HANDBOOK
for Enhancing Strategic Leadership
in the Math and Science Partnerships

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INTRODUCTION

The Math and Science Partnership (MSP) program is seeking deep, meaningful, and sustained changes in mathematics and science education in participating school districts, institutions of higher education (IHEs), and other core partners. In the MSP program, the National Science Foundation (NSF) and U. S. Department of Education (DOE) aim to improve mathematics and science education:

> … through support of partnerships that unite the efforts of local school districts with faculties of colleges and universities—especially disciplinary faculties in mathematics, science, and engineering—and with other stakeholders. MSP seeks to improve student outcomes in mathematics and science for all students, at all K–12 levels. As the achievement of students rises, MSP expects to significantly reduce achievement gaps in mathematics and science education among diverse student populations.
>
> To achieve these long-term outcomes, the MSP program supports the development, implementation, and sustainability of promising partnerships among: mathematics, science, engineering, and education faculty and their institutions of higher education; administrators, teachers, and guidance counselors in K–12 schools and school systems; and other important stakeholders to:
>
> - Ensure that all K–12 students have access to, are prepared for, and are encouraged to participate and succeed in challenging curricula and advanced mathematics and science courses;
> - Enhance the quality, quantity, and diversity of the K–12 mathematics and science teacher workforce; and
> - Develop evidence-based outcomes that contribute to our understanding of how students effectively learn mathematics and science. (NSF 03-605)

Moreover, the solicitation makes clear that substantial institutional changes are expected of both the IHE and district partners:

> To ensure project sustainability, K–20 core partner organizations redirect resources and design and implement new policies and practices to result in well-documented, inclusive and coordinated institutional change at both the college/ university and the local school district level. Higher education core partners reward faculty in mathematics, the sciences and/or engineering for strengthening their own teaching practices and for their work in K–20 mathematics and science education, including K–12 teacher preparation and professional development. K–12 core partner organizations create and sustain an environment that values an evidence-based approach and that recognizes and rewards significant

contributions to improved mathematics and science learning and teaching. (NSF 03-605)

Developing Strategic Leadership

Each current and prospective MSP has a "leadership team" that is responsible for designing and managing the initiative. The purpose of this *Handbook* is to assist these leadership teams in being as strategic as possible as they go about the challenging work of improving mathematics and science education in the partner districts and institutions of higher education. Although the size, composition, and titles of the leadership teams will vary, each is sure to include people with different backgrounds and experience. The target audience for this *Handbook* includes people who are new to some of these ideas; it also includes those who are already well-versed in the ideas of strategic leadership but can use the *Handbook* to engage others in conversations about these issues.

The *Handbook* is based on research on large-scale reform, as well as on the "wisdom of practice" of people who have been engaged in planning, implementing, and sustaining improvements in mathematics and science education over the last several decades. In particular, examples have been drawn from the authors' experience in studying NSF-funded systemic reform and teacher enhancement projects.

Judging from prior large-scale reform efforts, strategic leadership requires understanding the system one is trying to change, including who has power and influence; recognizing that virtually every decision has trade-offs, and considering the advantages and disadvantages of alternative courses of action; using available resources efficiently and effectively, and being deliberate in leveraging additional resources; working to create and take advantage of opportunities for more substantial and coherent reform; being explicit about what efforts need to be sustained over the long term; and using evidence effectively to monitor progress and ensure buy-in.

Key Ideas: Strategic Leadership

- Understanding the system one is trying to change

- Recognizing that virtually every decision has trade-offs

- Considering the advantages and disadvantages of alternative courses of action

- Using available resources efficiently and effectively

- Being deliberate about leveraging additional resources

- Creating and taking advantage of opportunities for more substantial and coherent reform

- Being explicit about what efforts need to sustained over the long term

- Using evidence effectively to monitor progress and ensure buy-in

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In simplest terms, strategic leadership in the MSPs entails: (1) ensuring there is a shared vision to guide the reform efforts; and (2) developing, implementing, evaluating, and refining a reform process that moves the system closer to that vision. The following sections address the need for true partnerships, where all parties benefit from the joint work; development of a shared vision; and the need to ensure both the capacity and will to work toward reform.

These sections are followed by an introduction of four key components of the reform process: designing and implementing MSP interventions; garnering support from key stakeholders; aligning policy; and scaling up interventions. It is important to note that these components are interrelated, and that being strategic means looking for opportunities to make progress in multiple components while focusing on any one of them. Components of the reform process are discussed separately in succeeding chapters, and then the concluding section describes "pulling it all together" for strategic, large-scale reform.

Developing Partnerships

By definition, each MSP must be a partnership between at least one school district and at least one institution of higher education. It is important to note that the kind of partnership envisioned by the MSP program involves far more than successful interaction among a small group of highly committed individuals in preparing a proposal and initiating the MSP activities. The type of alliance that individuals might forge at that level of involvement—agreeing to frequent communication and pledging cooperation in achieving a specific goal—is not sufficient for the kind of in-depth, long-term partnerships needed to realize large-scale improvement in mathematics and science education. As Astroth (1991) notes, what is needed are "strategic alliances"—organizations banding together as a coalition to achieve shared goals, collaborating on a long-term agenda. It takes attention and effort by leaders to ensure that a partnership—a relationship—is being built that is perceived as beneficial to each of the participating institutions and is strong enough to accommodate differences in perspectives and weather the inevitable disagreements. These kinds of partnerships involve a lot of hard work, but they promise significant payoff as well.

From the K–12 perspective, partnering with IHEs provides access to expertise in mathematics/science and mathematics/science education—for professional development of in-service teachers, improving course content and pedagogy, selecting appropriate instructional materials, etc. From the IHE perspective, partnering with K–12 districts provides an opportunity to improve the mathematics/science education of both entering undergraduates and the children of their faculty members; to focus attention on improving the quality of teaching at the college/university level; to enhance the preparation of prospective teachers through practicum experiences; and to demonstrate to legislators and others their commitment to K–12 education.

A key to true partnerships between these institutions, as well as partnerships with museums, businesses, and other institutions involved in the MSPs, is that the commitment to the relationship goes beyond the top echelon of each organization. For the partnership to succeed, there needs to be a belief among a sufficient number of the "rank and file" that the potential benefits are great enough to warrant the extra effort involved. The more widely this belief is

shared, the more likely a partnership will be able to sustain itself over time, especially when there is turnover among the individuals who initiated the arrangement.

Strategic leaders adopt the premise that developing partnerships, or forging a "we" out of "you," "I," "he," and "she," is likely to be challenging work. This is because partnerships are often being created between institutions or systems that are quite different from one another—a school district is a very different entity from an institution of higher education, and a university department certainly has a different worldview than does a high school faculty. Similarly, community groups have a different perspective on education than do teacher unions. It helps to think of these institutions or systems that come together as different cultures encountering each other—perhaps for the first time—and trying both to understand one another and to establish meaningful interactions.

When different cultures (i.e., partners) interact (i.e., decide to form an MSP partnership), it is quite likely that there will be culture clashes. The strategies, and underlying values, of an IHE for creating and sustaining improvement in mathematics and science education may be at odds with the strategies and values of a school district. The path to real partnership, then, is in understanding why these cultures clash and working to identify the common ground, the shared vision, and the mutual commitment to a reform process. Getting individual partners signed on through letters of commitment happens at a point in time and may be accomplished far more readily than the ongoing work of developing a meaningful partnership around a shared vision.

Developing a Shared Vision

The first stage in planning a journey is deciding where you want to go. In other words, partnerships need to begin with the end in mind, by identifying what the partners want to achieve. The development of a vision is also the articulation of what the partnership would like to sustain or institutionalize over time, recognizing that this vision will continue to evolve as the initiative progresses.

Key Ideas: Developing a Shared Vision

- Effective teaching and learning
- A reformed science/mathematics education system
- The strategy for reform

Shared Vision of Teaching and Learning
Although it is easy to agree in the abstract that all of us want improved teaching and learning for all students, there may well be different visions of what constitutes quality mathematics and science education. People may disagree, for example, on the extent to which the mathematics curriculum should focus on computational skills, or the science curriculum on key vocabulary, as opposed to more inquiry-oriented approaches. The first pitfall MSP projects face in terms of visioning is assuming that anyone who cares about students has the same idea of what constitutes quality education.

The publication of national standards documents intended to express a vision for the future, in one sense, made differences in perspectives more visible; for example, some research mathematicians have been actively supportive of the NCTM Standards, while others have been vocal in their opposition to particular aspects of the Standards. In another sense, the various national standards documents may have obscured real differences in vision, as people who indicate support for national standards often seem to interpret them quite differently.

For example, in a major statewide initiative several years ago, the leadership team thought they had a common vision; they certainly used the same terms when they described their goal of teaching for understanding. Then they watched a video of an elementary science lesson taught by a teacher who was reputed to be one of the reform's "success stories." To their amazement, team members who had previously "agreed" (to the point of being able to finish one another's sentences) had very different interpretations of the quality of the lesson they were seeing. Some people saw open exploration which they were quite convinced would lead to deeper understanding; others saw aimless messing about. This astonished group realized they still had considerable work to do to reach a real consensus on their vision for quality mathematics and science education.

Whether or not the development of an MSP proposal surfaced disagreements about the vision for quality mathematics and science education, such differences undoubtedly exist, especially given the wide range of backgrounds and experiences of the typical MSP leadership team. It will be helpful for MSP teams to revisit their vision periodically, perhaps by observing classrooms or viewing commercially available videos as a group, or by reviewing samples of student work, so they can work together to forge a more explicit, shared vision to guide their reform efforts, and to amend that vision appropriately as the initiative proceeds.

It is important to note that while a shared vision of teaching and learning among the members of the MSP leadership team is necessary, it is far from sufficient. MSP leadership teams have to consider the perspectives of all of the key stakeholders, creating opportunities for people with diverse views to provide input into the emerging vision. A vision that reflects the perspectives of a variety of stakeholders, rather than one that adheres strictly to the views of a single group, is more likely to survive the tough times ahead, when pieces of the reform may not fall into place exactly as intended. For example, although an MSP leadership team may prefer that mathematics and science education be based solely on "reform-oriented" instructional materials, it is likely that at least some teachers, and at least some parents, will have reservations about abandoning traditional methods. Using a "replacement" unit approach, incorporating some of the new materials into the curriculum and monitoring what transpires, may be a workable alternative in

some contexts, allowing both the people who favor more intensive reform, and those who are skeptical of these materials, to reconsider their views based on evidence.

It is particularly helpful to think about the incentives needed to encourage cooperation of the various stakeholders. For example, college faculty may be interested in ensuring that their prospective students have stronger backgrounds in mathematics and science. In addition, public colleges and universities may find that involvement in an MSP will demonstrate to the state legislature that they are committed to doing their part to improve K–12 education and thus help create a favorable climate for their funding requests. Similarly, NSF and other funders sometimes require evidence of involvement with K–12 teachers and students for prospective science, technology, engineering, and mathematics research projects, providing an incentive for IHE involvement in partnerships such as MSPs.

At the grade K–12 level, superintendents and principals are increasingly being held accountable for student achievement in mathematics and science; they are more likely to provide support for teachers to take on leadership roles in the MSP, and to provide release time for teachers to participate in MSP activities, if they anticipate that the initiative will lead to improved student performance in these areas. By highlighting how participation in the MSP will help individuals and institutions achieve their own goals, leadership teams can increase the likelihood of support for the MSP from a broad array of stakeholders.

Shared Vision of a Reformed System
Although helping to create a shared vision of quality teaching and learning is very important, it is not enough. A second potential pitfall in the visioning process is to ignore the fact that effective teaching and learning for all teachers and students, preschool through graduate school, depends on the entire system functioning in support of that vision. MSP leadership teams need to have a vision of a "reformed system" that includes a coherent curriculum, high quality courses and instructional materials, appropriate assessment/accountability systems, and ongoing professional development for teachers, IHE faculty, and administrators, all aligned with a shared vision of teaching and learning. Patchwork policies and practices can send conflicting messages to K–12 teachers, IHE faculty, and administrators at all levels, as well as to students, parents, and the broader community, getting in the way of implementing the desired reforms in teaching and learning. Although it is not realistic to expect that in five years of funding an MSP can get all of the key policies in multiple IHEs and multiple districts aligned with the vision, leadership teams need to understand how the policy environment is likely to affect their efforts, and they need strategies for dealing with those policies in the short term as they work toward greater alignment in the long term.

Shared Vision of a Strategy for Reform
A third potential pitfall in the visioning process is to assume that everyone who shares a vision for effective teaching and learning, even a vision for a reformed system, will agree on how best to get there. MSP leadership teams will want to use the best evidence available to them on which strategies will work most effectively to achieve their goals. If, as is sometimes the case, MSP leadership teams agree on the vision for a reformed system, but recognize they have insufficient knowledge of how to help bring it about, they may want to bring in consultants who have expertise in systems change. At the same time, it is important to recognize that our understanding of the reform process in complex social systems is, and will always be, limited, and different team members may well favor different approaches. For example, some may want to give priority to the groups that have been least successful in mathematics and science, while others may advocate the notion of "a rising tide lifting all boats."

It may take considerable effort to hammer out agreement on all of the pieces of the vision— quality teaching and learning, a reformed system, and a process for moving toward both—but it is almost certainly worth it. Leadership teams that cannot forge consensus on all of the pieces of the vision, both initially and as the initiative unfolds, are likely to be mired in disagreements throughout the process, forcing them to spend a great deal of time and energy arguing with one another, rather than moving ahead with the reforms.

Developing Capacity and Will for Reform

Policy analysts often distinguish between the "capacity" of a system for functioning in a desired way, and the "will" within that system for it to operate accordingly. To be successful, MSPs need to consider not only interventions to increase the capacity for improved teaching and learning in the IHEs and partner districts, e.g., by increasing faculty and teacher knowledge and skills, but also how they will go about changing priorities and incentives in the system in order to increase key players' willingness to work toward reform.

Key Ideas: Capacity and Will

- Capacity = Skills and Knowledge

- Will = Commitment and Investment

The MSP award focuses attention and additional resources on mathematics and/or science education. The charge of the MSP leadership team is to use this opportunity to improve the functioning of the mathematics/science education system (increasing both the capacity and the will of the system) so it will not only maintain the gains made during the funded period, but will sustain the process of improvement in the future. Unless reform leaders are malevolent or hopelessly misguided, and it is quite clear that MSP leadership teams are neither, all of the reform activities they are likely to devise will have merit—they are "good" things to do to help improve teaching and learning. But when time and resources are limited (and time and resources are *always* limited), good may not be good enough.

