

Both reports reflect the continued emphasis throughout the country on the value and need for professional development for teachers.

Although changes have been made in numerous schools and districts throughout the country, professional developers still face challenges in reallocating time for professional development. One barrier is the current structure of schools. Teachers typically have only their lunch or planning period designated as time away from their students. Rarely are teachers able to use this time to collaborate or consult with their peers, reflect on either their teaching or their students' learning, or connect with others outside of the school environment. Implied in this statement is that teachers' own time is "designated" for them; rarely, however, are teachers empowered, or trusted, to "use their noninstructional time wisely and [historically they] have had virtually no control over the structure or use of their time" (Castle & Watts, 1992, p. 2).

Given the organizational structure of schools and the perception of how teachers should spend their working hours, what can professional developers do? How do professional developers design programs and initiatives that overcome the obstacles and allocate the necessary time needed to create continuous learning opportunities for teachers of science and mathematics? The following section suggests questions for professional developers to ask themselves as they tackle the issues surrounding time for professional development.

How do you find ways to make more effective use of time currently available within the school calendar? Even with the current structure and organization of schools, professional developers have been able to find ways to "creatively restructure" the time that is already available to teachers within the school day and the calendar year. A review of the literature finds that the solutions being implemented fall into several categories: released time, restructured or rescheduled time, common time, better-used time, and purchased time (Castle & Watts, 1992; Darling-Hammond, 1999; Guskey, 1999; Murphy & Lick, 2001; WestEd, 2000).

- *Released time.* This strategy entails freeing teachers from their regular instructional time with students. The most obvious approach is to provide substitute teachers so that teachers can participate in professional devel-

opment. Some schools have recruited principals and other administrators, parents, and volunteers to serve as substitute teachers; other schools use specialist teachers, such as art, music, or part-time teachers. Other options include team teaching and instituting community-based learning experiences or library research for students that free individual teachers from instructional responsibilities.

- *Restructured or rescheduled time.* This solution requires formally altering overall instructional time—the school day, the school calendar year, or teaching schedules. For example, some schools are implementing schedules in which students attend school one hour longer on four days and are released early on the fifth day or in which students arrive one hour later in the morning and stay one hour longer at the end of day, providing time in the morning for teachers to meet with one another. Some schools combine this approach with teachers arriving 30 minutes early, creating additional nonteaching time. Others have combined and reallocated the small amount of time that teachers are required by contract to stay after school each day to "buy" one or two 45-minute periods for collegial work before school each week. Others group students and teachers, using a team teaching approach, so that groups of teachers have scheduled time outside of the classroom. Year-round scheduling is increasingly being used by many districts, which creates larger blocks of time during semester breaks (e.g., three or four weeks) for professional development.
- *Common time.* To move teachers out of individual preparation time, schools are reorganizing time so that teachers have "common" times together. Common planning or preparation times can enable teachers to meet by grade level or by discipline or subject areas or as interdisciplinary teams. This arrangement is used for mentor and mentee teachers, creating a regular time for them to conference. Many schools are organizing planning time to follow or precede lunch time, giving teachers as much as 90 minutes of nonteaching time when they can interact with colleagues informally and/or in learning activities such as study groups, case discussions, and examining student work.
- *Better-used time.* Often, teachers' time outside of the classroom during the school day is consumed by faculty meetings and administrative tasks that limit their opportunities for collaborating with peers. Schools are finding ways to reduce the administrative nature of this time, allowing teachers to focus on their own professional development. For example, using e-mail for routine communication between teachers and administrators can save time typically spent in faculty or management council meetings discussing administrative issues. Other schools designate one staff meeting each month for professional development. A unique solution has been to move "nonessential" student-oriented activities, such as assemblies and club meetings, to after-school time or to recruit staff other than teachers to participate in activities, thus providing more time for teachers to meet. Also, professional developers can closely examine the days that are formally scheduled for professional development (often only three or four days a year) and reassess whether they are being used to best meet the teachers' needs and are designed around a comprehensive plan. In addition to examining existing professional learning time, professional developers are turning to technology for teachers' professional development. This avenue for learning allows teachers to engage in reflective, in-depth, and collegial learning via online courses, online study groups, or online book study.

- *Purchased time.* Even in the face of limited funds, professional developers have found ways to reallocate existing funds to provide time for professional development. Many schools and districts have taken advantage of the funding opportunities for professional development by obtaining grants from agencies, such as the National Science Foundation, or private foundations. Some schools and districts have established a "pool" of permanent substitutes or provide stipends for teachers to attend professional development activities outside of the school day, usually in the evenings and on weekends.

How can you work toward influencing state policies and public perceptions that support professional development? The suggestions described previously primarily focus on implementing solutions at the school or district level. Inherent in those solutions is the assumption that schools and districts do in fact have control over their own programs, have budgets for professional development, and can institute the kinds of restructuring identified—reorganizing school days and calendar years. Many professional developers, however, are faced with policies and perceptions that further impede their efforts to create meaningful learning opportunities for teachers, such as limited numbers of days allocated by state boards of education for professional development or public concern about teachers' time out of classrooms.

Professional developers can do much toward moving the reform of professional development forward. One step is convincing key stakeholders and policymakers that new forms of professional development are essential to support improved student learning and that providing time for professional development is critical. To accomplish this, professional developers must identify and define what is considered professional development at their local sites. Schools and districts that investigate their current professional development practices (inservice days, Saturday workshops, and after-school presentations) often find that they do not meet the teachers' needs for growth and learning. By redefining professional development to include teacher learning experiences such as case discussions, summer months spent in a scientific research lab, or action research conducted in the classroom, schools have reallocated funds budgeted for the annual inservice days to support these alternative forms of teacher learning.

Increasing public awareness of and support for teachers' professional development includes conveying the importance of teachers' ongoing learning outside of the classroom and emphasizing how this enhances student learning. The literature abounds with studies and reports that reflect the benefits of teacher professional development on student learning (Cohen & Hill, 1998; Klentschy, Garrison, & Amaral, n.d.; National Education Goals Panel, 2000; Sparks, 2002a; U.S. Department of Education, 2000; Wenglinsky, 2000; WestEd, 2000). Changing perceptions about what professional development "looks like" and how it benefits student learning can increase parents' and communities' understanding of its importance.

For time for professional development to be valued, all involved—including teachers, administrators, policymakers, and the public—must begin to reconceptualize school time. As Margaret Wheatley (2002) states,

> Schools that are truly learning communities for students and teachers alike require time for teachers to study and collaborate during the school day. If we want our world to be different, our first act needs to be reclaiming time to think. (p. 99)

ENSURING EQUITY

Ensuring equity in a diverse society has become extremely important as science and mathematics reform has shifted from producing a relatively few highly skilled scientists and mathematicians to promoting literacy in these disciplines for all citizens. Numerous reports document the underrepresentation of women, persons of color, individuals from low socioeconomic groups, and persons with disabilities in various aspects of science and mathematics, including careers, higher-level coursework, and opportunities to learn from adequately prepared teachers. The inadequacies of curriculum materials and instructional approaches for such a diverse population are often cited as a problem, particularly with the movement to build new learning on the learner's experiences and context. Widespread strategies such as tracking have come under attack as obstructing access to mathematics and science learning for a large portion of the student population.

ENSURING EQUITY

- **Is access to the professional development experience equitable? Is this opportunity available to all or does it favor people in certain locations, with certain lifestyles, and from certain cultural, gender, or racial groups?**
- **Does the design of the professional development invite full engagement and learning by participants?**
- **Does the content of the professional development experience include the issues of equitable opportunity for all students to learn science and mathematics and participate in careers in science and mathematics?**

How does equity relate to a discussion of effective professional development? A major issue involves equity for the participants in professional development: equal access for all teachers to quality professional development. (See Figure 4.1.) Access is only the beginning, however. Another issue is whether the programs are designed to support educators to examine and challenge their beliefs about who can learn and how diverse groups of students best learn. Programs must accommodate the diverse characteristics of educators, who have a wide variety of needs, learning styles, cultural backgrounds, and experiences. A final issue relates directly to the students: ensuring that what teachers learn in professional development provides them with the skills, resources, and sensitivities necessary to help a diverse student body gain literacy in science and mathematics. Thus, the issues relate to both the design and the content of professional development. The discussion here is organized around these three areas and proposes questions that professional developers can ask about their programs.

Is access to the professional development experience equitable? Is this opportunity available to all or does it favor people in certain locations, with certain lifestyles, and from certain cultural, gender, or racial groups? Access is a simple concept, but it is often ignored by professional development designers, who are not aware of the inequities that can be created when opportunities are offered to teachers. They may think they offer the same chance to everyone to participate in professional development, but many factors, some of which are in their control, inhibit participation. Some of these factors include scheduling, distance, and resources required to use what is learned. For example, there are many opportunities for teachers to participate in research during the summer and work side by side with scientists and mathematicians. Unfortunately, these opportunities are not always accessible to all teachers. Many teachers have summer jobs, and others have family obligations that prohibit them from enrolling in an intensive professional development program that will keep them away from home for multiple days or weeks.

States with a large number of rural schools struggle with the challenge of providing quality professional development for all teachers in all schools. Many districts, regions, and states have addressed this issue by instituting online professional learning and networking opportunities for teachers. For example, the Maine Governor's Academy for Science Education Leadership addresses the need to reach science teachers throughout the state. The program provides in-person learning sessions complemented by online study group and book study discussions and electronic networking, ensuring that teachers in the most remote regions, serving the poorest of students, have access to quality professional development. In other instances, videoconferencing allows isolated teachers to participate in

common learning experiences even when they are dispersed throughout a region.

Inequitable policies and practices in school funding can create unequal opportunities for professional development. Just examining the variation in how professional development funds are distributed and then used in different schools, districts, and states is enlightening. Resource-rich schools, which are unlikely to be those serving underrepresented groups, can better support the learning of their staff, considered by some to be a luxury or frill when lab equipment and books are in short supply. Access to professional development is restricted when teachers do not have the resources to buy the new materials the professional development program requires or recommends.

Does the design of the professional development invite full engagement and learning by participants? Making professional development accessible is a necessary first step, but the adequacy of its design will determine if it is truly equitable. Professional development strategies should be chosen to meet the diverse needs and learning styles of participating teachers. Unfortunately, professional development planners are not always aware of the characteristics of programs that could be problematic. Cultural norms may create barriers to some professional development activities, such as modeling and giving critical feedback. Programs that require consumption of large volumes of reading materials do not serve auditory and kinesthetic learners well.

Demonstrating equity in the design of professional development programs also involves who is chosen to play leadership roles. The designation of leaders sends a strong message about the priority of equity and its role in what and how educators learn. Schools need to select professional development leaders who represent the diversity in both the teacher and student population, understand and value equity and diversity, and proactively involve teachers in professional development efforts who are from underrepresented groups and/or teach underrepresented students.

In California, Carne Barnett Clarke and Alma Ramirez have actively recruited and supported teacher leadership development among African American, Latino, Native American, and other underrepresented groups through WestEd's Mathematics Case Methods Project. In the initial stages of the project, Clarke found relatively few minority teachers volunteering to participate in the professional development sessions that use mathematics case discussions to enhance teachers' pedagogical content knowledge. Since one of the explicit goals of the project is to reach a diverse audience of teachers and to develop a diverse group of teacher leaders as case facilitators, Clarke examined the ways in which teachers were recruited and invited to participate. She found that the practice of contacting schools and sending out fliers resulted in recruitment of the "usual suspects"—the most active, frequently engaged teachers were the ones who attended or were

nominated by their principals and were most often not representative of a diverse group of teachers. For example, Clarke found that in the initial case discussions most teachers were white, shared a common pedagogy and philosophy of teaching and learning, and were more experienced teachers. There were few teachers of color and no new and inexperienced teachers, and there was a lack of diverse perspectives about teaching.

To address the lack of diversity among participating teachers and the resulting pool of people to develop into case facilitators, Clarke and her staff began to personally invite teachers from more diverse backgrounds, contact previous case discussants asking them to nominate teachers, and encourage and support leadership among diverse participants. Case discussions were also designed to help teachers move from low-risk engagement to higher-risk participation, such as sharing the facts and details of the case before critically examining the teaching beliefs or behaviors of the case teacher. These strategies resulted in case discussions characterized by diverse perspectives, confident case discussants, and case facilitators who represent varied cultural backgrounds and experiences (Ramirez & Barnett Clarke, 2000).

Does the content of the professional development experience include the issues of equitable opportunity for all students to learn science and mathematics and participate in careers in science and mathematics? The goal of equitable science and mathematics education is to equalize outcomes for all students regardless of their race, ethnic heritage, gender, disability, class, or learning style. How can professional development help teachers improve their strategies for reaching all students with effective science and mathematics education? One way is to introduce tools that assess student progress and allow teachers to identify differential impact on groups of students; areas of identified weakness can be the focus of professional development. Research-based programs that show results for increasing motivation and achievement among minority children and females can be included in professional development. Support groups can explore the problem of equity through reading and discussing research and evaluation reports. Schools can carefully examine their student learning data and data on structures, such as tracking, to identify imbalances in equitable opportunities for student learning.

In addition, research increasingly shows that "the professional development that makes a difference for students of color is professional development that deepens teachers' knowledge of the curriculum they are teaching, helps them find or create effective lessons, and enables them to assess and respond to student performance" (Haycock & Robinson, 2001, p. 18). In other words, *effective* professional development—professional learning opportunities that embody the characteristics of practice-based learning for teachers—leads to enhanced learning of *all* students. The content of professional development should focus squarely on the practice of teaching

and learning; that focus in and of itself can enhance equitable learning for students. In fact, in Pittsburgh, Briars and Resnick (2001) found that African American students in schools whose teachers were involved in ongoing curriculum-based, mathematics professional development performed better on standardized tests than did Anglo students in schools that were not considered "high-implementation" schools.