The challenge for MSP leadership teams is to be strategic in making optimal use of the resources—and the prestige—of the award in order to create a reformed system. As Elmore (1996) notes, there is a difference between "scaling up" particular reform activities to reach a larger proportion of the current population of K–12 teachers, IHE faculty, administrators, and students with the award resources, and "going to scale" with the reforms, which entails changing the system so that the reform vision becomes part of its core mission. This distinction reminds us that reform isn't simply doing more and more of a particular set of interventions, but rather it is fundamentally altering the organization, functioning, priorities, commitments, and incentives of an education system.

The *Handbook* is designed to help MSP leadership teams think about four important components of MSP work, all of which need to be addressed well in order to go to scale with reform and create widespread change that can be sustained over time:

- Designing and implementing MSP interventions;
- Garnering support from key stakeholders;
- Aligning policy; and
- Scaling up interventions.

Successful attention to these components requires MSP leadership teams that are highly knowledgeable and skilled in developing capacity and cultivating will for large-scale reform in mathematics/science education.

Components of Reform Initiatives

Designing and Implementing MSP Interventions
People undertake reform because of one or more needs in the current system, and they choose an intervention or set of interventions they believe will address those needs and improve the performance of the system. Reform in K–12 mathematics and science education typically includes professional development interventions to increase the knowledge and skills of participating teachers, and may also include activities involving students, administrators, guidance counselors, and parents. At the IHE level, reform may focus on improving undergraduate and graduate mathematics and science courses, as well as improving the quality of the preparation of prospective K–12 teachers through practicum experiences.

The intervention component is the one most people think about when they plan for reform, and proposals typically describe these plans in detail. Also included in this component would be the steps taken to refine the interventions based on how well they work during their initial implementation.

Garnering Support from Key Stakeholders
MSP projects are typically large and complex, involving a wide range of individuals in the districts, institutions of higher education, and other partner institutions. Not only does the MSP need the support of the people who will be integrally involved in MSP activities, e.g., providing

(and/or participating in) professional development, it needs the support of a variety of other "key stakeholders" as well.

One way to think about key stakeholders is to consider whose support the MSP will need in order for the initiative to succeed, and whose opposition could stifle it. Using this definition, not only would mathematics and science teachers and IHE faculty be considered key stakeholders, but also college/university presidents, provosts, deans, and department chairs; district superintendents; school board members; science/mathematics supervisors; principals; guidance counselors; union leaders; parents; business/industry leaders; other influential members of the community; and students as well.

Of course, simply identifying important stakeholders is far from sufficient; leadership teams must also consider the MSP plans from the perspectives of these groups and ensure that all of the key players will see benefit to being involved. It is interesting to note that K–12 education reform projects often describe plans to involve principals, parents, and/or guidance counselors; the problem is that these plans are typically limited to indicating how the stakeholders' involvement will benefit the reform effort, not how it will benefit the stakeholders. Many education reformers are aware of the importance of involving key stakeholders but may not consider, or know how to go about, making sure the involvement is a "win-win" proposition for all parties.

Aligning Policy
There is no shortage of education policy at both the state and district levels, and MSPs need to be prepared to contend with much of it. Typically, states determine the mathematics and science content that should be addressed, high school graduation requirements, and teacher certification and renewal requirements. Districts layer on additional policies, perhaps more detail about what content should be taught at particular grade levels, how much time should be spent on these subjects, what instructional materials will be used, what "counts" toward teacher certificate renewal, etc. Often there are assessments administered at both the state and district levels, especially in mathematics, with various stakes attached for students, teachers, and/or schools. To varying extents, and at various times, these policies influence the actions of key players throughout the system. Although it is difficult to imagine long-lasting reform if district curriculum, instruction, student assessment, teacher evaluation, and professional development policies are not aligned with the reform vision, proposals for external funding are often sketchy about the current status of these policies or their plans to ensure alignment, or at least work around the unaligned policies.

Institutions of higher education have their own sets of policies, as well. MSPs may plan to develop new mathematics/science courses, and as a result may have to contend with complicated processes for approval of new mathematics and science courses, and complex rules about who gets credit for teaching courses that cut across disciplinary lines. MSPs will also have to contend with tenure and promotion policies at the IHE partners. Especially at the major research universities, these policies often provide incentives for faculty to focus on research rather than on teaching, whether at the K–12, undergraduate, or graduate level. For faculty in mathematics, science, and engineering departments research in their disciplinary area is typically rewarded far more than research on teaching and learning about the discipline. Interestingly, based on

previous reform efforts, it appears that the K–12 partners know how difficult it is to change a K–12 system but tend to underestimate the difficulty of changing policy and practice at the IHE level, and vice versa.

Scaling Up Interventions

Typically, IHE and district personnel devote most of their time and energy, as well as most of the available resources, to the substantial work associated with the system as it now exists; they rarely have the luxury to think about, much less enact, reform. An MSP provides additional expertise and resources to make large-scale reform possible. However, while a highly skilled and experienced core group of MSP leaders may be able to deliver the interventions themselves initially, they will almost certainly need to bring in other, typically less experienced people, in order to reach the numbers of participants who will need to be involved in order to ensure large-scale reform. Accordingly, MSPs need to be concerned with developing the capacity and infrastructure to create, and sustain, large-scale reform.

In the planning and early implementation phases, reform leaders are often fairly vague about their plans for scaling up the initiatives. For example, having involved the most enthusiastic and innovative faculty in teaching the initial sections of the new courses at the partner IHEs, the MSP may have underestimated the difficulty of engaging a broader cross-section of faculty in teaching these courses to large numbers of undergraduates. Similarly, they may intend to use teacher leaders in order to provide professional development for a large number of teachers in the partner districts, but typically have not thought through these plans in detail, leaving it unclear how these teacher leaders will develop the skills or find the time and opportunity necessary to do this work.

The following sections of the *Handbook* address these four components of the MSP reform process. Each section includes a vignette about a hypothetical MSP, providing a specific context within which to consider some of the key ideas in that component area. Questions are posed after each vignette to help MSP leaders reflect on the application of these ideas in their own setting.

Strategic MSP leaders will have reform plans that address all of these components, although not necessarily all at once, and will look for ways to take advantage of activities in one arena to make progress in others as well. For example, piloting an intervention provides multiple opportunities beyond simply making sure it works smoothly. Involving mathematicians/ scientists/engineers and teacher leaders beyond the core team in implementing the pilot efforts can be used to develop the human resources an MSP will need for scaling up the interventions. Similarly, as the pilot interventions move forward, collecting data on their effectiveness in achieving important outcomes can help garner support from key IHE and district stakeholders.

A recent district-based initiative provides an example of the interrelatedness (and potential for synergy) among the components of reform. In addition to offering professional development to elementary teachers, the leadership team worked to help principals understand the new vision of quality science teaching and learning. The district superintendent, who served as Principal Investigator of the initiative, decided to use the regular meetings he had with principals to reinforce the message of science reform, asking principals to bring in samples of student work in science. This requirement led to principals discussing science instruction with their teachers in

order to select the student work samples, which in turn increased teachers' attention to science instruction, subsequently leading to increased teacher interest in participating in science-related professional development to help them develop their knowledge and skills. As this example illustrates, savvy reform leaders recognize the interconnectedness within the system, and plan to capitalize on it. This theme is taken up again in the last section of the *Handbook*.

DESIGNING AND IMPLEMENTING MSP INTERVENTIONS[1]

Interventions refer to reform activities intended to improve the quality of mathematics/science instruction, often by attempting to increase the knowledge and skills of grade K–12 teachers, IHE faculty, or other key players in the system. For maximum effect, interventions need to be carefully chosen, well-implemented, and scaled up with their quality maintained. That sounds pretty straightforward, but as anyone who has attempted large-scale reform knows, and those who are new to the enterprise will soon find out, it's a lot harder than it sounds, with major challenges at every juncture.

There is no shortage of potential interventions that might be included in an MSP, although professional development for in-service teachers is often the primary intervention in large-scale reform projects in K–12 mathematics and science education (Zucker et al., 1998). Interventions for teachers can focus on any of the content areas included in a district curriculum at any of the targeted grades, and within a given area might focus on teacher content knowledge, understanding how students learn, and/or implementation of particular instructional materials.

Some MSPs might choose to work directly with students, perhaps providing tutoring to individual students, or counseling to students in underserved groups in order to encourage them to take higher level mathematics/science courses. Other interventions at the K–12 level might include orienting principals to the reform vision, or working with parents to help them understand the importance of students enrolling in Algebra before the ninth grade so they will be able to take advanced mathematics and science courses in high school.

At the IHE level, interventions might include developing new courses; or redesigning the content and pedagogy of existing courses; or revising pre-service education programs so prospective teachers have stronger backgrounds in mathematics/science, more in-depth understanding of student thinking in these areas, and more practical experience in schools.

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[1] For a brief review of key literature, see Appendix A.

Defining the Terrain: Possible MSP Interventions

Professional Development for Teachers/IHE Faculty
- Providing workshops/institutes to deepen teacher content knowledge and understanding of student thinking
- Organizing study groups focused on problems of practice
- Offering demonstration teaching/coaching opportunities

Course Improvement at the K–12/IHE Level
- Aligning course content with learning goals
- Redesigning learning tasks based on assessment results

Enhancing Pre-Service Education
- Helping prospective teachers understand student thinking about key mathematics/science concepts
- Providing opportunities for more practical experience in the schools

Providing Direct Services to Students
- Tutoring students with particular needs
- Encouraging students from underserved groups to enroll in advanced courses

Orienting Others to the MSP Vision
- Providing presentations for deans, department chairs, principals, guidance counselors, parents

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It is important to note that "interventions" and "reform" are not synonymous. MSP plans almost certainly include interventions aimed at teachers and teaching at both the IHE and district levels, and may target students and other groups, but to be successful in creating a reformed system, MSPs need to work on aligning policy, garnering stakeholder support, and developing infrastructure for scaling up as well.

Clearly the intervention plans of active MSPs "make sense," or they wouldn't have been funded; reviewers judged the choice of target populations appropriate given the profile of needs described in the proposal, and they considered the planned activities to address those needs promising. At the same time, prior research and evaluation indicate that within any set of projects that appear promising initially, some "work" and others do not. This section of the *Handbook* explores some of the issues involved in designing, implementing, and refining interventions within the context of large-scale reform, using lessons gleaned from research and the "wisdom of practice" to suggest ways to increase the likelihood that MSP interventions will be effective.

Key Ideas: Designing and Implementing MSP Interventions

- Understand the nature and extent of needs in your context

- Select effective, promising intervention approaches

- Pilot the interventions to get the "kinks" out and demonstrate their effectiveness

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Each leadership team needs to make sure that the interventions address important needs of the system in relation to the MSP reform vision. At the same time, there are likely to be a myriad of interventions that meet this criterion, and MSPs do not have the time and resources to do more than a small subset of them. Therefore, it is important that an MSP plan focus on priority needs, using interventions that are considered appropriate and valuable by the key stakeholders, and are likely to be effective in the particular context.

It is also important to recognize that large-scale reform cannot be accomplished by adding a course here or there, or working only with small groups of "volunteer" teachers and IHE faculty. Improving mathematics and science education for all students requires that MSPs choose interventions that can feasibly be "scaled up" to reach all mathematics/science/engineering teachers and students. Choosing such interventions requires understanding that what works with the most willing and enthusiastic teachers and IHE faculty will not necessarily work with all.

Finally, it is advisable to pilot interventions on a small scale as "existence proofs"— demonstrating to the various stakeholder audiences that these interventions can be well-implemented in this context, and that they in fact lead to the desired changes in teaching and learning. Piloting interventions also provides an opportunity to get the "kinks" out before going to the effort and expense of scaling them up.

Understanding Nature and Extent of Needs

It is important to have a realistic view of the nature and extent of the needs in the partner districts and IHEs to use in planning the MSP interventions. At the same time, MSP leadership teams want to be sure they don't spend so much time and energy diagnosing needs that they don't have resources left to address the needs they have identified. Before embarking on additional data collection, MSP leadership teams are well-advised to find out what data are already available, e.g., the extent to which teachers in the IHE pre-service program are hired, and retained, by the partner districts; enrollments in advanced courses by gender and race/ethnicity; and district scores on state assessments compared to those in districts with similar demographics. MSP teams will probably want to supplement these data by observing mathematics/science classes in both the districts and IHEs, and talking to teachers/faculty, administrators, students, parents, and guidance counselors.

How formal and systematic MSPs need to be in these assessments depends on how they plan to use the data. Observations in a handful of classes, and conversations with a few people who know the programs well, are likely to provide sufficient information for planning interventions, especially if the data provide a fairly consistent picture. In contrast, if MSPs are planning to use the needs assessment results as baseline data for evaluating the impact of their initiatives, they will likely want to get a professional evaluator involved in designing instruments, drawing samples, and analyzing the data to make sure the results will be credible to external audiences.

Selecting Effective and Promising Intervention Approaches

The MSP program stresses the importance of ensuring that "all students are taught by high quality mathematics and science teachers," and notes that achieving this goal may involve strategies for recruitment, induction, retention, and professional development to increase teacher content and pedagogical content knowledge. At the same time, MSP projects are expected to ensure that "K–12 students are prepared for, have access to, and succeed in challenging mathematics and science curricula and advanced courses." At the IHE level, MSP projects are expected to improve mathematics/science teaching, including but not limited to courses for prospective teachers.

Given the diversity of MSP contexts—higher education partners that include community colleges, small liberal arts colleges, and major research universities, and district partners that vary greatly in size and demographics —it is unlikely that any one approach will succeed in all places. At the same time, it is neither necessary nor wise for projects to start from scratch in developing interventions to address the needs in their particular contexts. Although there is still a great deal not understood about what works in a given context, research and "the wisdom of practice" have identified a number of promising approaches, and there are materials available to facilitate the implementation of some of these approaches. Given the time and resources it takes to develop quality interventions, MSPs should try to identify intervention approaches/materials that have proven effective in addressing some of their particular needs in similar contexts; in many cases, it would even make sense for an MSP to start by addressing some of the not-quite-at-the-top of the list of priority needs when promising materials to address these needs are available, rather than attempting to develop its own materials.[2]

Of course, in order to be effective, the existing approaches have to be feasible in a given MSP setting. If an intervention aimed at a particular need is likely to spark opposition, perhaps because it reminds key stakeholders of something that didn't work in the past, MSPs would likely want to choose another approach, or move on to address another important need. For example, if the state had previously introduced a science performance assessment with great fanfare, only to abandon it because of cost and reliability issues, an MSP might want to hold off suggesting classroom use of performance assessment to teachers and principals. Even though performance assessment at the classroom level would likely be helpful to teachers in figuring out what students know and are able to do, and wouldn't face the same issues of cost and reliability in scoring, an MSP probably wouldn't want to risk having its idea weighted down by the excess baggage of the earlier effort.