Issues of equity in mathematics and science education reveal themselves in many elements of education; opportunities for educators to become aware of the current situation and ways to think about change are very appropriate as content for professional development. Exploration of how students best learn challenging content in a second language, the impact of tracking on opportunities to learn, cooperative learning as an alternative pedagogical approach, testing, and parent and community collaboration can all be important issues for professional development for mathematics and science teachers, administrators, and other educators.

Numerous programs have been developed in recent years to specifically address equity in teaching, learning, and schools, including the work of the Education Trust (www.edtrust.org), the Dana Center's Advanced Placement Equity Initiative (www.utdanacenter.org, and TERC's Weaving Gender Equity Into Math Reform. Many Web sites, books, and journals, including publications by the NCTM and the National Staff Development Council (NSDC), are now devoted to the topics of equity and diversity. In addition, Weissglass's (1996) early work in mathematics education remains a good example of addressing the issues of equity for both education in general and professional development. His work suggests the need to make equity the central focus of the reform effort. His professional development goal is to help educators understand the relationship of mathematics and culture and to increase their capacity to provide mathematical experiences that meet both the needs of a diverse student population and the NCTM standards. Through reading, discussion, and observation, educators in Weissglass's programs explore how cultural values and ways of understanding can affect mathematics learning and teaching; understand the culture of mathematics and the value of building classroom mathematics on children's own experiences; examine instructional materials though an "equity filter"; and experience the application of mathematics to understanding important social issues, such as hunger, poverty, and teen pregnancy. These kinds of experiences help educators to better understand the issues of equity as part of their own professional development.

BUILDING PROFESSIONAL CULTURE

The culture of a school contributes to the learning of all within its walls. As described in Chapter 3, a school that embodies a collaborative culture and professional learning community is characterized by a strong vision of

learning, is focused on continuous learning, promotes a community of learners who all take responsibility for learning, "deprivatizes" teaching through collaborative and collegial interactions, and routinely supports and engages in collaborative inquiry and dialogue (DuFour & Eaker, 1998; Fullan, 2001; Love, 2002). Without a supportive culture, professional learning of teachers has little chance of survival —teachers' newly gained knowledge and skills have little chance of having a lasting impact on their practice. What can professional developers who aim to help teachers foster improved learning of science and mathematics do? Especially in instances in which the professional development opportunity is neither inside the school nor connected with the school or district in any way, professional developers have special challenges for nourishing professional cultures. The first step in that direction, however, is to understand what is known about professional culture and why it is important. (See Figure 4.1.)

BUILDING PROFESSIONAL CULTURE

- **What is a good starting place for building a professional learning culture?**
- **What can professional developers specifically do to build professional communities among teachers?**

Rosenholtz (1991) aptly coined the terms *learning enriched* and *learning impoverished* to describe elementary schools in which students, teachers, and other members of the school community either learned and grew in an exciting, supportive environment or languished with none of the expectations, norms, and rich learning experiences to help them grow. Little's (1982) early work on professional development pointed out differences between schools in which teachers talked continuously about their teaching and their students, experimenting with new strategies and sharing successes and failures, and those in which teachers were isolated, private, and not prone to innovation. Both researchers found student learning differences that favored schools in which teachers also learned. More recently, researchers (Bransford, Brown, & Cocking, 1999) have identified four characteristics of effective learning environments:

- Learner-centered environments that focus on the knowledge and experiences learners bring to the situation
- Knowledge-centered environments that emphasize teaching new content and concepts in ways that align with how people learn the discipline
- Assessment-centered environments that provide learners with ongoing feedback on their learning and promote self-reflection on learning

- Community-centered environments that nurture learning communities characterized by collaboration, collegial interaction, and reflection

Schools that develop learning environments that incorporate all four aspects of professional communities provide a *learning enriched* environment for both students and teachers.

In their studies of high school departments, McLaughlin and Talbert (2001) determined that strong professional cultures are "essential" to changing norms of practice and pedagogy. This happens when teachers examine assumptions, focus their collective experience on solutions, and support efforts on the part of everyone to grow professionally. Professional communities with norms of privacy and unchallenged sacred principles or personal beliefs breed embittered, frustrated teachers. Interestingly, departments within a single high school can have such different professional cultures that the influence of school leadership seems much less important.

Researchers with the Qualitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) project have examined teacher development and change in middle schools through a "community of practice" framework (Stein, Smith, Henningsen, & Silver, 2000), which was originally developed by Lave and Wenger (1991). The notion of a "community of practice" helps describe how teacher learning occurs in collaborative, school-based communities. For example, in looking at ways in which "newcomers" to a school were participating in the community, QUASAR found that simply being a "member of a community of practitioners provides meaning and context to newcomers' learning experiences" (Stein et al., 2000). The community provided opportunities to observe teaching strategies in action, to hear stories about the process of changing, and to become immersed in the "language" of reform. Rather than teacher collaboration being simply a contextual variable that enhances individual change and growth, it also nurtures and supports learning and change in the community. It is the culture of the community itself that contributes to both individual and group changes and learning.

These findings about the power of professional community cut across levels of schooling. They provide clues to what professional developers working with teachers of science and mathematics can do to foster deeper learning and development. The following paragraphs provide questions that professional developers can ask themselves to improve the impact of their programs by building professional culture.

What is a good starting place? Professional developers have used three strategies to build professional communities. First, they have increasingly required teacher participants to bring colleagues and principals with them to share in learning. For example, teachers are asked to participate in pairs or

teams with an administrator. Having an administrator present can be important in creating both the culture and the structures to support professional community back at the school. In other cases, the professional development is for the whole department (as in high schools and some middle schools), whole school, or even whole district so that an entire staff learns together. Community District 2 in New York City (see Chapter 3) is an example of an entire district transforming the culture of both individual schools and the way in which teaching and learning are perceived throughout the district.

A second strategy is for professional developers to build their own professional communities outside the boundaries of departments, schools, or districts. The professional networks described in Chapter 5 provide examples. The professional developers supporting these networks take pains to build relationships among their members that lack only the physical proximity of an intact teaching staff. A critical ingredient of what some call "temporary systems" is that they continue overtime, purposely nurturing the relationships between their members in an ongoing way rather than severing them after a "main event," such as an institute or workshop experience.

A third strategy that professional developers have used to nurture professional community is to work with individual participants to equip them with ways to build their own professional communities "back home." This is not the "each one, teach one" strategy that some use, largely unsuccessfully, in which teachers learn new skills and strategies and are expected to return to their schools and teach others the same skills and strategies. In the case of developing a professional community, professional developers suggest and encourage sharing of strategies for teachers to use in their schools to (a) initiate and sustain dialogues about what they have learned, (b) work with their administrators to build realistic expectations and garner support, and (c) encourage others to participate in similar, complementary learning experiences. For example, teachers may return home with study guides for examining articles or videos that engage others in what they are learning. They practice "reentry" behaviors that keep them from becoming isolated by virtue of their changing beliefs and values and enthusiasm for new ideas and approaches and that allow them to respond constructively to questions and issues raised by others. They may also learn how to work collegially with peer teachers and how to coach prospective teachers who are placed with them for practice teaching. These kinds of strategies help teachers make inroads in building or strengthening their own professional communities.