As these decisions are made, it is essential to think about how to scale-up the activities; if the interventions are so labor-intensive that the MSPs won't have the necessary human or material

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[2] There are resources available to help MSPs identify promising approaches/materials. For example, The National Science Digital Library provides access to STEM educational resources (www.nsdl.org), and the Project Information Resource System (PIRS) provides a gateway to award abstracts and other information about projects supported by NSF's Division of Undergraduate Education (www.ehr.nsf.gov/pirs_prs_web/search). NSF also supported the development of an electronic data base (www.te-mat.org) that includes reviews of materials for the professional development of mathematics and science teachers.

resources to reach the targeted numbers, they need to either modify the approaches, or choose others. For example, a number of mathematics/science education reform efforts have incorporated coaching for classroom teachers, with the idea of working with a different group of teachers each year. This strategy seems to work very well initially, with teachers benefiting greatly from the one-on-one interactions. In some instances, the coaching approach may work *too* well; in at least one case, when the planned year of coaching had ended, the teachers were not at all ready to let the coaches go! Working as quickly and diligently as they could, the coaches were nevertheless unable to provide adequate services to two, and then three, cohorts of teachers. The project leaders realized that they had erred in choosing a depth of treatment that prevented them from reaching the numbers of teachers they needed to reach. The important consideration is that MSP leadership teams select a set of interventions that will be perceived as valuable *and* that the MSP can do well on a large scale, so that they will *in fact* be valuable to the system as a whole.

Piloting Interventions to Get Out "Kinks" and Demonstrate Effectiveness

Piloting interventions can help communicate the MSP vision early on, showing others what the reforms "look like" when well-implemented in classrooms in their systems. Another very important reason for piloting an intervention is to make sure it can be implemented as intended in the particular MSP context, even if it has been successfully implemented in other contexts. Although the vision for a reformed system will eventually need to involve all students, teachers, and schools at the target grade ranges in the partner districts, and all mathematics/science faculty/departments in the partner colleges/universities, it makes sense to try out any intervention on a pilot basis and refine it before going to the effort and expense of rolling it out on a large scale.

In addition to providing an opportunity to refine the interventions, another important purpose of piloting interventions is to enable the MSPs to provide evidence that these reforms will in fact lead to the desired student learning outcomes in order to help garner support from key stakeholders. MSPs need to consider the kinds of evidence that will capture the attention of stakeholders—to reinforce the commitment of advocates, help convince the skeptics, and possibly even win over some of the active opponents.

One possibility is to *start with the best case scenario*, fostering the reform in a small number of places where it is most likely to "work." For example, an MSP might start with a group of "pioneer" college faculty or K–12 teachers who share their reform vision and who, with a limited amount of support, will be able to create the kinds of classroom learning environments the MSP envisions as existence proofs for others to see. In this scenario, MSPs would want to begin scaling up their pilot efforts as soon as possible, showing that more "typical" instructors can also implement the reforms well, with perhaps a bit more professional development and support, including the opportunity to learn from the efforts of the "pioneers."

An alternative approach would be for an MSP to *start where the need is greatest*, focusing its initial efforts on the places where making the reforms "work" would cause others in the system to take the most notice, deciding if it can succeed there, it can succeed anywhere. Regardless of

where MSPs choose to begin, it is important that the critical aspects of the reform vision (i.e., equity, deep content learning, teaching for understanding) be evident in the interventions, and that the evidence from the interventions signals audiences to the nature and depth of intended outcomes.

The following vignette, "Improving Science Teaching at Manchester University," highlights some of the issues in designing and implementing interventions. As you read the vignette consider how the MSP realized there was a problem and redesigned the plan to address that problem.

Vignette 1

Designing and Implementing MSP Interventions:
Improving Science Teaching at Manchester University

This large targeted MSP is focused on science teaching at the secondary and postsecondary levels. It includes 22 districts; 3 community colleges; a small, historically black university; and a major research university. To help ensure institutional commitment, high-level administrators from each of these institutions were included in the MSP Advisory Board.

The initial plan for improving science teaching at the college/university level was centered around study groups that would be convened at the five institutions. Each study group would be led by a scientist from that institution who was recognized for expertise in teaching at the undergraduate level. The plan was to use lesson videotapes and examples of student work that the MSP had compiled as a stimulus for discussion about effective teaching and learning. (For example, the study groups would be provided with copies of The Private Universe videotapes, showing one after another bright undergraduate provide an articulate, but completely incorrect, explanation for Earth's seasons, even though most had "covered" the topic in their science coursework.)

The study group leaders met periodically to talk about progress and exchange ideas. It soon became clear that while this strategy was working well at four of the five IHEs, with a critical mass of science faculty attending the study group meetings, it was a dismal failure at Manchester, the major research university. Only a small proportion of the science faculty participated, primarily those who were already the most attuned to excellence in teaching; there was no way this intervention as initially designed was going to have the intended impact on undergraduate teaching at this particular university. Clearly a redesign was needed.

In a discussion of the issue among the MSP leadership team, one of the scientists recounted the experience of Arnold Arons and Lillian McDermott, physicists from the University of Washington who spent much of their careers focusing on improving undergraduate physics education. Dr. Arons and Dr. McDermott had become concerned that many students who had received high grades in the introductory physics course nevertheless did not seem to really understand very much about physics when they enrolled in the upper level courses. They spoke with large numbers of students who had completed introductory physics courses in a variety of colleges across the United States to assess their understanding of fundamental ideas, and found much the same results. Interestingly, they found that faculty at the more prestigious universities would not be convinced that it was a problem at *their* university until shown the results from their own students. The MSP leadership team wondered if the key to getting the attention of the scientists at Manchester was having them see for themselves that the existing courses were not producing the desired results.

Recognizing the value of providing incentives for faculty involvement, the MSP leadership team was delighted to accept the offer of the Dean of Arts and Sciences at Manchester University (who served on the MSP Advisory Board along with faculty and administrators from each of the participating IHEs) to ask for descriptions of undergraduate teaching improvement efforts in the annual report prepared by each department. The Dean also agreed to co-sponsor a kick-off event for the science faculty that would include a showing of the Private Universe

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video, and a presentation by a scientist from another university on their course improvement initiative, including evidence of deepened student understanding.

The MSP leadership team planned to offer assistance to departments in fulfilling the "improving teaching" requirement for their annual reports, including highlighting the availability of the study groups. They also planned to monitor the situation to see if this redesign was successful, or if additional modifications were needed.

The leadership team in this MSP discovered that their interventions worked in some contexts, but not others. Think about the interventions in your MSP. Is it possible that some of the interventions are not working as intended? Are there settings where the interventions aren't taking root, and if so, why not? Are there mechanisms in place to provide an early warning to the leadership team? Are the needs you identified at the beginning still the priorities for intervention at this point?

GARNERING SUPPORT FROM KEY STAKEHOLDERS[3]

Although there is no formula for accomplishing it, securing the support of key players is critical as MSPs engage in large-scale reform. The goal is to make sure that all of these stakeholders believe in the MSP vision, understand how the MSP interventions reflect the vision, and are willing to do their part to achieve the vision.

The "Defining the Terrain" box identifies some of the possible stakeholders for an MSP. Some of them, like students and mathematics and science teachers/faculty, will be key in any MSP; others may be more or less important depending on the particular context.

Defining the Terrain: Garnering Support from Key Stakeholders

Partner Districts
- K–12 Students
- Teachers of Mathematics and Science
- Mathematics and Science Department Chairs
- Principals
- Guidance Counselors
- Central Office Personnel
- School Board
- Teachers' Union

Institutions of Higher Education
- College Students
- Mathematics/Science/Engineering Faculty
- Education Faculty
- College and University Department Chairs, Deans, Provosts, Other Administrators

The Broader Community
- Parents
- Business Community
- Community-Based Organizations
- Museums/Science Centers

The first challenge for an MSP in this area is in identifying the key stakeholders, those whose support will be most critical to the success of the MSP. The second challenge is in building support among the key stakeholders. Some stakeholders are particularly influential, and the final challenge in this area is leveraging their support.

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[3] For a brief review of key literature, see Appendix B.

> **Key Ideas: Garnering Support from Key Stakeholders**
>
> - Identify the key stakeholders
>
> - Build support for the reform vision as well as for the direct interventions
>
> - Leverage the support of influential stakeholders

Identifying Key Stakeholders

MSP leadership teams need to have a deep understanding of their context in order to garner support from key stakeholders. The nature of this support, and the particular mix of stakeholders needed, will vary. For example, for an MSP involving a district with a long history of troubled labor relations, work with the teachers' union may prove absolutely central to success. Other stakeholders would also be important for successful reform at the district level, but for this MSP, the linchpin would be the union. In another place, the business community or parent groups might be the make-it-or-break-it constituency. In all cases, working with the proper combination of stakeholder groups will promote success; the actual mix of groups depends on local context.

Identifying the key stakeholders involves an assessment of the kind of support needed to make an MSP successful, including decision-making authority and access to resources. It is a process of determining the kind of influence needed to get an MSP off the ground and to keep it moving forward. Without evidence of support from a range of important players, an MSP proposal is unlikely to have received funding in the first place. However, such initial good will—from faculty and administrators in the IHEs and superintendents, principals, and teachers in the partner districts, as well as parents and the business community—will carry the MSP only so far. MSP leadership teams will want to assess the existing prospects for implementing the MSP reforms in their particular context, including looking realistically at the level of commitment among key stakeholders for achieving the goals of the MSP.

One way to think about stakeholder support would be for the MSP leadership team to create a list of the individual stakeholders whose support is critical to the enterprise, brainstorming freely to make sure that all potentially key individuals and groups are included. The next step would be to identify the issues that are most salient to each of these individuals/groups, and consider if the MSP plans need to be modified to help address these issues. Finally, it would be important to identify possible ways to involve the various stakeholders, perhaps by considering whose opinions matter to each group, as well as what kinds of evidence they would find most compelling.

At the IHE level, university mathematicians/scientists/engineers are key stakeholders in every MSP, by definition. Having spent many years in intensive study in mathematics/science/ engineering, it is likely that university faculty care deeply about the discipline. In many IHEs, disciplinary faculty will be concerned about the content background of entering freshman, as well as ensuring that majors in the discipline are able to get the quality preparation they need for further study at the graduate level. Mathematicians/scientists/engineers are likely to listen to

peers who share their passion for the discipline: if a respected colleague has reviewed a set of instructional materials intended for K–12 use and finds it complete and rigorous, that's likely good enough for them. One MSP has used "Evening Chat" sessions to build alliances with higher education faculty, providing a vehicle for opening conversations within a "safe" environment.

The subset of IHE disciplinary faculty who do not yet have tenure is worthy of special note. What matters a great deal to them is getting tenure, and they will pay particularly careful attention to people who have the most say in those decisions, typically full professors in their departments. However much untenured faculty may care about improving undergraduate teaching, or K–12 education, they are likely to recognize that success in those efforts does not weigh heavily in tenure decisions at research-oriented IHEs. Consequently, there is a disincentive for untenured mathematics/science faculty to devote time to an MSP. (In contrast, untenured mathematics and science *education* faculty have an incentive to participate in MSP activities that can serve as contexts for their research and publication activities.)

College and university presidents, chancellors, provosts, deans, and department chairs have varying degrees of authority and influence at institutions of higher education.   It typically helps a reform effort to have high level support, but given the individualistic culture in many IHEs, such support does not guarantee faculty willingness to consider, no less embrace, the reforms.

At the district level, teachers are central stakeholders in virtually every MSP. When teachers are well-informed, and recognize that their needs have been considered in the planning, they will not just "accept" the reforms, but are more likely to work hard to make the planned changes a lasting reality. As an example, coordinating mathematics/science instruction with language arts instruction may be well-received by elementary teachers who tend to feel better prepared in reading/language arts than in other subjects.

Previous large-scale reform efforts have emphasized the importance of other key players in the school districts. For example, the superintendent in each MSP partner district needs to have a broad understanding of the MSP vision for a reformed mathematics/science system, and enough buy-in to the reforms to be willing to support them through other district policies and practices. The superintendent can set the tone for the support the MSP team will receive from other central office administrators as well, including not only the district mathematics and science supervisors, but those responsible for professional development, Title I, etc. at the district level. Similarly, whether a school board is politicized or not, wields a great deal of power or is laissez faire, it is important that all members of the school board understand the vision for reform and see it as consistent with the board's own goals for the district.

Principals need to understand and buy in to the MSP vision so they will encourage teachers to implement the reforms, and ensure that school policies and practices are supportive of the reform as well. Similarly, school counselors often influence students' decisions about elective courses; they need to understand the importance of students taking particular gatekeeper courses in order to have the possibility of advanced study, and the particular need to encourage students in underrepresented groups to pursue such study.

MSPs also need to consider stakeholders who are not a formal part of the education system, but may have a substantial influence on it. It is particularly important that parents understand the impact of the reforms on their children, and see those reforms as an integral part of a vision of better education for them. Similarly, the business community is likely to carry considerable weight with the superintendent, school board, and IHE administrators, so it helps to have them invested in the outcomes of the MSP, e.g., for the long-term employment needs of the community.

Community organizations such as the Urban League and Girls Clubs, to name two, are natural allies for MSPs in that they are invested in the well-being of students in the partner districts and already have deep roots in the communities. It is important that these groups understand and support the MSP reforms, possibly collaborating with the MSP in after-school, summer, and Saturday Academy activities to help all of the participating groups fulfill their missions. In many communities, museums and science centers are important partners with the schools, providing professional development for teachers as well as opportunities for students to explore their interests in science and technology.   Again, alliances with MSPs can help all involved achieve their mutual goals

Building Support among Key Stakeholders

Regardless of the initial level of commitment, MSPs are engaged in building additional support among key players both for specific interventions and for the larger MSP reform vision. The reform vision needn't be thought of as a static set of ideas that players must accept unquestioningly. In fact, key stakeholders bring different perspectives and abilities to the table and can contribute to the ongoing evolution of this vision: some are strategically insightful; some are politically powerful; and some possess critical technical capacities that can inform the planning process. Successful MSP leaders will know these different strengths, help *all* stakeholders learn what the MSP stands to offer, and develop a shared, but evolving vision for the work.

It is important to emphasize that garnering stakeholder support is not a one-way street. It is not simply about what the MSP wants from stakeholders, but also what the stakeholders can expect from the MSP. To this end, it is important that MSP leadership teams listen carefully to stakeholders, and work to modify their plans so that they speak to the concerns of stakeholders. MSPs are involved in a bit of a juggling act, an ongoing process of creating a vision of reform, maintaining the focus on quality mathematics/science education for all students, while working to incorporate the perspectives of an ever-widening circle of stakeholders.