What can professional developers specifically do to build professional communities among teachers? Research indicates that professional communities thrive where collaboration, experimentation, and challenging discourse are

possible and welcome (Elmore & Burney, 1999; Fullan, 2001; Hord & Boyd, 1995; Little, 1993; Norris, 1994; Sparks, 2002a; St. John & Pratt, 1997). Collaboration is fostered through finding time for professional learning (see the section Finding Time for Professional Development above). Also, collaboration must meet the needs of participants; there must be something in it for each of them, and it must have a purpose that is better served by collective rather than individual work or expertise. The purpose of collaboration must be improving student learning; clear goals for students coupled with use of student learning data, including student work, help teachers to maintain that focus. Effective collaboration requires special skills—in communication, "data-driven dialogue," decision making, problem solving, and managing meetings. Finally, collaboration requires a genuine caring about others that can be strengthened through opportunities to do constructive work together and to share interesting and stimulating experiences. Professional developers can foster collaboration through structuring experiences of shared learning and special skill development.

It is important to note that collaboration as a vehicle for learning and community building can be a negative as well as a positive force. Fullan and Hargreaves (1991) point out that "contrived collaboration" can take teachers away from valuable time with students, and "groupthink" can stifle rather than stimulate innovation and imaginative solutions. McLaughlin's (1993) research has found collegiality can focus on being critical of students and reinforcing norms of mediocrity. The chances of collaboration taking a more "learning-enriched" path are increased when it is accompanied by experimentation and challenging discourse.

Experimentation requires skills and dispositions toward inquiry, norms that recognize and support failure, and ideas with which to experiment. Although this does not refer specifically to formal action research, insights into fostering inquiry are provided in the discussion of action research as a professional development strategy in Chapter 5. Professional development programs can be sources of new ideas and practices with which to experiment and can assist teachers to do so in ways that increase their potential for learning. More difficult is the issue of making it okay to fail. Teachers, who are often perfectionists, have traditionally been expected to be the source of knowledge and thus must always have the right answers. Learning to accept and learn from failure is harder for some than others. It can be enhanced by having a critical mass of people who value it, a structured way to reflect on both successes and failures, and a clear picture of which situations are low stakes and which are high—that is, the ability to analyze the consequences of failure for different situations.

Finally, challenging discussions are not very common among teachers, who often equate criticism with personal inadequacies. Building professional cultures, however, by the very definition of *professional*, carries with it a commitment to effective practice in oneself and in others who share the profession. Desiring high-quality teaching for all students requires teachers

to challenge their own practices and the practices of others to improve the learning opportunities for all. Teachers need skills and practice in applying standards of effectiveness to their and others' practice; in gathering, analyzing, and explaining the evidence for their convictions; and in communicating criticisms to each other, both positive and negative. It cannot be otherwise because the science and mathematics teaching promoted by the standards requires challenging what the learner thinks he or she knows to reorganize or deepen understanding. What we want for students, we should want for ourselves as learners. Often, difficult discussions are the ones we learn from most.

Professional developers can purposely build structures that promote a positive professional culture by breaking down isolation through strategies such as study groups, coaching, mentoring, lesson study, examining student work, networks, and case discussions (see Chapter 5). They can teach teachers skills of collaboration, problem solving, and inquiry. Also, they can equip teachers with tools and techniques to build and maintain supportive, professional communities in their schools.

DEVELOPING LEADERSHIP

Leadership is a critical issue in professional development for two reasons. First, leadership development is an explicit goal of a large majority of professional development initiatives in science and mathematics. Numerous science and mathematics projects design professional development experiences for principals and administrators, teachers, and other educators involved in the improvement of science and mathematics education. The extent to which the goal of developing leaders is achieved, however, varies greatly. Second, from research on professional development and change in schools it is clear that leadership and support are required for professional development experiences to be turned into changes in teaching and learning (Bybee, 1993; Fullan, 1991; St. John & Pratt, 1997). The support and advocacy of leaders for the professional learning of teachers legitimize changes, provide resources, and create expectations that changes will occur. (See Figure 4.1.)

DEVELOPING LEADERSHIP

- **Is leadership development a goal of the professional development program or initiative?**
- **If developing leaders is important, what is meant by a leader and what roles do leaders play?**
- **What specific roles of teacher leaders are we interested in developing?**
- **How can these and other roles be developed?**
- **Are there roles other leaders must play for professional development to be successful? If so, how can they be developed?**

In this section, leadership is addressed from these two perspectives, and questions to attend to in designing professional development are suggested.

Is leadership development a goal of the professional development program or initiative? The answer to this question should be "yes." In Chapter 5, developing leadership is identified as one of the major purposes of professional development programs; it should influence the selection and combination of strategies. Currently, most professional development programs or initiatives identify developing leaders as a goal of their work in education based on the overwhelming literature that emphasizes the critical role that leaders play in reforming science and mathematics education. For example, in an examination of national standards focused on professional development for science and mathematics teachers, professional development in general for teachers and principals, and professional development for technology for teachers and administrators, leadership development is a component of effective professional development mentioned in all of the documents. Studies also indicate that leadership is an essential element of educational change. St. John and Pratt (1997) found that in sites in which science and mathematics reforms were successful, there was one or more long-term, highly skilled leader involved. There are hundreds of institutes and academies that have been initiated in recent years to focus on the professional learning of leaders, from classroom teachers to principals and other administrators. The key issue for professional developers designing programs is to ensure that individual leadership efforts align with and complement the entire design of the program.

If developing leaders is important, what is meant by a leader and what roles do leaders play? Effective leaders are connected to networks through which they gain access to resources and support for continuing the work of reform. They primarily focus on issues of educational substance such as supporting new curriculum and instructional and assessment practices, while remaining smart about the politics and organizational and cultural issues that may thwart them (Kaser, Mundry, Stiles, & Loucks-Horsley, 2002). They see standards not as a lockstep formula to be followed but rather as guideposts to lead and direct efforts. They anchor change efforts in a vision of effective learning and build support for the vision and the practices needed to support it. They continuously reflect on and inquire into teaching and learning and engage in professional discourse. They use research-based models as a way of understanding and leading change (Anderson & Pratt, 1995). They have moral purpose, actively build relationships, create coherence, and encourage the creation and sharing of knowledge (Fullan, 2001).

Kouzes and Posner (2001) identify five practices exemplary leaders use:

- Challenging the process: Searching for opportunities to change the status quo and innovative ways to improve.

- Inspiring a shared vision: Seeing the future and helping others create an ideal image of what the organization can become.
- Enabling others to act: Fostering collaboration and actively involving others.
- Modeling the way: Creating standards of excellence and leading by example.
- Encouraging the heart: Recognizing the many contributions that individuals make, sharing in the rewards of their efforts, and celebrating accomplishments.

All leaders need to develop the knowledge, skills, and abilities previously identified—teachers, principals, district administrators, policymakers, and other educators involved in science and mathematics education. Leaders play different roles at different times. Leadership implies that there are others to lead and, thus, a leader must have authority whether it be vested in the position itself; in the personality, character, or expertise of the person; or in the vision that is espoused. They recognize and accept the responsibilities of leadership. Teacher leaders and administrators alike share leadership roles of advocating for science and mathematics education with parents and the community. Although the specific roles that leaders play varies, as Michael Fullan (1993) notes, for change to be successful, everyone must be a leader.

What specific roles of teacher leaders are we interested in developing in science and mathematics education? Increasingly, teachers are taking on formal and informal roles as educational leaders. Through the National Academy for Science and Mathematics Education Leadership at WestEd, we have seen firsthand the passion and power that are unleashed when talented teachers take responsibility for changing the quality of teaching and learning in their schools. Using data to guide them, they become superb diagnosticians focusing in on what needs to be done, who needs to be involved, and where to start the "treatment." New forms of teacher leadership are resulting in teachers who believe they can do something about the crisis in education. As Crowther, Kaagan, Ferguson, and Hann (2002) write: "Ultimately, teacher leadership as we intend it, is about action that transforms teaching and learning in a school, that ties school and community together on behalf of learning, and that advances social sustainability and quality of life for a community" (p. xvii). Teachers are playing key leadership roles in supporting the learning of their colleagues, including the following:

- *Teacher development.* Many professional development programs support teachers to conduct presentations or workshops for other teachers in the new practices they themselves are learning. In addition to the role of presenter, teachers can act as coaches and facilitators of various kinds of profes-

sional learning experiences, such as study groups, case discussions, or demonstration lessons. As professional development opportunities shift from workshops offered by external experts to job-embedded forms rooted in teaching practice, teachers' ability to guide these efforts is increasingly important. They can also plan and initiate professional development for others, even if they do not conduct it themselves.

- *Curriculum, instruction, and assessment.* As an extension of their involvement in professional development, teachers can play leadership roles in curriculum, instruction, and assessment. Teachers play key roles as members of school and district committees that plan curriculum, adopt textbooks and other instructional materials, select or develop assessments, and respond to new initiatives—for example, a call to implement national and state standards for the teaching of science and mathematics. Finally, teachers can use their mathematics or science expertise by being a resource teacher for their peers.
- *School improvement.* Teachers can play additional leadership roles beyond their classrooms by facilitating communication among teachers, serving on school leadership or management councils, and addressing political problems with administrators and community members that relate to new ways of teaching and learning science and mathematics (Ferrini-Mundy, 1997). They can participate in or facilitate networks within or across schools, both in person and through electronic means.

Leadership roles provide teachers with numerous benefits, both personally and professionally. As Roland Barth (2001) states,

> Teachers win something important. They experience a reduction in isolation; the personal and professional satisfaction that comes from improving their schools; a sense of instrumentality, investment, and membership in the school community; and new learning about schools, about the process of change, and about themselves. All of these positive experiences spill over into their classroom teaching. These teachers become owners and investors in the school, rather than mere tenants. They become professionals. (p. 449)

How can these and other roles be developed? Professional developers in mathematics and science have made it increasingly clear that good teachers of students do not necessarily make good leaders of adults. Although even the business literature increasingly views effective leaders as those who can teach and coach (Senge, 1990), experienced teachers require special development opportunities to effectively take on roles of leadership (Ball & Cohen, 1999; Darling-Hammond & McLaughlin, 1999; Friel & Danielson, 1997; Grady, 1997; Katzenmeyer & Moller, 1996). Furthermore, professional developers must be clear about their expectations of the roles participating

teachers are to play during or after their professional development experiences (Joyner, 1997). Often, teachers are surprised by the expectation that they are responsible for leading others in the new practices they are learning. In Chapter 5, the strategy in the section Developing Professional Developers describes the skills that teachers find useful as they take responsibility for the professional development of others. As they take on additional leadership roles, however, teachers need more. They need an understanding of leadership, including the bases of power and different leadership styles. They also need skills in decision making, building and managing teams, conflict resolution, using data as a guide to instructional improvement, problem solving, vision building, communicating, and managing diversity. They need to be astute about how to operate as leaders among their peers. Especially in the absence of a professional culture, teacher leaders can become targets and find that their colleagues are reluctant to accept them in their new roles.

Developing leadership does not stop with learning new knowledge and skills. As in any other professional development, teachers learning to be leaders require ongoing support and opportunities to learn over time and to experiment with some of their new skills and strategies, receive feedback, discuss problems that arise, and make appropriate changes. Professional development designers have found it useful to structure regular meetings of teacher leaders for these and other purposes (see especially the Cambridge school district and Mathematics Renaissance cases in Chapter 6).

Are there roles other leaders must play for professional development to be successful? If so, how can they be developed? Administrator leadership is required for professional development to promote learning and changes in classroom practices. Principals, for example, support changes in school mathematics and science through such roles as advocate, facilitator of curriculum selection or development, provider of funds and other resources, broker of professional development and other support, monitor of progress, and troubleshooter (Mechling & Oliver, 1983). They also must understand their role in supporting teachers by learning to anticipate how teachers will feel and behave as they change their practices; what help teachers are apt to need and when; what materials, other supplies, and support staff are required; and what outcomes they can expect from the changes teachers are implementing. In addition, principals must become instructional leaders and therefore must develop their own in-depth understanding of science and mathematics standards, instructional strategies, professional development, the change process, assessment, and curriculum (Fullan, 2000, 2002; Institute for Educational Leadership, 2000). Their own professional development, in fact, mirrors effective professional development for teachers: It should be long term and planned, focus on student achievement, job-embedded, supportive of reflective practice, and provide opportunities to work, discuss, and problem solve with peers (Educational Research Service,

1999). All these leadership activities and experiences reinforce the importance of building a learning community around new ways of learning and teaching and of working together to change perspectives and expectations. Learning together, when it is done in an open and trusting environment, can build respect for different roles and relationships that help school staffs with the difficulties of significant change.

Leadership is required for professional development to make its impact felt in schools and classrooms. Professional development programs can address this by building the leadership knowledge, skills, and dispositions of participating mathematics and science teachers, as well as in administrators, at all levels of schooling.

BUILDING CAPACITY FOR SUSTAINABILITY

Often, professional developers view their role as more than providing opportunities for individual teachers, or even all teachers within a school or a district, to learn and grow. Indeed, they see an important role in building the capacity of the system—whether of a school or a district or some combination of those and universities, and other members of the community—to support teacher learning and development in an ongoing way. What would it mean to build capacity? What would it look like if there were capacity to sustain ongoing professional learning? This section suggests some questions that professional developers can use to determine how they do or could contribute to the capacity of their systems to sustain ongoing professional growth. (See Figure 4.1.)