MSP leadership teams need to recognize that some important stakeholders do not possess much of a voice in the present scheme of things and may not be reached by existing communication mechanisms. Consider the case of an urban district where a standards-based curriculum was being implemented in all elementary schools. District leaders realized they needed considerable parent involvement for the program to take hold, but the traditional communication modes weren't working well; only a small group of parents attended the various outreach sessions. To address the need to have a greater number of parents become familiar enough with the new

curriculum that they could support it at home, the district leaders augmented their dialogues with parents at PTA meetings, with presentations at churches and civic groups. The result was increased support for the new curriculum and a renewed focus on the importance of closing the achievement gap between those who were traditionally well-represented in mathematics and science, and those who were not.

Previous reform initiatives have found that in garnering stakeholder support, it is vital to consider those players with different points of view from their own. It is not necessary to "sell" one and all on the reforms to the extent that they become starry-eyed converts. It may be enough to search for common ground in order to diffuse active opposition; in all likelihood, finding the common ground will improve the MSP plan as well. In the ideal, the MSP will benefit from a very powerful synergy, where incorporating diverse perspectives into the initiative will both improve its design *and* increase the likelihood that others will attend to it.

Leveraging Support of Influential Stakeholders

In any social system, it is inevitable that some people will have more clout than others. Strategic MSP leaders take advantage of this fact, positioning their initiatives to benefit from the support of influential stakeholders. For example, university administrators and district superintendents who are not themselves deeply engaged in the day-to-day work of an MSP can be given a visible role at kick-off meetings, communicating their support for the initiative in welcoming remarks, or simply by being there. Similarly, when there is a need for in-depth involvement of a small number of faculty, K–12 teachers, principals, etc., the MSP may want to recruit the "opinion leaders," those whose views matter a great deal to their peers.

Selecting people to participate in MSP advisory groups provides a good opportunity to benefit from the involvement of influential individuals and groups. As an example, a statewide initiative decided it was important to involve every district superintendent in the state on one of the regional advisory boards. At the same time, the leaders recognized that superintendents would not be able to devote a large amount of time to the enterprise, and that if a few superintendents starting sending designees to the meetings, others would soon follow suit, and the whole structure would disintegrate. Their solution, which worked beautifully, was to have two advisory boards in each region. The group that included the superintendents and high level corporate executives met only once annually, and they appreciated the opportunity to exchange ideas with one another. The second group was comprised of representatives of the superintendents and corporate executives; they met quarterly to work at a more operational level, and were charged with keeping their bosses in the loop. As a result, all of the advisors felt valued, all felt that their time was well spent, and all considered themselves an important part of the initiative.

When considering who those in each stakeholder group are most likely to listen to, it is important to recognize that people are likely to listen to those with whom they have the most in common. Superintendents listen to other superintendents, scientists/mathematicians/engineers to other scientists/mathematicians/engineers, superintendents to other superintendents, teachers to other teachers, parents to other parents, etc. It is also the case that many of these stakeholders have precious few opportunities to communicate with their peers about the kinds of substantive issues

the MSP is targeting. A strategic way to capitalize on these two ideas is to arrange some "job-alike" activities where stakeholders have a chance to work together, in-depth, on the issues of the most importance to them. Conducting these activities can signal that the MSP is serious about involving its stakeholders and meeting their varied needs. Such activities have the additional advantage of providing a vehicle for the most involved and committed representatives of each stakeholding group to communicate directly with their peers why the MSP might be important to them, what contributions they can make, and what benefits they can expect. Similarly, skeptics and critics are given a chance to air their views in a forum where they are most likely to be heard, incorporated into the conversation, and given fair treatment.

Another way the MSP leadership team can be strategic in utilizing stakeholder support is by knowing when to give credit to others and when to claim credit for themselves. This point can be illustrated with an example from a large-scale reform effort that preceded the MSP program. The leaders of one statewide project invited a wide range of stakeholders into the process and worked to coordinate their efforts with existing reform programs to form a more coherent whole. Within their state, they often touted their connectedness with other reform programs and were modest about their own contributions, thus helping to build solidarity among the stakeholder projects. Unfortunately, when meeting with their national funders, this group expressed the same modesty, emphasizing the efforts of the other programs. This was a *big* mistake. The funders wanted to see clear evidence that this *particular* reform effort was working, not that it was coordinating successfully with a busy field of reform activities. In hindsight, it would have been wiser for them to have highlighted their own particular successes and contributions more strongly. In this case, coordinating with active stakeholders extended the program's reach, but damaged its prospects for ongoing funding.

The following vignette, "Mathematics at the Middle Grades," provides an opportunity to consider some of the issues around garnering support of key stakeholders. It describes an MSP made up of two urban and three suburban districts working to implement a new standards-based mathematics program at the middle school level. This MSP succeeds early in securing the commitment of key stakeholders to the program vision; the problem comes in *maintaining* this support commitment over time, as principal interest wanes. As you read through this vignette, think about what this MSP seemed to get "right" as they built support from this group of stakeholders, as well as important considerations that they seem to have overlooked.

Vignette 2

Garnering Stakeholder Support:
Mathematics at the Middle Grades

A comprehensive MSP involving two urban and three suburban districts, Mathematics at the Middle Grades, has set as its goal the introduction of a standards-based mathematics program across all middle schools in all five districts. Their ultimate vision is to create a reformed system in which everyone shares a lasting commitment to, and understanding of, standards-based mathematics education. Fully aware that curriculum change of this magnitude will require substantial buy-in of multiple key players, the MSP is targeting teachers, principals, parents, and the business community for various types of orientation sessions and workshops aimed at raising awareness and support. In addition, MSP leaders plan to hold meetings with decision-makers in the central administration to ensure their support.

The MSP leadership team knows it is fortunate to have broad support for this intervention among the five districts. At the proposal stage, the team made the rounds visiting schools, administrators, and parents groups, explaining the planned intervention. They were proud of their public relations campaign that led to this widespread buy-in. The program had been piloted in several urban and suburban schools, and teachers involved in the pilot accompanied MSP team members on these rounds. They talked about what they liked about the new program, and how they had seen student work improve. Their testimonies provided evidence that the new approach could work in participating districts, and the MSP team used these teacher testimonies to full political effect. The successful pilot sites gave the MSP team, and those with whom they met, confidence that the new program would "work" in their sites.

The leadership team was delighted to find that, everywhere they went, participants expressed enthusiasm for a new approach to middle school mathematics. Parents stressed that the current approach just wasn't engaging enough kids. Principals noted that they "lost" a lot of kids at the middle school level, when interest in mathematics declined dramatically. Far from resisting the reforms, the majority of teachers said they looked forward to trying the new program.

With the heartening degree of interest and optimism they encountered among teachers, principals, parents and others, the leadership team believed that their MSP enjoyed support for the reform. However, problems started to emerge in the fall of the first year of full implementation. During the previous summer, hundreds of teachers across all five districts had received extensive professional development in the use of the new instructional program. The MSP leadership team had invited principals to this professional development as well, reasoning that the more principals knew about the program, the better they could support its implementation. However, only a small number attended. Then, when school opened in the fall, the rumblings of protest began almost immediately.

First, principals noted that when they asked their teachers to provide test preparation for the state standardized 8th grade test, the teachers resisted. Next, principals raised concerns about their teachers' ongoing professional development needs. Although it had been agreed in the beginning that teachers' summer involvement would be supplemented with release time activities during the school year, the principals found this a logistical headache. The teachers wanted a cadre of regular substitute teachers on these days, but principals had trouble finding enough high quality substitutes to come in on a regular basis. This situation made principals want to cut down on their teachers' participation in professional development; they believed that students were beginning to suffer with their teachers missing so many days of instruction, and they feared that parents would soon begin to complain.

The MSP leadership team felt frustrated. At the planning stage, principals had been gung-ho; the MSP team had thought they had complete principal buy-in. Now principals wanted more test preparation and less release time. And many teachers were beginning to contact the MSP team to say that they felt their work was no longer "popular" with their principals, making them vulnerable come performance review time. The MSP team members wondered where they had gone wrong. How had they "lost" principals, among their most stalwart early supporters?

In this vignette, the MSP team succeeded in securing early commitment from stakeholders, but struggled to maintain that commitment from principals over time. Think about your MSP. Are there mechanisms in place to touch base with key stakeholders and make sure that the initiative is maintaining their support? Are there additional key stakeholders that need to be involved as the MSP progresses to help ensure the broadest and deepest possible support for the reforms, both during and beyond the funded period? What additional mechanisms might the MSP need to establish to be more inclusive and responsive as it reaches out to stakeholders?

ALIGNING POLICY[4]

MSP projects do not get to start with a blank slate. Each partner district comes to the table with a history of ways of going about mathematics and science education, including cultural traditions at the school and district level (e.g., the tone and substance of department meetings, faculty lounge conversations, and school board deliberations); and school, district, and state curriculum, instruction, and assessment policies that have varying amounts of influence on teaching and learning in mathematics and science. Each partner IHE has its own culture, traditions, and set of policies and practices for course approvals, assigning faculty to courses, and tenure and promotion. In most settings, some of the existing policies and practices will fit well with the MSP vision, while others will make it more difficult for the reforms to be implemented and take root.

In order to be more deliberate about addressing policy as a key dimension of reform, MSPs can begin by considering what aspects of education policy are most relevant to mathematics and science education in their context. In creating a framework for research on the influence of national standards, a committee working under the auspices of the National Research Council identified three "channels" of influence on teaching and learning—curriculum, teacher development, and assessment/accountability—noting that reform efforts must negotiate one or more of these channels in order to affect what happens in mathematics and science classes (NRC, 2002). In any given district, some of the policies related to curriculum, teacher development, and assessment/accountability will be more influential than others.

Defining the Terrain: Aligning Policy

Curriculum Policy
State graduation requirements, state content standards for K–12 mathematics and science education, and in some cases state textbook adoption decisions, are part of the relevant curriculum policy for partner districts. Many districts add more detailed specifications to the state curriculum policy, as well. At the IHE level, individual departments, and in many cases individual faculty, have a great deal of latitude in what gets taught.

Teacher Development Policy
States set policy on teacher certification, and establish requirements for recertification. Districts decide which teachers to hire, who gets assigned to teach particular courses, and which professional development opportunities to support. At the IHE level, some colleges and universities provide assistance for faculty to improve their teaching practice, either on a voluntary basis or based on the results of teaching evaluations.

Assessment and Accountability Policy
States assess student achievement in mathematics and science in at least some of the grade levels, and many districts administer additional assessments as well. As part of the federal "No Child Left Behind" legislation, schools that are not making "adequate yearly progress" may face consequences. At the IHE level, student assessment is typically left up to the individual faculty member.

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[4] For a brief review of key literature, see Appendix C.

There is an implicit assumption in many education reform projects that the logic behind the reform vision, demonstrations of the quality of the reform interventions, and evidence of results will present so compelling a case that policymakers will have to take notice and act accordingly. Unfortunately, this chain of reasoning almost never plays out as planned. In some cases, even with favorable evidence of quality and impact, the reform vision may fail to capture the attention of policymakers or the interventions may be deemed too costly or burdensome to implement on a large scale. In other cases, policymakers may make changes to education policies intended to support the reforms, but without understanding the central features of the reform vision, end up creating policies that result in change but not improvement. In still other cases, the policies may provide the appropriate guidance, but lack incentives for people to change their behavior; behind the classroom doors, practice goes on as it always did.

Even if an MSP is not in a position to actively influence policy in mathematics and science education, it can do a great deal to help partner IHEs/schools/districts progress successfully toward the MSP vision within the constraints and opportunities provided by their policy contexts. For example, MSP interventions may provide IHEs an opportunity to fulfill their outreach mission or teachers a means to meet continuing education requirements, or schools a way to address identified needs in their school improvement plans, meeting other important needs of these individuals and institutions while at the same time helping to achieve the MSP vision.

Key Ideas: Aligning Policy

- Identify the most influential policies and have a plan for dealing with them

- Leverage aligned policies to move forward

- Seek and create opportunities to align policies

At both the district and IHE levels, it is important that MSP leaders understand the policy landscape and, whenever possible, establish a means to bring the more influential policies into alignment with the reform vision. A previous section of the *Handbook* described the importance of garnering support from key stakeholders, and the need to create a critical mass of people committed to the MSP vision so that it can increasingly permeate the system. Having the support of key stakeholders enables an MSP to move forward in the policy arena as well, working to ensure that all of the pieces fit together coherently so that college faculty, K–12 teachers, administrators, students, parents, and other important players all get the same message about what is valued in mathematics and science education.

Identifying and Dealing with the Influential Policies

Each of the MSP partner IHEs and districts is likely to have a myriad of policies related to curriculum, teacher development, and assessment/accountability, but there's little to be gained by

doing an extensive excavation to unearth them. Rather, an MSP's efforts in the policy arena should be highly focused; it is likely that only a few policies really hold the attention of faculty/teachers and administrators, as well as students, parents, and other stakeholders.

An important first step in thinking about how to engage in policy work, then, is to identify the key policies, who makes them, and who pays attention to them. Sometimes it is quite obvious. For example, at the IHE level, tenure and promotion policies are a major driving force. Certainly at large research universities, but also at other IHEs as well, faculty may get the message that research productivity carries greater weight in tenure and promotion decisions than does excellence in teaching, and apportion their efforts accordingly.

At other times, it may take some research on the part of the MSP. For example, a survey of teachers can reveal what policies most influence their selection of content to be taught in their courses. Focus groups with parents can be used to uncover what kinds of information they pay most attention to when judging the quality of their children's schools and educational experiences. Interviews with administrators can help to identify what qualifications they consider in hiring, what aspects of teacher/faculty performance they judge most important in teaching evaluations, and what tools they use when conducting these influential aspects of their work. Determining which policies matter most is the first step in understanding opportunities available and constraints imposed.

It is important to recognize that the absence of policy can sometimes be influential as well. Teachers, principals, and superintendents pay attention to high stakes assessments, so a mathematics assessment that isn't well-aligned with the MSP vision will clearly be problematic. The lack of science assessment at the elementary level can be just as problematic, albeit in a different way. Key players will focus on those subjects that *are* assessed, typically reading as well as mathematics, and pay far less attention to subjects that are not assessed, which frequently include science. Similarly, the fact that recertification policies lack specificity can be problematic for MSPs that conduct rigorous professional development programs, as teachers may gravitate toward less demanding offerings. The lack of policies to ensure alignment of pre-service teachers' preparation with the mathematics and science content they are expected to teach is, in many cases, another example of how the absence of policy can be problematic for MSPs. At the IHE level, the alignment of mathematics and science content courses for prospective teachers to K–12 content standards is often not particularly strong and policies for achieving such alignment, if present at all, are often weak.

Leveraging Policies to Move Forward

MSPs will inevitably operate in policy environments that are not fully supportive of reform, but generally some policies can be leveraged to support the initiatives. Reform interventions can often be positioned to meet the requirements of existing policies, e.g., arranging for teachers to receive continuing education units or graduate credit for participating in the project's professional development. However, MSPs may find that even though the interventions they offer can fulfill the requirements of policies, so can many other options that are far less aligned with the reform vision.

MSPs need to be opportunistic when it comes to policies. By monitoring policies that will require people to make changes in how they go about their work, MSP leadership teams can help IHE faculty, K–12 teachers, and administrators meet emerging requirements. Especially strategic projects often find, develop, and "market" tools and services designed to address specific requirements of education policies. For example, states/districts that are planning to adopt new textbooks will want to ensure alignment with state content standards. An MSP project might identify an appropriate tool for instructional materials review and offer the tool and training in its use to textbook adoption committees. As another example, more and more administrators are being required to use performance data, including student achievement results, in their school improvement planning. A number of recent reform projects have developed technical assistance programs to aid administrators in this task, with a focus on helping them make data-informed decisions aligned with the reform vision—about hiring, scheduling, student placement, professional development, and other important issues.

IHEs often have an outreach mission that includes work with K–12 schools. Also, recent changes in requirements for federal funding for research in mathematics, science, and engineering have strengthened requirements for connections to K–12 education. By becoming aware of these policies, MSPs can actively seek opportunities to help higher education faculty meet requirements of their work in ways that advance the MSP reform vision. In some cases, district policy can be used to leverage pre-service education as well as the in-service education provided by colleges and universities. For example, districts can choose to become involved in proposed professional development programs only if they address priority district needs, or they can let the colleges and universities know how well their graduates are performing in the mathematics/science classroom and that they will use these kinds of data in making hiring decisions.

Seeking and Creating Opportunities to Align Policies

Clearly, if any policies present obstacles to their reform plans, MSP leadership teams will want to become aware of those obstacles and negotiate ways to overcome them. Sometimes the best bet is to work around the constraints of unaligned policies, rather than confronting them head on. For example, some reform efforts have had success in getting waivers from particular state or district policies, e.g., getting permission to use state textbook funds for standards-based programs not on the state adopted list. Similarly, some initiatives have recognized the disincentives for untenured university faculty to get deeply engaged in K–12 reform, since promotion typically depends heavily on research productivity, and have begun their work with senior faculty who do not face the same obstacles.

It is important to recognize that however much finding ways around current policies might allow MSPs to begin their work, in the long term the MSPs will encounter considerable challenges in scaling up and sustaining reform unless key policies are brought into alignment with their reform visions. States, districts, and IHEs may be willing to allow a pilot effort to operate essentially outside of current policies, but going to scale requires changing the relevant policies. If an MSP has a chance to operate apart from one or more unaligned policies, it helps to establish a

powerful existence proof demonstrating that the MSP interventions are effective and valuable, and emphasizing that under current policy guidelines, these highly beneficial interventions cannot be provided on a widespread basis. Recommendations for policy changes that will permit, or even encourage, the MSP interventions will go much farther when combined with evidence that the interventions work well.

Experience in previous large-scale reform efforts has highlighted some ways to break into policy work in education. One fairly straightforward strategy is to include on the project's advisory board or steering committee people whose involvement in policy work is assured because of their positions, including superintendents and curriculum supervisors in districts, and provosts, deans, and department chairs in colleges and universities. Although they may not think of themselves as making policy in terms of laws and regulations, people in these positions tend to be integrally involved in the development of specific policy instruments such as curriculum frameworks and continuing education policies. They are also involved with tenure and promotion decisions and teacher/faculty hiring and placement guidelines. By including some of these people in the leadership team and/or advisory board, an MSP can create opportunities for substantial influence on how policies are interpreted and communicated.

Another strategy for engaging in policy work that has proven effective for some reform projects is to develop precursors to forthcoming policies. For example, standards and assessments are revisited and revised on a fairly regular basis in most districts and states. Similarly, course offerings are revised, new courses are added, and degree/certification requirements are reviewed periodically in districts and college and university departments. Some projects have been able to draw attention to their reform vision and to set a place for themselves at the decision-making table by crafting and disseminating position papers, policy reviews, recommendations, and tools related to upcoming policy decisions. These activities can serve to announce an MSP's interest in contributing to policy decisions, and to establish some authority for the MSP to engage in policy work. Two tactics that have served reform projects well in these respects are involving a broad array of stakeholders in these precursor-to-policy efforts, so that the work of the project is widely known; and commissioning external reviews of the products, so that the quality and credibility of the project and its work are strengthened.

The fact that K–12 teachers and IHE faculty are frequently involved in the development and implementation of policy instruments, such as curriculum or syllabi development, or textbook selection, can provide another opportunity for MSPs. Many K–12 reform projects have had success in encouraging teachers with whom they work to volunteer for these committees, or they have directly "placed" teachers on these committees through their contacts with administrators and supervisors. By working with these teachers to help them understand and advance specific recommendations aligned with the reform vision, an MSP can exert considerable influence on mathematics and science education policy.

In the vignette below, "Planning for Policy Change," the plan of one MSP to influence an upcoming textbook adoption is described. The MSP leadership team has conducted some analysis, and plans to present some of their findings in order to make the case for changes in the textbook adoption process. As you read the vignette, consider the strengths and weaknesses of

this plan in terms of how the MSP has positioned itself, and the evidence the MSP leadership team plans to use in order to influence textbook adoption policy.

Vignette 3

Aligning Policy:
Planning for Policy Change

Eight suburban K–12 districts have partnered with a local university in an MSP intended to promote a standards-based program of mathematics instruction K–12. The state adopted mathematics content standards six years ago and aligned its assessments with the content standards two years later. Along with the newly-aligned assessments, the state created performance expectations that guide the reporting of student, school, and district outcomes. Although the content standards were intended to be a guiding document for district curricula from the start, it wasn't until scores from the new assessments were reported that most districts paid careful attention to the new content called for in the standards. For the three years that the standards-aligned assessments have been given, these districts have generally performed at or above expectation in most mathematics areas, but below expectation on the Data Analysis and Algebraic Reasoning standards at grades 3, 5, 8, and 10.

The MSP leadership team identified the districts' low achievement in Data Analysis and Algebraic Reasoning as key targets for its Partnership to address. The project views these two mathematics content areas as gatekeepers to continued study of mathematics in advanced courses in high school and in post-secondary education.

In collaboration with the districts, university mathematics and mathematics education faculty undertook a needs assessment of teaching and learning around these two content areas. Specifically, the analysis of student achievement results showed that students were performing reasonably well on items assessing symbolic manipulation in algebra, and reading graphs in data analysis, but especially poorly on items assessing higher order reasoning. The results also showed that the district curriculum frameworks were aligned with the state content standards and the specifications of the state assessments. However, the mathematics instructional materials, especially those used at the elementary grades, were very weak in these two areas.

A major opportunity will occur at the end of the first year of the project as these districts will be adopting new instructional materials in mathematics. As a part of putting the MSP proposal together, the leadership team presented its analysis of student achievement to the superintendents and assistant superintendents in the eight districts. These presentations were effective in gaining the support of district administrators for the project. Capitalizing on this support, the MSP leadership team now plans to use its analysis of achievement results and its needs assessment results to gain access to the instructional materials adoption process. In addition, the MSP plans to use its prestige as a federally-funded university-school mathematics initiative, and its link to the district administration and mathematics curriculum specialists, to "place" project leaders, staff, and associates on district adoption committees.

Although the MSP does not want to be perceived as advocating for a particular set of instructional materials, the leadership team does want to push some criteria for the adoption process that they hope will influence the nature of the materials that are ultimately adopted. The districts are in the process of crafting policies and procedures for the instructional materials adoption to ensure alignment with the state standards and assessments. Knowing that almost all of the textbooks and programs under consideration will address algebraic reasoning and data analysis, since these are in the state's standards, the leadership team hopes to help the committees differentiate between simply having these topics included in the materials and providing explicit attention to higher order reasoning in algebra and data analysis. Again, the leadership team believes it has the support of the district administrations, so that their criteria have a good chance of becoming a part of the curriculum adoption policy.

In this vignette, the MSP leadership team identified priority needs and a key policy relevant to those needs. The team pinpointed an important opportunity and utilized connections of the team

to position the MSP to influence this policy. Thinking about your own MSP, which are the most influential policies providing guidance and incentives to K–12 teachers and IHE faculty? To what extent are these policies consistent with the MSP vision? What steps can you take to assure that the MSP capitalizes on the most aligned policies? What pathways might the MSP use to work around particularly problematic policies? How can the MSP put itself in a position to influence the nature of these policies in the longer-term?

SCALING UP INTERVENTIONS[5]

In many externally-funded reform efforts, scaling up interventions has typically occurred toward the end of—or after—the funded period. Often, even the planning for scaling up interventions is delayed, since most of the time and energy of the leadership team goes into launching the specific interventions, and building support among stakeholders. Without strategic planning for scaling up, ideally from the outset of an MSP, it is unlikely that the initiative will have sufficient human resources and adequate infrastructure to carry out its work on a large scale.

Defining the Terrain: Scaling Up Interventions

Scale Up
Scale up is the mobilizing of resources to reach large numbers of participants with specific interventions as part of realizing an MSP vision.

Human Resources
Human resources refer to those individuals who will lead or support large-scale implementation of interventions. These individuals may include the MSP leadership team, and additional university faculty, teacher leaders, principals, and district central office staff. In most cases, an MSP will need to provide professional development to help people gain the knowledge and skills they will need to carry out their new roles effectively.

Infrastructure
Infrastructure refers to the system in which interventions are situated and the constellation of structures and resources that can support or hinder large-scale reform. These include policies about, and resources allocated toward, professional development, curriculum, and assessment; they also include organizational structures for decision-making and follow-through.

Quality Control
As an initiative expands, people beyond the core team will increasingly be involved in providing interventions. Especially if these individuals are less experienced in this role, it is important that the MSP monitor the quality of the interventions and take corrective action as needed.

Scaling up interventions is a goal of all MSPs, as part of the enactment of the reform vision. MSPs work toward improving an entire pre-service system, or improving teaching and learning in all mathematics/science classrooms at a particular grade range. Developing capacity for scale-up is far from automatic; MSP leadership teams need to develop a specific plan for implementing interventions on a large scale. Typically, this means tapping or developing more human resources than the MSP leadership team and core staff, a strong infrastructure to sustain interventions on a large scale and the means to ensure quality throughout.

Major reform initiatives are always pressured to reach large numbers of participants and make sweeping changes as quickly as possible. Although the demand for greater speed is not likely to go away, MSPs can be more planful about just how they will scale-up their interventions,

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[5] For a brief review of key literature, see Appendix D.

articulating the trade-offs they want to make between depth and breadth. For example, many education reform initiatives rely on teacher leaders to reach large numbers of teachers with a specific intervention, such as implementation of a new curriculum. Part of the scaling up plan is not just the deployment of teacher leaders (deciding which teacher leaders will work with which teachers in what schools), but also detailing the knowledge and skills each teacher is expected to develop through the support of a teacher leader, and identifying the depth of knowledge and skill each teacher leader needs to possess to work effectively with teachers. Part of the scaling up plan is an assessment and application of what has been learned from smaller-scale intervention (for example, the work of a few teacher leaders with a small number of teachers) to the larger-scale efforts. With strategic planning at the design and implementation stages, targeted mid-course corrections, and attention to the MSP vision throughout the process, an MSP stands a far better chance to create change that scales up to high levels and becomes institutionalized.

Key Ideas: Scaling Up Interventions

- Develop human resources

- Develop infrastructure

- Create a system for maintaining quality

Developing Human Resources

Before an MSP can scale-up its interventions to reach large numbers of participants, the MSP leadership team will want to determine if the right number and mix of individuals are available and if they have the knowledge and skills needed to carry out the work on scale. It's one thing to have a few experts provide many hours of professional development and classroom coaching to a small number of teachers. It's another thing entirely to identify and put in place the individuals who can implement this plan on a large scale. Armed with accurate information from an assessment of existing resources, the leadership team can plan strategically.

Since MSPs typically include interventions at multiple levels in the mathematics/science education system, it is important to find out about the status of human resources at the different levels. MSP leaders need to assess whether individuals with authority are in place at the IHE, school, and district levels to make and/or enforce decisions about resource allocation and other policies that impact the MSP interventions on scale. Are there sufficient numbers of people, at appropriate places in the various institutions, who understand teacher/faculty change and are empowered to support and promote it in meaningful ways, including monitoring quality?

When MSP leadership teams assess current human resources at the IHE and district levels, they may well discover the need to further develop the knowledge and skills of key leaders. For example, faculty, teacher leaders, and principals leading course revision efforts may need additional orientation and education concerning the roles they will play in the interventions, and an understanding of the bigger picture the MSP has developed of a reformed system. Developing human resources for scaling up means attending to needs assessment results and planning for required development accordingly.

It is important to note that the development of human resources for scaling up may well mean more than simply providing professional development based on assessed needs. Recall the earlier discussion that both capacity (skills and knowledge) and will (commitment and investment) are necessary for successful reform. When MSP leaders examine the existing human resources for scale-up, they need to sort out the extent to which the problem is that key players don't know *how* to do what is needed, or that they are *unwilling* to do it. If the former, certain development moves make sense. For example, if key players have only foggy notions about the nature of the MSP changes, they may just need to learn more. This could mean visits to other districts/IHEs where the innovations are in place, talks with practitioners from these institutions, visits from "experts," and focused training. However, if the problem stems from unwillingness to implement the MSP—let's say some stakeholders who are key to scale-up don't like the MSP plan—it is their will, rather than their capacity, that needs to be addressed. Interestingly, the "solution" may be similar; for example, additional information and leadership development may help, just as it did for those leaders who lacked understanding. But in the latter case, MSP leaders need also to figure out how to help key players learn to care about the MSP intervention, listening carefully to why these stakeholders are reluctant to participate, and considering if the interventions should be modified in some way during scale-up.

Developing Infrastructure

Beyond an assessment of the human resources needed to go to scale with the various interventions, MSPs need to assess the status of the infrastructure within which these interventions are situated. For example, preparing a cadre of teacher leaders to provide in-class support to other teachers won't help in scaling up if the teacher leaders aren't given released time during the school day or opportunities for access to teachers and their classrooms.