BUILDING CAPACITY FOR SUSTAINABILITY

- **Would you know capacity if you saw it?**
- **Do you employ and develop people who can work with teachers to support their learning and teaching?**
- **Do you build support systems for professional development providers?**
- **Do you recognize, study, and apply the knowledge base of professional development theory and practice and help others do so?**
- **Does your professional development program support "subcultures" in which professional development can flourish?**
- **Do you work to create and influence policies, resources, and structures that make professional development a central rather than a marginal activity?**

Would you know capacity if you saw it? A conference of mathematics and science educators pondered this question (and others) in the fall of 1994 (for the full report, see Friel & Bright, 1997). The conference proceedings concluded that components of capacity, which can be present at any system level from local to national, are the following:

- People who can work with teachers in supporting their learning and teaching

- Support systems for professional development providers
- A knowledge base of professional development theory and practice
- Supported subcultures in which professional development flourishes
- Policies, resources, and structures that make professional development a central rather than a marginal activity

These elements constitute an "infrastructure" for professional development. Without a strong infrastructure, professional development can be of uneven quality and insufficient quantity, is not cost-effective, and comes in the form of projects that are not sustainable, accessible, or inclusive.

The Consortium for Policy Research in Education (CPRE) conducted a study of 22 schools districts to examine the ways in which school districts effectively support sustained capacity for student and teacher learning. The report (Massell, 2000) notes four strategies common to all of the districts: (1) interpreting and using data to drive decisions about teaching and learning, (2) building teacher knowledge and skills through professional development, (3) aligning curriculum and instruction with both state policies and other reform efforts in the schools and districts, and (4) targeting additional interventions on low-performing students or schools.

Do you employ and develop people who can work with teachers to support their learning and teaching? In the previous section, leadership for professional development was discussed. Here, the importance of leadership is underscored. Traditionally, most of the individuals responsible for staff development were located in higher education and midlevel school district administration. The current view of professional development calls for a much broader range of individuals who can facilitate and lead professional development experiences for and with teachers. These include teachers who are in leadership positions, science and mathematics resource teachers, staff developers within school systems, and principals. Building capacity for mathematics and science reform means developing a wide range of opportunities for individuals in all these roles to expand their existing professional knowledge to work with teachers in facilitating learning.

Professional development initiatives that are invested in building the capacity of the system to sustain the gains they help teachers make must identify individuals who are willing and able to provide leadership and must provide professional development that assists them in understanding and taking on expanded leadership roles. The previous section on leadership and the Developing Professional Developers section in Chapter 5 discuss how this might be done.

Do you build support systems for professional development providers? In addition to teachers, professional developers also need support and opportunities for ongoing learning and development. The development of a larger and

more cohesive cadre of professional development providers is of critical importance to sustaining effective professional development. They need opportunities to learn, network with others in similar roles, and confront challenges and solve problems together that are too large for them as individuals. Building capacity and sustainability for mathematics and science education thus means developing and maintaining a diverse array of structures to provide this ongoing support.

Do you recognize, study, and apply the knowledge base of professional development theory and practice and help others do so? As described in Chapter 2, there is a substantial knowledge base for professional development theory and practice that covers a wide range of both the contexts for professional development and the kinds of professional development experiences that can occur. This knowledge base includes psychological studies of teachers in the process of changing their beliefs, mathematics and scientific knowledge, and classroom practice; research on the process of staff development itself; studies of teachers in subject matter collaboratives and networks; studies of a variety of strategies of professional development; and teachers' own writing about their practice and about changed classrooms.

Professions are defined, in part, by shared knowledge, both practical and theoretical, that becomes a common language with which to communicate and improve. In fact, creating and sharing knowledge is one of the key roles of leaders (Fullan, 2000). Building the profession of professional development, and thus building capacity in the system to initiate and sustain ongoing learning, requires that the knowledge base be recognized, built on, shared, and implemented.

Does your professional development program support "subcultures" in which professional development can flourish? Increasing systems' capacities to sustain the continuous learning and growth of teachers is not limited to increasing the number of programs in which teachers can participate for specific lengths of time. It also includes making opportunities available to teachers on an ongoing basis in which they can "join" a subculture that embodies the values of high-quality teaching and inquiry about teaching. Such subcultures provide ongoing support for teachers who have participated in a particular program and those who might join one again but currently choose a different form of learning. They also provide "rampways" for teachers who have not previously been engaged in intensive professional development but would like to try it on a limited basis. Finally, they provide contexts that can sustain teachers over the long term and in which continuous questioning and learning about teaching are encouraged.

The nature of the reform movement that is embodied in the mathematics and science standards not only requires change and learning on the part of a large number of teachers but also implies a different intellectual culture for schools than is typical. Therefore, capacity must be built not only for each teacher to reflect on and examine his or her own teaching but also

for the culture of teaching and schooling itself to change. Viewing reform as a cultural matter, as well as an individual psychological one, opens new avenues. The deliberate creation of supportive subcultures in different parts of the system would begin the process of cultural change.

Thus, building capacity for sustainability means initiating, developing, and supporting teacher subcultures at social and organizational levels that will complement efforts designed to build capacity at individual levels.

Do you work to create and influence policies, resources, and structures that make professional development a central rather than a marginal activity? In addition to adding a variety of structures and activities to what is currently available for teachers' learning, it is clear that certain current state and local policies and financial arrangements constrain the degree to which teachers can participate thoughtfully in the professional development opportunities available. This means that to increase what is available to teachers, it is necessary to identify and institute policies that increase the capacity of teachers and schools to take advantage of what is available. As long as structures and financial policies marginalize professional development, whatever capacity can be built will be underutilized.

For example, educational systems are plagued by schedules that impede professional development during the school day, a major obstacle to promoting job-embedded learning. Schedules also challenge teachers' ability to work in teams, often a condition that supports job-embedded learning. Schools and districts often lack a commitment to long-term and consistent priorities for teacher learning that would support teachers to develop in any one content area over time.

Professional developers must work with policymakers at all levels to develop and institute policies that recognize that professional development for all educational personnel is an essential component of an effective school system rather than an add-on activity that can be eliminated in difficult times. Strategies for developing supportive policies are also addressed in Chapter 3 and in this chapter in the sections Garnering Public Support and Finding Time for Professional Development.

SCALING UP

Scaling up becomes an area of great concern as school districts implement new teaching and learning strategies. At the school level, programs are often initiated with vol-

SCALING UP

- **Is the innovation clearly defined and based on a sound foundation?**
- **How do you provide professional development opportunities to large numbers of people?**
- **Does each teacher have sufficient support to change his or her practice?**
- **What mechanisms are in place for quality control of the professional development for all?**
- **Is there a plan at each unit of implementation (department, school, district, state, etc.) for ongoing use, support, and institutionalization?**

unteer teachers or the "early adopters." Many resources are invested in this first wave of users, often without a plan for bringing the rest of the faculty on board—which can be a bigger challenge. There is a need to scale up the use of effective practice throughout the school district. (See Figure 4.1.)

At state and regional levels, there are some districts or schools that have benefited from educational changes while others have been untouched. There is a need to scale up to reach those that have not been served. Since there are about 100,000 schools and more than 3 million educators in this country, the challenge of reaching these large numbers is daunting.