It is quite likely that the MSP leadership team will need to strengthen the district/IHE infrastructure in order to scale-up interventions and realize the MSP vision of a reformed system. Based on an infrastructure assessment, this work could entail putting new policies in place, allocating resources in new ways, aligning existing programs with MSP interventions, articulating authority lines so that sufficient leadership backs the interventions, or troubleshooting the areas where the demands of going to scale run counter to pre-existing initiatives.

For example, the college or university infrastructure may need strengthening if processes for recruiting faculty or resources for working with existing faculty are not in line with MSP goals to improve mathematics/science education. Or, if existing university programs conflict with an

MSP intervention, the leadership team will need to work on better alignment if large-scale and sustained reform is to occur.

Creating a System for Maintaining Quality

MSP leadership teams need to balance the pressure to scale up their efforts with their commitment to quality. This means that they will probably want to lean heavily on their own monitoring practices to provide them with information about how extensively, and how well, interventions are progressing. Monitoring can take any of a number of forms: external evaluation from the beginning of the MSP program; participation in outside research efforts that help to track program effects; and/or an ongoing internal reflection process among MSP team members. The information that results from these various channels can help MSP leadership teams see if their interventions are working as they are scaling up and what adjustments may be needed.

The following vignette, "The Midwest Partnership for Science Improvement" illustrates efforts to ensure that the interventions reach beyond the "pioneers," at both the district and the university levels, so that all students have an opportunity to benefit from the reforms. As you read the vignette, consider the ways the MSP has attended to developing human resources, infrastructure, and quality control in its plan for scale-up.

Vignette 4

Scaling Up Interventions:
The Midwest Partnership for Science Improvement

Three urban school districts in the Midwest have joined forces with a large local university to improve science instruction in all four of these institutions. Called the Midwest Partnership for Science Improvement, this MSP's long-term goal is to increase the numbers of students accessing high quality curriculum taught by strong, knowledgeable instructors. The MSP leadership team, consisting of representatives of each district and the university, has an ambitious plan for reform, one that takes seriously the need to scale up the interventions so all students have access to quality science education.

The three districts have agreed to adopt common instructional materials in science, with the MSP providing professional development focused on quality implementation of those materials. In the past, when most in-service education was offered on college and university campuses, teachers were free to choose how to fulfill their continuing education requirements, and there was no guarantee that what they chose would be well-aligned with the curriculum in their districts. Although by union contract the districts are not able to "require" that teachers participate in the MSP professional development, MSP leaders reason that if the activities are offered within the districts, teachers will be more likely to participate in them, especially if some of the activities take place within the regular school day.

The plan is for university science and science education faculty to work with the districts' science coordinators to prepare a cadre of three teachers per district to become full-time release "teachers-on-special-assignment" (TOSAs). The TOSAs will in turn provide workshops on the use of the new instructional materials to teachers throughout the three districts, with support from the university faculty and district coordinators.

University faculty, the science coordinators, and the TOSAs will work together to prepare another tier of teachers to serve as science teacher leaders in the buildings where they teach; these teacher leaders will troubleshoot the

use of new materials on a day-to-day basis in their own schools, and serve as liaisons to the TOSAs.   District administrators have agreed to pick up the costs of one TOSA per district once the funded period has ended to continue to provide workshops, with a focus on teachers new to the districts and those that change grades. They will also continue to work with the school-based teacher leaders, preparing other teachers to fill this role as needed.

The MSP leadership team is well aware of the fact that the current infrastructure for this ambitious MSP intervention is not entirely what it should be in any of the districts, although their specific needs vary. One of the districts has had particular difficulty in recruiting classroom teachers, so it will be hard for them to hire replacements for teachers who are to be released full-time from the classroom to serve as TOSAs. Another district has had difficulty identifying qualified substitute teachers, so it will be hard for them to arrange times for school-based teacher leaders to visit other classrooms to support their colleagues. The MSP leaders, and other key leaders in each of the districts, are concerned about the extent to which they will be able to manipulate elements of infrastructure to support MSP-led change.

Despite challenges such as these, leaders in each of the three participating MSP districts are already feeling pressure to scale up their planned interventions as quickly as possible. They are struggling to train TOSAs and teacher leaders and implement instructional materials on a large scale immediately, knowing that they are expected to think about reaching *all* science teachers with the teacher leadership intervention as soon as possible. MSP team members worry that they will be forced to sacrifice quality in order to reach all teachers, and they wonder what "reaching" these teachers can mean if the intervention loses its strength in the process. They are concerned that the overall infrastructure is not yet up to the challenge of supporting the intervention, and wish they had planned for a lengthier start-up phase. The MSP leadership team fervently believes in their vision for reform, however, they are also aware of its vulnerability given the fledgling nature of existing human resources and infrastructure in the three districts.

Reform at the university level has its own set of challenges. The last time substantial course improvement was attempted here, it didn't get very far in terms of changing instruction. With grant support, two biology faculty members had spearheaded a major revision of the introductory biology course. The new course was well-received by the participating students, a number of whom attributed their choice of majors in biology or science education to this experience. However, even though the revised courses are now being used by other faculty across the country, most of the biology faculty on this campus aren't interested, indicating that they have seen differences in the instruction, but not any credible evidence that the changes led to improved learning. Clearly the idea that "if we build it, they will come" did not work in this instance; another strategy is needed.

Since the PI in an organic chemist, the MSP plans to begin the course improvement process this time with organic chemistry, a course that is on the trajectory toward degrees for both chemistry majors and prospective teachers. In a typical semester, two sections of organic chemistry are taught, each with about 50 students, with the faculty administering a common final examination. The plan is to offer the two sections at the same time, one for the revised course and the other for the traditional course, randomly assigning students to the two sections. At the end of the semester, the MSP plans to compare the final examination results of the chemistry majors in the two sections, and share the results with the entire science faculty at the university.

The hope is that based on these data, the science faculty will see where the reform is producing superior results, increasing the likelihood that they will be willing to teach those components of the new course in the future. Equally important, the MSP will see where the reform course is falling short, so they can incorporate the components of the regular course that are more effective into the new course. The MSP hopes that the result will be a revised organic chemistry course that results in improved learning for all students, with a consensus among the science faculty that this kind of course improvement process – trying new things and incorporating only those that are proven to result in increased learning – should be extended to other courses in the various science departments as well. The MSP recognizes that changing the course syllabi will not necessarily mean that faculty will teach the courses the way their developers intended, but for now want to focus on opening up willingness to consider course reform.

In this case, the primary challenges for scaling up the interventions with quality were identified as teacher knowledge and skills at the district level and commitment to reform at the university level. Think about the strengths and weaknesses of the approach developed by the Midwest Partnership for Science Improvement, and about the implications for your MSP. Has your MSP identified the key challenges to scaling up the interventions with quality? Are appropriate steps being taken to develop both the capacity (knowledge and skills) and the will (commitment and investment) for scaling up the various efforts? How can you ensure that you are maintaining the quality of the interventions as you scale them up?

PULLING IT ALL TOGETHER

MSP leadership teams want, and need, to be as strategic as possible in the challenging work of improving mathematics and science education. As noted earlier, the purpose of this *Handbook* is to address the issues that MSP leaders face in designing and implementing strategic reform programs, situating that discussion in examples from research and wisdom of practice. This conclusion to the *Handbook* attempts to pull together many of the ideas that, for the sake of clarity and reflection, have been teased apart in earlier sections. It begins with reflections on the nature of strategic leadership as outlined in the *Handbook*. This section is followed by a discussion of the interrelatedness of the four components of reform, referring to the vignettes to show the connections among these four components. Finally, there is a presentation of particular stances that strategic leaders take to ensure that they maintain a focus on realizing their evolving vision. "Stance" refers to adopting a consistent approach in one's MSP leadership work, involving actions like using evidence or making and monitoring trade-offs. These stances are tools MSP leadership teams will use again and again as they navigate the reform process. This concluding section offers another vignette, about the New Visions MSP, to play out these strategic stances for MSP leadership teams.

Strategic Leadership Redux

As discussed in the introduction, strategic leadership requires a systems perspective—understanding and influencing the education system—and not simply an interventionist perspective—carrying out specific interventions. Being strategic means articulating a shared vision of quality teaching and learning as well as what constitutes a reformed system. The purpose of the MSP is to realize that vision, which means developing, implementing, evaluating and refining a reform process that moves the system closer to that vision.

MSP leaders are charged with realizing their vision for mathematics and science education in the partner districts and IHEs, at the same time allowing the vision to evolve to better address the needs in that particular context. Reaching an MSP's goals requires attention to four critical components for reform: designing, implementing and refining interventions; garnering support from key stakeholders; aligning policies; and scaling up interventions. It is crucial, though, not to confuse the endpoint (i.e., realizing the MSP vision) with the means (interventions, stakeholder support, policies, and infrastructure). Being strategic means being able to take advantage of work in one component to make progress in other areas, all designed to achieve the MSP vision.

If the sky were the limit, MSPs could design marvelous plans and be successful in implementing amazing reforms. However, MSPs do not have unlimited time and resources and therefore must be strategic, being very purposeful about *what kind* of capacity and will is needed to achieve a vision of mathematics and science education. The reform process is about building capacity–the particular knowledge and skills–to implement interventions, to garner stakeholder support, to align policies, and to create an infrastructure to scale up. Simultaneously, the reform process is

about building will—the willingness—to back interventions, to actively support reform, to tackle policy issues, and to embrace scaling up.

Think Big, Start Small
Overall, strategic leadership entails adopting the mantra of "think big, start small." Thinking big means staying connected to the MSP vision and consistently inquiring about how day-in and day-out decisions and activities contribute to refining and realizing that vision. Starting small means being realistic and purposeful about the tangible work that MSP teams do, making sure that activities are working well before expanding them, and looking to maximize the impact of efforts in one component to advance work in other areas. There are two very different analogies that express what MSP leadership entails. The first (spinning plates) may represent how many MSP leaders currently feel, prompting them to want to be more strategic. The second (interlocking gears) is offered as a better representation of strategic leadership.

Years ago on the Ed Sullivan Show (and still seen in carnivals and talent shows), there were acts involving a number of tall poles, each of which had a plate on top. The task of the performer was to keep each plate on top of each pole spinning, a task that required dexterity, speed and, apparently, not a small amount of luck. This is the experience of many MSP leaders; they are running from one pole to another, giving each plate another push to keep it spinning, and dodging the debris from those plates that have gone crashing to the floor. The pace is frenetic and dependent on the individual who provides momentum to each individual plate on each individual pole. If there were multiple plate spinners, the best strategy for these folks might be to stay out of each other's way, not to attempt to coordinate efforts. But, with only one plate spinner, the strategy is to move as fast as you can to keep all the plates spinning and hope that you can beat the pull of gravity.
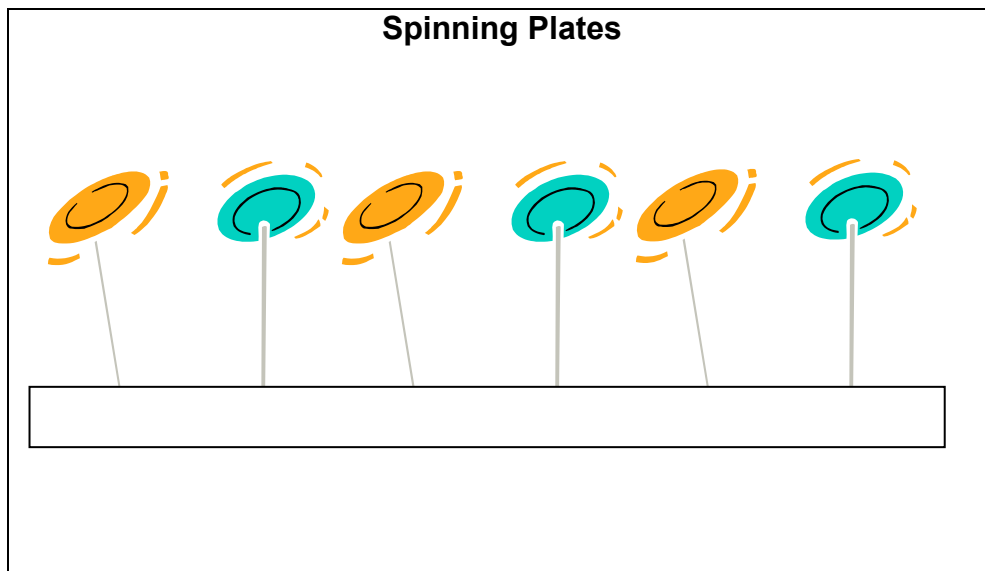

Spinning Plates

Figure 1

A different and more productive image of strategic leadership is found with an interlocking gears analogy. Consider the internal workings of a mechanical watch or the pulleys, belts and gears of turn of the century machinery, imagining a set of two, three, five, or ten interlocking gears. The task of the engineer is to create a system in which those gears can work together productively tapping an energy source to get the gears moving. The operator's task is to ensure that the gears do not lock up very often, and to get the system up and running when they do. It requires imagination to create those interlocking gears and skill to build and troubleshoot the system. This situation is akin to the experience of strategic MSP leaders, who see their job as implementing and refining a reform process that will help them realize their vision for mathematics and science education reform. As strategic leaders, MSP teams are engineers and troubleshooters, involved in design, management and oversight, as much as (or perhaps more than) the actual engines for the reform process, providing the human capacity to implement specific interventions.

Interlocking Gears

Figure 2

Although the interlocking gears analogy appears to be a more useful representation of strategic leadership than the spinning plates image, it is important to acknowledge that the interlocking gears metaphor has limitations as well. Mathematics and science education systems are far more complicated than any machine, and there is little that is "mechanistic" about working toward large-scale reform in such systems. There is a certain amount of uncertainty, and new issues always need to be attended to in district and university systems, along with the predictable "wear and tear" on existing components. The important message for MSP leadership teams is not to adopt the somewhat flawed gears model, but to recognize that they need to go beyond simply keeping the various pieces of the proposal plan "spinning." MSP leadership teams are trying to change a system—how IHEs and districts go about the mathematics/science education enterprise—and need to recognize that reform activities in one part of the system will affect other parts of the system as well. It is important that MSP leadership teams try to make these

interconnections work in their favor, with changes in one part of the system facilitating changes in other parts, all toward the ultimate goal of quality mathematics/science education for all students.

Interrelatedness of the Four Components

In order to be more concrete about what it means to be strategic, rather than replicating the spinning plates experience, let's take a look at how the four components for reform, described in this *Handbook*, are interrelated. As noted earlier, work on these four components needs to be iterative, rather than having the pieces carried out one at a time in some particular order. To some extent, viewing each component through the perspectives of the others can provide a deeper understanding of each of them. To that end, this section of the *Handbook* reviews each component and refers to the vignettes used earlier in order to highlight the interrelatedness of the four components and how they can and should fit together, like those interlocking gears.