The particular challenge for many professional developers is how to design programs and initiatives so that they are able to reach a significant number of teachers. In the past, many have been able to work with the volunteer teachers in summer institutes, help a school select and get training in a new curriculum or instructional practice, or work with one or two teachers from each of several schools who then return and help their schools implement changes. None of these strategies have worked particularly well for reaching large numbers of teachers however, except in the most superficial ways. Furthermore, funding agencies are less interested in creating "pockets of innovation" and are impatient to spread reform more broadly. Witness the large percentage of resources from the National Science Foundation that are currently supporting systemwide initiatives, such as the Mathematics and Science Partnerships, designed to provide in-depth professional development to all teachers in a school district or region.

How can professional developers address this need to reach large numbers—that is, to scale up from a few to many? Although there is no single answer to this question, several factors, discussed in this section, can contribute to success.

Is the innovation clearly defined and based on a sound foundation? The literature reflects different ways of thinking about what is being scaled up. In the implementation literature, the "innovation" is a program or practice new to the setting (Fullan, 1991; Wilson & Davis, 1994). School improvement and reform efforts refer to a vision or purpose (Olson, 1994). Others refer to standards or "normative practice" (Elmore, 1996). The common theme is that it is important to articulate what the change is supposed to look like when it is being practiced: what teachers and students are doing (and not doing) and what one would see in classrooms and schools if the program was working well (Hall & Hord, 1987, 2001). This does not necessarily imply a highly prescriptive set of teaching behaviors and materials, although it could; even the national standards for science and mathematics are specific enough to reveal themselves in teachers' practices and students' responses. One knows them when one sees them.

Therefore, clarity is important but so are utility and practicality because unless a change seems possible, it will not be attempted. There must be evidence that it does not require superhuman efforts, skills that few have or can

develop, exotic equipment, or special classroom or school situations (e.g., extra staff), or that it does not rely on a specific teacher or a unique situation. Finally, the change must be credible and backed by evidence that if this change were to occur, clear benefits would ensue for teachers, students, and schools. These attributes of a change make it better able to be shared from one place to another, to be picked up by larger numbers of people, and to be communicated to those whose support is needed for it to become common practice (Fullan, 1991).

How do you provide professional development opportunities to large numbers of people? This is a particularly difficult question to address. Rarely does professional development succeed when it is "delivered en masse" because it usually lacks attention to individual needs, person-to-person interaction, and opportunity for in-depth study and experimentation. Several strategies, however, are being used to reach large numbers. One is technology for professional development (as discussed in Chapter 5). Technology enables teachers from throughout the country to engage in ongoing professional learning with other teachers, facilitators, scientists and mathematicians, and course instructors. In some instances, such as a videoconference course, there is no limit to how many people can participate, especially when combined with smaller group learning strategies, such as online book study or online study groups. Other means of providing professional development through technology, as noted in Chapter 5, have limitations similar to other in-person professional learning strategies: They are limited by how many participants a single moderator or instructor can respond to and engage in learning.

Another strategy is to use a *multiplier*, which is referred to by many names, including *certified trainers*, *teacher leadership cadres*, or *teachers on special assignment*. This strategy is discussed in Chapter 5 in the Developing Professional Developers section, in the cases in Chapters 6 and examples in Chapter 7, and in this chapter in the Developing Leadership section. Here, a cadre of teachers or other educators learn science or mathematics content and pedagogy, master the new practice(s) in their own classrooms, and are prepared to work with adult learners and are given time to do so. This can have a *multiplier* effect, enabling larger numbers of teachers to be reached.

Professional development does not have to be "one size fits all" but rather should be a combination of strategies. For example, teachers can learn new teaching practices through workshops, institutes, coaching, study groups, case discussions, and immersion experiences. Reaching large numbers is not about everyone having the same experience and having that experience in a constrained period of time. When teachers are offered a variety of strategies from which to learn, and these are offered over an extended period of time, many people can be reached. Here, the issue may be one of focus. When schools or districts decide to focus their professional development resources on one particular change or area of change, teachers have

the opportunity to learn fewer new practices more in depth (Bennett & Green, 1995; Elmore, 1996). They can be engaged intellectually, rather than superficially, in the change (Klein, McArthur, & Stecher, 1995).

Does each teacher have sufficient support to change his or her practice? Klein and associates (1995) note that "economies of scale operate only weakly in educational reform" (p. 145). Although it may be economical to supply teachers with materials in large numbers, such as in the use of science kits in elementary schools, it is still the case that each teacher needs professional development, follow-up support, time to learn and experiment, and ways to assess results with students. Scale-up cannot occur if teachers lack what they need to change. Furthermore, it may take increasingly more resources, largely in the form of time and energy on the part of "change agents," to reach those who come to a change at the end of the line—that is, the "late adopters." These schools or individuals may require more evidence to be motivated, assistance to develop new knowledge and skills, and lower assister-to-teacher ratios to troubleshoot during implementation (Klein et al., 1995). These are all issues that need to be anticipated in a support plan for all those who will ultimately be involved. The support plan must accurately estimate and ensure provision of the resources that are necessary to reach everyone.

This points out the importance of coordinating different components of the system and multiple actors in ways that will focus support on the change that is to become widespread. Curriculum and assessment practices, school administration and policies, school structures (including time, materials support, and teaching assignments), and other change initiatives must be coordinated and focused for scale-up to succeed.

What mechanisms are in place for quality control of the professional development for all? This is a particularly important issue, especially where a multiplier strategy is being used. When a particular change has been chosen that promises certain outcomes if all of its critical elements, however generally defined, are in use, it is important that all who are involved in the change learn those elements well. This requires professional developers who have mastered the required knowledge, practiced the strategies, and demonstrated their abilities to work with adults. They are both competent and conscious of their competence; therefore, they are not on "automatic pilot" with no ability to communicate to others and help them change.

Previously noted was the preparation professional developers require to be effective. Some programs fail because they expect teachers with limited professional development to return to their schools and share what they have learned with other teachers. Since the teachers have not had the opportunity to practice and reflect on what they have learned, they are ill prepared to help other teachers. This results in the use of the practice becoming watered-down or distorted. Quality control requires intense attention to developing professional developers, coaching them to develop their

content and professional development skills, and supporting them over time as they work with increasing numbers of teachers and encounter different kinds of challenges and problems.

Other quality control mechanisms include clear expectations for the roles of professional developers, written guidelines for professional development activities (e.g., workshop plans and materials, cases and facilitator notes, coaching guides, and immersion activities), and tools for monitoring and evaluating the work of professional developers.

Is there a plan at each unit of implementation (department, school, district, state, etc.) for ongoing use, support, and institutionalization? Plans at each level acknowledge that successful change is simultaneously top down and bottom up (Fullan, 1991). Individual progress in learning and changing can be anticipated (Loucks-Horsley & Stiegelbauer, 1991), as can the management and policy moves that each unit of organization will need to make to support increasing numbers of people involved in the change. Institutionalization, the stage at which a change becomes "how we do things around here," requires attention to such issues as routine professional development for new teachers or those who change grade levels; support networks; routine ordering of required materials and equipment; continuous reflection, monitoring, evaluation, and commitment to changes based on what is learned; and ensuring a line item in the budget for support of the change (Miles, 1983).

Scaling up is a challenge that many are currently taking on in an effort to provide all students with challenging science and mathematics programs. This challenge has inspired innovative, creative, and entrepreneurial approaches by many professional development initiatives (Education Commission of the States, 1995).

GARNERING PUBLIC SUPPORT

Constantly shrinking resources are a sign of the times and nowhere is it felt more keenly than when the public (often through the eyes of school board members) scrutinizes an education budget. What stays and what goes is based on what is valued. Keeping time and funding for professional development in the budget requires public support. (See Figure 4.1.)

GARNERING PUBLIC SUPPORT

- **How can professional developers build awareness of the importance of mathematics and science education reform and of effective professional development?**
- **How can professional developers engage the public in improving mathematics and science teaching and learning?**

Public support for professional development is needed at times other than when budgets are being determined. When substitute teachers are in classrooms, school is out because of professional days, or teachers are attending a conference far from home, the public needs to voice its support for ongoing teacher learning and know the benefit it has on student achievement.

Public support for professional development is intimately related to public support for science and mathematics education. A public that values quality science and mathematics learning for all children knows that teachers need opportunities to continually update their knowledge and skills to support students. Such supporters acknowledge and commit to playing an ongoing role of advocacy and support for the science and mathematics education over time.

Professional developers can address the dual purpose of garnering public support for science and mathematics education reform and for teacher professional development. They can do so by paying attention to three areas: (a) increasing awareness of the importance of effective teaching and learning of science and mathematics as well as effective professional development and what they entail, (b) involving the public in learning situations (of both students and teachers) and in various roles, and (c) gathering and publicizing the results of teaching and professional development.

How can professional developers build awareness of the importance of mathematics and science education reform and of effective professional development? The first step is to clarify why reform and the public's support for it are essential. There are several reasons; many relate directly to parents, who are an important segment of "the public." The reasons include the following:

- Parents and the general public can benefit from a better understanding of science and mathematics—for example, they can see how it is used to understand and propose solutions to everyday problems and to better understand technological developments happening all around us.
- Parents can help by supporting their children to learn in new ways—for example, parents can help their children use inquiry and problem solving by asking and investigating questions that arise in everyday life.
- Schools can benefit from the contributions of committed parents and community members, such as scientists and mathematicians, who have expertise to contribute. In addition, generating their interest could increase the resources available to the school.
- An informed public will be more skeptical about and able to address misinformation about science and mathematics education—for example, be able to address issues that arise regarding the teaching of evolution in science or problem solving and computation skills in mathematics.
- Authentic partnerships between schools and parents and the community benefit students' learning.

Mathematics and science educators are clear about the need for public engagement around the future of science and mathematics education. For example, in its charge to groups writing the *National Science Education Standards*, the NRC (1996a) stated the following:

> The traditions and values of science and the history of science curriculum reforms . . . argue for a large critique and consensus effort. Science is tested knowledge; therefore, no matter how broadly based the perspective of the developers, their judgment must be informed by others' responses . . . particularly teachers, policymakers, and the customers of education systems—students, parents, business, employers, taxpayers. One of several reasons for the limited impact of past reform efforts was the weakness of their consensus building activities. (p. 2)

Professional developers can help teachers and other educators understand the importance of improved mathematics and science teaching and learning and, more important, become articulate about it. They can help educators communicate with parents and the public about the benefits of a mathematically and scientifically informed populace.

Mathematics and science educators have found that parent involvement is essential in their reform initiatives. As Parker (1997) notes, "Parents become strong advocates for change if they are kept informed of the need to change and the nature of the change needed in mathematics education" (p. 240). Staying informed, however, is only one step in the process toward developing authentic relationships and partnerships with parents who can be strong advocates for science and mathematics education. Schools must develop a broader conception of what "parent involvement" means and expand the roles of parents beyond volunteering for field trips or helping out in classrooms. As Mike Murphy (2001) notes, too often "parent involvement can merely be empty rhetoric or window dressing" (p. 3). If parents and families are viewed as true partners in children's education, their involvement includes activities such as participating in school planning and governance, engaging in decision-making processes regarding the ways structures and policies influence students' learning, examining their child's work with the teacher to better understand what the child is learning, and participating in science or mathematics "curriculum and concept awareness" activities to enhance their understanding of the instruction their students receive. Numerous schools and districts have found that when

parents and families are truly engaged as partners in children's learning, they are advocates for the school and the ways in which their students learn.

The University of Washington's professional development project for elementary school teachers directly addressed the issue of garnering public support for science education through a three-day mini-institute for teachers. During that time, teachers learned how to craft messages to address the questions and concerns of various audiences, including parents, principals, business executives, and city council members. They interacted with a panel representing these groups regarding the question, "What would motivate you to support science education?" They identified the common threads and the unique needs of the various groups (C. Kubota, personal communication, July 1996).

In addition to awareness of effective mathematics and science education, the public must have awareness of the importance and nature of effective professional development. It helps to state how little education systems invest in their employees compared with corporations. Again, clear articulation of what professional development is for, what it entails, and what its benefits are can help to increase the public's support. Linking professional development to student learning—as in the statement, "the more teachers know and are able to do, the more students can learn"—is an effective motivator for parent and community support. Sharing recent research and literature on the relationship between teacher professional learning and student learning can also increase the community's understanding of and support for teachers' learning. More important, local school or district data on the ways in which students' learning is increasing in science or mathematics and the relationships to their teachers' professional learning can "convince" and motivate the community to support time and resources for teacher professional development.

How can professional developers engage the public in improving mathematics and science teaching and learning? Another strategy for garnering public support is by actually engaging people from the community in mathematics and science education. This can be done in several ways. First, parents and community members can be invited into the professional development experiences as learners; for example, they may join teams from schools or districts for professional development during summer institutes. In other cases, parents and community members can collaborate together in learning experiences, such as study groups to examine and understand national or state standards. Second, they can be invited in as "teachers," working with students in classrooms and teachers in professional development settings. This is of particular benefit when they have science or mathematics expertise and experiences to share. Examples of how this can happen were discussed in the section on Finding Time for Professional Development.

5

Strategies for Professional Learning

The decision about which strategies for professional learning to include in your design is informed by all other inputs into the process of designing. (See Figure 5.1.) The goals of the professional development program—which are grounded in the vision and in data analysis—drive the selection of specific strategies. Strategy choices are also informed by the knowledge and beliefs the designers hold about the change process, teaching, learning, professional development, and the nature of science and mathematics. The context within which the strategies will be implemented shapes the selection, combination, and sequence of the learning opportunities provided. The critical issues that influence the successful implementation and outcomes of any professional development program play a role in determining the selection of strategies. For example, building capacity for sustainability may lead to a decision to combine strategies such as immersion, curriculum implementation, and technology for professional learning to meet different teachers' needs at different times. Finally, professional learning opportunities are often the specific components of the design that are evaluated and assessed.

A word of caution—strategies in isolation do not constitute effective professional development. Strategies are frequently what professional developers "grab at"; this book emphasizes why different strategies are better choices within different contexts, for different goals and purposes, and for different circumstances. As noted above, it is the intricate interplay of all