Four Components of MSP Work

Designing MSP Interventions

- Understand priority needs in your context
- Select effective, promising interventions
- Pilot the interventions to provide "existence proofs"

Garnering Support from Key Stakeholders

- Determine who are the key stakeholders
- Build support for the reform vision as well as the direct interventions
- Leverage the support of influential stakeholders

Aligning Policy

- Identify the most influential policies and have a plan for dealing with them
- Leverage aligned policies to move forward
- Seek and create opportunities to align policies

Scaling Up Interventions

- Develop human resources for scaling up
- Develop infrastructure for scaling up
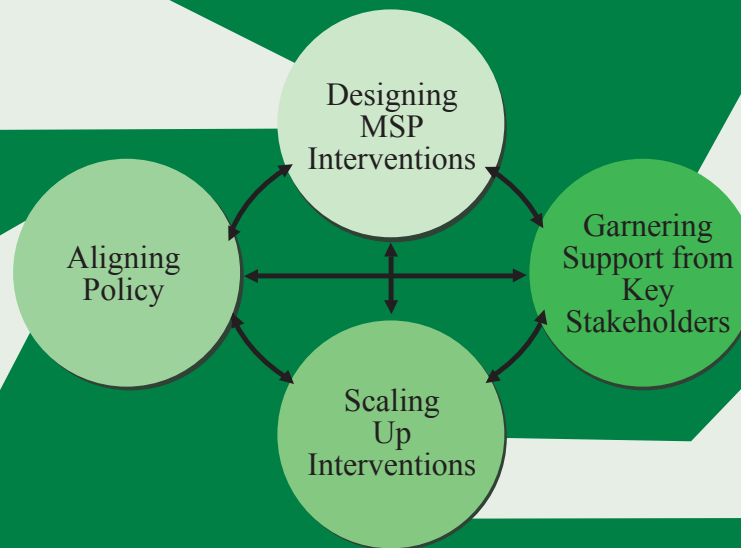- Create a system for maintaining quality in scaling up

Designing MSP Interventions

Aligning Policy

Garnering Support from Key Stakeholders

Scaling Up Interventions

Figure 3

Designing and Implementing MSP Interventions

Perhaps the most tangible aspect of MSP work is designing, implementing, evaluating and refining interventions. However, this work is necessarily tied to the other three reform components because, bottom line, reform isn't simply about a particular intervention—it's about realizing a vision for reform. A few examples of the relationship among the four components, when viewed from the perspective of interventions, include:

- The intervention should be one that could be scaled up without sacrificing quality;
- The needs of stakeholders in different settings should be considered, and other stakeholders can become important leaders of the intervention; and
- A powerful intervention can address policies that are meaningful for participants.

Let's play this out in terms of the vignette entitled "Improving Science Teaching at Manchester University" (Vignette 1). In this vignette, the proposed *intervention* was a study group model, where a group of science faculty at each institution was led by a scientist with recognized teaching expertise in a discussion of effective teaching and learning, prompted by lesson videotapes and examples of student work. The intention of the MSP leadership team was that the study group would comprise a critical mass of science faculty. When only a few participated at the research university, it was clear that this intervention would never reach the *scale* that was intended. The intervention needed to be revised in order to engage the faculty responsible for science undergraduate education. By calling upon a *key stakeholder*—the Dean of Arts and Sciences—the MSP leadership team was able to create a more meaningful intervention for the research university faculty. The Dean focused attention on the required undergraduate teaching improvement efforts that were a part of each department's annual report, and the ensuing study groups in the departments became the opportunity for faculty to work on that requirement. In this vignette, the MSP leadership team paid attention to the *policy* environment that was meaningful for the faculty at this university.

Garnering Support from Key Stakeholders

Repeatedly, the *Handbook* has called for identifying key stakeholders and developing their support since it is the investment of stakeholders—the people who are implicated in, involved in, and/or affected by interventions—that helps determine whether a reform vision can be realized. A few examples of how this component is related to the others include:

- Building stakeholder support occurs during the design/start-up phase of an intervention as well as during the implementation/maintenance phase;
- Aligning or creating policies is a powerful catalyst for garnering stakeholder support; and
- Scaling up interventions typically involves more stakeholders than does a pilot intervention.

Let's play this out in terms of the entitled "Mathematics at the Middle Grades" (Vignette 2). In this vignette, the MSP leadership team worked to develop initial *stakeholder* support among principals around a particular *intervention* (implementing new middle grades mathematics curriculum), but realized that this wasn't the same as the work needed to maintain support among

those stakeholders. As an intervention is implemented, the collective understanding of what the intervention really means must be cultivated, and this includes attending to the *policy* implications as well (e.g., securing professional development release time, aligning the new curriculum with state tests). Similarly, an intervention that might have been perceived as limited in time or scope needs to be reconsidered when it turns out to be ongoing and larger *scale*, pointing to the need to continue to develop and monitor stakeholder support.

Aligning Policy

There are policies in place in any system in which MSPs operate, and additional policies may need to be developed to promote the MSP vision of reform. A few examples of how this component is related to others include:

- The need to identify influential policies that affect the interventions;
- Looking to leverage existing policies and to create a demand for new policies by building on stakeholder support; and
- Viewing the scaling up enterprise as being as much about creating opportunities for new policies in support of the reform vision as it is pushing a direct intervention to larger numbers of participants.

Let's play this out in terms of the vignette entitled "Planning for Policy Change" (Vignette 3). In this vignette, the MSP leadership team selected curriculum *policy* as a target of their efforts, which involved articulating policies that would contribute to realizing their vision for mathematics and science education (e.g., criteria for textbook adoption, curriculum adoption process). As a result, they identified a clear need for the particular *intervention* (elementary instructional materials that are stronger in algebraic reasoning and data analysis). The team works to build *stakeholder* support at the district level, with university faculty, and on the curriculum adoption committees, but will need to assess whether these stakeholders are all in support of the same policies. Here, changing and aligning policies is part of the infrastructure needed to *scale up* their efforts.

Scaling Up Interventions

Given the MSP mandate to reach large numbers of teachers and students, attention to scaling up interventions is crucial. This means considering both the kind of human resources and the type of infrastructure needed to work in a sustained and long-term fashion. A few examples of how this component is related to others include:

- Developing the human resources to implement the intervention on a large scale with quality;
- Building the will for reform among stakeholders with different interests; and
- Supporting or creating new policies as part of the infrastructure for scaling up.

Let's play this out in terms of the vignette entitled "The Midwest Partnership for Science Improvement" (Vignette 4). In this vignette, there are two stories of *scaling up*. The first involves the development of a corps of teacher leaders to support implementation of common instructional materials in science. Teacher leaders are, themselves, an *intervention* in these three districts since they represent a new strategy for reaching all science teachers. The MSP

leadership team must address the interests of *key stakeholders*—teachers—to ensure that the implementation workshops led by teacher leaders will be well-received. This means addressing *policies* that can make or break these workshops: providing quality substitutes for teachers in the workshops and having effective recruiting strategies to replace the teacher leaders who have left the classroom. The related story, about reform at the university level in terms of substantial course improvement, takes into account the absence of *policy* governing curriculum for mathematics/science/engineering courses since individual faculty can decide what and how to teach. Thus, the MSP leadership team decided to begin with a plan to generate evidence that the *interventions* are effective, by comparing results achieved in a reform section of a chemistry course with those found in a regular course. This evidence would be used in order to generate *stakeholder* support for reform, in this case, the rest of the science faculty.

As an MSP leader, being strategic is not simply about making sure there is activity related to each of the four components outlined in this *Handbook*. (Remember the spinning plates analogy.) Rather, being strategic means looking for opportunities to make progress on multiple components, seeking and promoting the interrelatedness among the components. (Think of those interlocking gears.)

As referenced at various points in the *Handbook*, MSP leadership teams are in the business of both developing the capacity for reform within their systems and building the will within their systems to implement and sustain reform. The two go hand-in-hand. One can hardly imagine developing capacity—the skills and knowledge needed—to realize the MSP vision when there is no commitment or backing for that vision and for the strategies to get there.

In each of the four components of MSP work, capacity and will are highlighted in different ways. Designing, implementing and refining direct interventions is easily understood as developing capacity for reform among participants and among those who lead interventions. Yet, the challenge of these interventions is often as much about building the willingness to work toward reform as it is about developing skills and knowledge. Garnering stakeholder support is a good example of developing will, since developing support is usually synonymous with enhancing commitment to, and investment in, the MSP vision and plan for realizing it. However, garnering support in a system often calls for developing capacity among many players to cultivate and sustain that support.

Similarly, aligning policies is clearly about building will within a system since policies provide not only guidance, but also incentives for reform, making it possible for deeper buy-in to MSP work. This, too, often calls for developing capacity to identify, leverage, and create policies that support reform. Scaling up interventions is fundamentally about accessing or developing the human resources and infrastructure needed to move interventions to scale and, therefore, is another good example of building capacity for reform. Not surprisingly, though, scaling up is not possible if there isn't also attention to building and sustaining the will, across an entire system, for making steady progress toward the MSP vision for improved teaching and learning in mathematics and science. The *Handbook* calls attention to the centrality of developing capacity and developing will in MSP efforts because it is tempting to overlook one or the other. MSP leadership teams are encouraged to monitor their MSP work and make certain that both are addressed, and addressed well.

Strategic Stances

With discussion of the four components, much of this *Handbook* has focused on the actions that MSP leadership teams can take to realize their vision for mathematics and science education. At the same time, there are a set of stances or perspectives that leaders need to adopt to be most strategic in their work within and across these components. Most importantly, strategic leadership requires a long term view of MSP work, not thinking of each MSP task as simply "one more thing to do."

These stances are larger than specific actions; they are mindsets that are critical to strategic leadership of MSPs. MSP leaders may find that they have already adopted some of these stances. However, by adopting these mindsets consciously, and employing them strategically, MSP leaders can begin to see longer term implications of their efforts and escape the confines of the "here and now."   In short, they can become more strategic as leaders.

Defining the Terrain: Strategic Stances

- Make and Monitor Trade-Offs
- Leverage Opportunities
- Develop Coherence within the Reform System
- Aim for Sustainability
- Use Evidence Effectively

Making and Monitoring Trade-Offs
It is the nature of reform to make trade-offs among possible options. If you invest resources in this intervention, you can't invest the same resources in that intervention. If you start first with garnering support among this group, you can't also "start first" with another group. If you work on the policies that offer the most long-term impact, you may not be able to attend in the same way to those with short-term impact. If you tackle scaling up in one way, you might not be able to simultaneously take on another strategy for reaching large numbers of participants. The point is simple: trade-offs are part of the very fabric of reform. Thus, as strategic leaders, MSP leadership teams are well-served by being conscious of the choices they are making and the relative costs and benefits compared to other choices, as well as monitoring the implications of choices made.

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│              Key Ideas: Making and Monitoring Trade-offs           │
│                                                                   │
│    •  Make choices by considering trade-offs                      │
│                                                                   │
│    •  Hypothesize the costs and benefits of alternatives          │
│                                                                   │
│    •  Forecast contingencies                                      │
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The oft-quoted poem by Robert Frost of the "road not taken" comes to mind. While some may fear that the "road not taken" may have been the better choice (and, in the words of the poet, "made all the difference"), it is more often the case that people are not even aware of roads not taken. In effect, we don't see the actions we take as choices we make—we see only the road we are on, and not the other roads that are possible. Thus, mindfulness of other options can help MSP leaders identify the relative costs and benefits of the choices that they make.

MSP leadership teams make trade-offs when they select one particular intervention (e.g., implement a certain curriculum) over another (e.g., redesign a university teacher preparation program) or when they decide to start work on one intervention before commencing with another. They make trade-offs when they decide to try and build support among those who are mostly committed to the program or who are easily persuaded rather than to try and build support among more resistant or skeptical colleagues. They make trade-offs when they focus on aligning assessment policies rather than resource allocation policies. Yes, it is true that in a large-scale reform plan leaders attempt to attend to all of these issues. However, the reality is that time and resources are limited, and the decision to start in a particular place reflects trade-offs between the benefits of focusing on this particular intervention versus the benefits of focusing on another one.

In an era of research-based and data-driven decision-making, leaders look for the best option for a given situation. While some choices may indeed be better than others, the activity of determining what makes one choice better than another is part of developing awareness of trade-offs. It is impossible to know the full impact of one choice over another, yet one can hypothesize about what the impact might be and monitor to see if that hypothesis is borne out. Thus, for example, the "Midwest Partnership for Science and Mathematics Improvement" (Vignette 4) is essentially hypothesizing that a cadre of full-time and no-time release teacher leaders is needed to support curriculum implementation at the school level. As work proceeds, the MSP leaders can inquire about whether both types of teacher leaders are needed; whether their support is sufficient to promote curriculum implementation; and whether progress is being made in all schools.

MSP leaders are more likely to think in terms of what they want to see happen (plans) and what is happening (current efforts), and less likely to think in terms of what is *not* happening. However, in order to remain strategic, it is important to forecast contingencies based on what is not yet happening or the unexpected event that turns a plan on its head. What are the circumstances that might diminish the benefits the MSP leaders seek from the choices they have made? How can an MSP articulate some alternatives and monitor to see whether those alternatives need to be pursued? For example, the MSP leadership team in "Mathematics at the Middle Grades" (Vignette 2) needed to ask questions about the circumstances under which

principals' support for the new middle grades curriculum might start to waver. Doing so would help them anticipate problems and plan accordingly.

Forecasting contingencies can sound like crystal-ball gazing. How can one possibly know the future? Rather than approach it as a questionable parlor game, MSP leaders need to consider the most critical assumptions they make as they develop and implement their reform plans. Does the reform work hinge centrally on the continued availability of a stream of funds? Does it rest squarely on the continued support of a handful of people? Does it rely primarily on the efforts of a small group of leaders to implement an intervention? What if that assumption doesn't hold or is only partially true (i.e., funds are no longer available, support disappears, or efforts are redirected)? What is the back-up plan? This kind of thinking is what is meant by forecasting contingencies.

Leveraging Opportunities
MSPs work within systems that are in constant flux. A changing political climate demands new responses and, in complex systems, change is simply the name of the game. MSP leadership teams are wise to seek ways to leverage their work off of the efforts of other IHE or district initiatives, always being alert to new opportunities. Similarly, a good leveraging strategy for MSP teams is to use the results of one part of an MSP program to set the stage for other parts. By building points of leverage, MSP leaders are creating more integration and more internal stability across the entire program. For example, MSP efforts for improved instructional strategies could extend an existing grant-supported effort to redesign the undergraduate calculus course sequence. Similarly, MSP reform efforts in a partner district could be incorporated into an existing comprehensive school reform model.

Key Ideas: Leveraging Opportunities

- Connect MSP work to other initiatives

- Articulate conceptual alignment

- Tap available resources

Leveraging opportunities is certainly about articulating the conceptual links among efforts and acknowledging the groundwork that one initiative has laid for another. Leveraging opportunities is also about aligning the experiences for participants (e.g., playing out how implementing this curriculum is a manifestation of the district's commitment to whole school reform). And, leveraging opportunities is about tapping into available resources that are consistent with an MSP's goals (e.g., using Title I dollars to extend an MSP program effort).

There is a simple truth behind leveraging opportunities: the current MSP program is meant as a catalyst for reform. It is not the sum total of the reform. Therefore, by adopting a leveraging mindset, MSP leaders will be continually seeking opportunities to enact their reform vision as they work to tap into various resources, initiatives, and funding sources including, but not limited to, the MSP.

Developing Coherence within a Reform System

Often, a reform program ends up consisting of a variety of efforts that are only loosely linked. An MSP is usually trying to move on many fronts (e.g., improve undergraduate teaching, change assessment policies, draw in disenfranchised parents, secure grade level commitments to a single curriculum, and design professional development to upgrade teacher content and pedagogical content knowledge). The original plan may have seemed coherent. At a minimum, it offered some conceptual unity among the various efforts. However, enacting the plans can often end up fracturing that unity as some parts of the plan get stalled or play out differently than anticipated.

Thus, it is important to be developing and testing for coherence within the reform system as MSP work proceeds. It may become impossible (or even inadvisable) to implement one's plan exactly as it was originally conceptualized. This does not mean, however, that MSP leaders should set aside any hope of coherence. Rather, coherence is something to be increasingly developed as the MSP moves forward. In fact, it is the quest for coherence that can illuminate efforts that are not consistent with an MSP's reform vision or spotlight work that is not aligned with other efforts.

Key Ideas: Developing Coherence within a Reform System

- Relate (or create) a storyline

- Weave connections among components

Imagine this: What if, at any point in time, an MSP leader needed to tell a coherent reform story based on what is currently underway? Would it make sense? Where would the holes be? Where would there be only limited synergy among the various efforts? Developing coherence means going beyond the satisfaction that various efforts are underway and even showing good results. Developing coherence is seeking out and creating connections among those efforts so that the fit is apparent not only to the MSP leadership team, but also to those providing interventions, to key stakeholders, and, most importantly, to teachers. Without such coherence, an MSP program runs the risk of being a set of essentially independent activities that are not contributing very much to achieving the larger reform vision.

Aiming for Sustainability

Looking beyond the press of current MSP work is critical for long-term success, and this requires striving for sustainability of your efforts. At the same time, it may not be possible, or advisable, to sustain all of the MSP activities; ironically, some interventions that often characterize MSP efforts are not the best candidates for sustainability. In many MSPs, a particular intervention (e.g., extensive professional development for large numbers of teachers in support of a new curriculum) is meant to be a catalyst for other, longer-term endeavors. The point of all that professional development for teachers may be to acquaint them with new curriculum and increase their content knowledge. If this work is successful, then the larger goals of implementing new instructional materials will be realized and that is what should be sustained. In this example, the level of professional development funded by the MSP is a short-term strategy, not one meant to be sustained over time. The point is that each MSP needs to articulate its theory of change—how the MSP work will lead to sustained improvements in the system.

Note that it is important to distinguish between those efforts that are meant to catalyze other work (e.g., professional development focused on new instructional materials) from those efforts that need to be sustained over time (e.g., a system for purchasing and refurbishing consumables associated with those materials). If MSP leaders want to argue that professional development needs to continue at the same levels as experienced under the MSP, they need to have an explicit plan for sustaining that expensive level of professional development beyond the life of the MSP grant.

By aiming for sustainability, MSP leaders are consistently inquiring whether a particular effort is meant to be a catalyst as part of a plan to mobilize resources to make progress in a particular area, or is intended to be continued in more or less the same fashion and level of effort beyond the current MSP funding. Many large-scale reform efforts founder because they did not hold a realistic sustainability mindset and, consequently, assumed that all (or most, or costly) efforts funded under a reform initiative would somehow continue indefinitely. By identifying which efforts need to be sustained, an MSP leadership team is building in some benchmarks to measure their progress. They can then assess whether the capacity and will have been developed to sustain those efforts into the future.

Using Evidence Effectively
MSP proposals are expected to make the case that the interventions being proposed are likely to be effective, based on evidence of their previous effectiveness in similar settings. However, given the complexities of system change, no plan is foolproof; activities that have the potential to succeed also have the potential to fail. Monitoring progress, and being willing to make mid-course corrections, is the best way to ensure success. In some cases, the mid-course corrections may be substantial, and the leadership team will need to consult with their Program Officer before implementing those changes. If those corrections are necessary to achieving the vision, though, the leadership team can't shy away from making changes to what they proposed to do.

Through project management, monitoring, and evaluation MSPs will collect a great deal of data. Leadership teams will have many uses for these data, including but not limited to helping in making mid-course corrections. However, to be useful as "evidence" to inform decisions or speak to the interests of participants and other stakeholders, the raw data first need to be aggregated, displayed, and/or analyzed. Strategic leaders use different kinds of evidence for different purposes in their work: to understand how the reform is being received among key stakeholders; to gauge the progress of implementation of interventions; and to assess the quality and impacts of interventions; and to inform their decisions. Finally, strategic leaders use evidence to make the case that the reform is progressing successfully and resulting in valuable outcomes.

Piloting the interventions provides an opportunity for the MSP leadership team to collect evidence in its own setting about the needs for developing human capacity and infrastructure to scale up. In studies of large-scale reform efforts, one lesson that leaders have learned is that a little evidence can go a long way. Strategic leaders, it seems, know how to make good use of the evidence they have, and are also very deliberate in collecting evidence for specific purposes. For example, designing the reform interventions requires decisions about what is likely to be effective, what the project has the capacity to provide with quality, and what will be well-received by participants and other stakeholders. Initially, these decisions can be informed by the use of the interventions in similar settings; an assessment of resources, human capacity, and infrastructure to carry out the interventions; and conversations with representatives of key participant and other stakeholder groups to gauge their reactions to the interventions. At this stage, it is important to avoid selecting interventions of unknown quality or impact, interventions that the project cannot implement well, or interventions that may create a backlash among participants or other stakeholders. If evidence is available about the effectiveness or impacts of the interventions in similar settings, strategic leaders use it to make the case to participants and other key stakeholders that the interventions are likely to bring about valuable change. Additionally, MSP leadership teams can use this information to plan for collecting evidence of their partnership's effectiveness and impacts on an appropriate timeline.

As the reform moves forward, evidence about the MSP's capabilities, effectiveness, and impacts can have many important uses. For instance, the MSP leadership can monitor the policy environment to understand which policies are likely to support, or present barriers, to the intended reforms. Individual or focus groups interviews can provide information about what policies are most influential and whether participants and other key stakeholders see congruence or conflict between the intended reforms and the policies that are most important to them.

Perhaps the most influential way that strategic leaders use evidence in large-scale reform efforts is to link partnership activities with data on effectiveness and impacts. It is especially important to consider what kinds of evidence are likely to capture the attention of different stakeholders and convince them that the partnership is adding value to the outcomes they care most about. If an MSP can provide credible evidence that its pilot efforts are producing the intended impacts, e.g., narrowing achievement gaps among demographic groups, the resources for scaling-up the efforts are likely to be easier to obtain. Similarly, if the MSP can provide credible evidence that its interventions satisfy the demands of accountability policies, stakeholders can be convinced that supporting and participating in the reforms will help them meet their own needs. Using evidence effectively means collecting and employing evidence deliberately and purposefully to move the MSP forward.

However it is to be used, credibility of the evidence is essential. MSP leadership teams must resist the temptation to highlight only the positive results, as the goal is not simply to implement the reforms that appear effective, but rather to improve the actual functioning of the mathematics/science education system.

Strategic Leadership in the "New Visions" MSP

The following vignette, of the New Visions MSP, is provided in order to play out these strategic stances. MSP leaders are encouraged to read and reflect on this vignette, and consider what evidence they see of strategic leadership by the MSP team. Are they making and monitoring trade-offs? How are they leveraging opportunities? Are they developing coherence within a reform system? Do they aim for sustainability of the parts of the initiative that can and should be sustained? How effectively is this team using evidence? The authors' analysis of this MSP's plans in light of these strategic stances is provided at the end of the vignette

Vignette 5

Strategic Leadership:
"New Visions" MSP

In response to public concerns about students' low performance in mathematics on the SAT and ACT, the state recently revised the K–12 mathematics curriculum standards; developed assessments that measure both computational skill and conceptual understanding; and enacted legislation requiring students who enter 9th grade starting three years from now to pass an Algebra I course in order to graduate from high school. Mathematics educators throughout the state have noted a need to focus on how algebraic thinking is addressed, including improving mathematics curriculum and instruction in the elementary and middle grades, so all students will be prepared to succeed in high school algebra. Mathematicians and mathematics educators from colleges and universities across the state have suggested that the problem does not stop with the Algebra I course, noting that a large proportion of students who had taken high school mathematics through Algebra II and Trigonometry were having to take remedial mathematics courses before proceeding with college-level mathematics.

A partnership between one of the campuses of the state's university and a nearby district was convened to prepare a proposal for the MSP. The district has approximately 10,000 students enrolled in twelve elementary, four middle and two high schools, and many of the district's teachers come from this IHE, either through the traditional teacher preparation program or, recently, via the lateral entry program coordinated by the university. Consequently, improving the mathematics and mathematics education courses at the university should prove beneficial for the district as well as for the university.

The district is moving towards school-based management, with decisions about teacher planning time, professional development, and the like, made at the school level, consistent with each school's improvement plan. At the same time, decisions in a number of areas continue to be made at the district level, especially curriculum-related decisions. The district mathematics supervisor wants to make sure all students are being prepared for high school algebra and has suggested that each elementary and middle school improvement plan address this need.

The district has been using a K–12 textbook program from one of the major publishers for quite some time. In preparation for the next mathematics instructional materials adoption, the district had arranged for a number of teachers to pilot materials from several of the "reform-oriented" programs on the state-approved list. Based on teacher feedback, the district chose one of the reform programs for district-wide use at the elementary level, left it

up to each middle school to decide whether to adopt reform-oriented mathematics materials, and decided to continue with the more traditional textbooks at the high school level, in the belief that these would be more acceptable to teachers and parents.

The MSP plan is to take a look at the entire K–12 curriculum as it relates to the development of algebraic thinking, using district resources to support the K–5 part of the work, since the MSP proposal is focused on grades 6–12. The plan is to form a committee of district teachers and mathematicians and mathematics educators from the university to review the current instructional materials and identify the gaps in the development of algebraic ideas over time. As the gaps are identified, the MSP will seek out proven supplementary materials to address them, and will provide professional development to help teachers implement both the adopted and supplementary materials. The plan is to convene grade level study groups to analyze student work, and cross-grade discussions to ensure that everyone sees the "big picture" of how ideas taught at one grade level relate to earlier and later ideas.

The professional development for K–12 teachers will focus on what the MSP leadership team believes to be the most salient areas of need at each level—mathematics background for K–5 teachers, as well as those now teaching grade 6–8 mathematics who were prepared as K–8 teachers; how to engage diverse learners for mathematics teachers at the middle and high school levels; and understanding student mathematical thinking for teachers at all grade levels. To help develop support for adopting more reform-oriented mathematics materials in the next adoption cycle, middle and high school teachers who are now using traditional textbooks will be encouraged to try out some more investigative activities in their classes, with assistance from the MSP project staff as requested.

Recognizing the importance of other key stakeholders—principals, the superintendent, the school board, and parents—the MSP leadership team also plans activities to engage them with the MSP vision of algebra for all. To help garner stakeholder support, the MSP plans to share samples of student work, as well as the student assessment results as they became available, to demonstrate the effectiveness of this approach.

The MSP project staff includes several mathematicians (including the PI) and mathematics educators with successful track records in working with K–12 teachers, so the leadership team is confident that the professional development component of the project is in good hands. However, "New Visions" applies to the IHE as well, in particular making sure that the mathematics and mathematics education courses are revised as needed so that the next generation of mathematics teachers is well-prepared for the challenges of algebra for all. The fact that the new Dean of Arts and Sciences has highlighted improving undergraduate education across the board as a major priority will provide an opportunity for progress in this area, but the MSP recognizes that sustaining any changes for the long-term will require much broader support among the faculty. The MSP proposal had only vague plans in this area—mostly stating that they recognized the challenge and would attend to it, with special emphasis on preparing pre-service and lateral entry teachers to work with diverse learners—so now the hard part begins.

Making and Monitoring Trade-offs in "New Visions"

As noted earlier, strategic MSP leadership teams adopt the mindset that they are consistently making and monitoring trade-offs. The key is to be clear about what choices (or roads) are being followed and what options are not being pursued, and to assess what the impact appears to be along the way. In the New Visions MSP, the leadership team is focusing their efforts on algebra, grades K–12, and on the university pre-service program as well. The plan is to form a committee of teachers and university mathematicians/mathematics educators to review the K–12 program and identify gaps in the development of algebraic thinking; provide professional development district-wide on the development of algebraic thinking; and support grade-level efforts where teachers share samples of student work on grade-appropriate problems. Although district funds will be used to support the work in grades K–5, and MSP resources for grades 6–12, the leadership team intends the plan to be seamless. The PI, a mathematician from the

partner university, will lead the pre-service work, where university mathematicians and mathematics educators look for opportunities to enhance the pre-service and lateral entry programs.

This, in essence, is the "road taken" by the New Visions MSP to respond to the situation they face in their state and the mandate of success with Algebra I. There are other ways that the New Visions MSP could have responded, and other plans they could have tried to implement. For example, the team could have decided to build on the pilot work with the new instructional materials at the elementary and middle school levels. They might have started by working with the teachers who were already familiar with, and had favorable views toward, the new instructional materials, perhaps using videotapes of the reforms being well-implemented in the district's context as an "existence proof" for other teachers. In this plan, university mathematics educators and mathematicians could have helped to make sure that the elementary/middle grades reform-oriented materials were taught well, with the emphasis on mathematics, especially algebraic thinking, and not simply on pedagogy, waiting until later to work with the teachers who were using the traditional materials. This plan represents the "road not taken" by the New Visions MSP. As such, it is useful for the MSP leadership team to consider what they gave up by *not* implementing this plan. In this "road not taken," the MSP would have highlighted the first wave of teachers, capitalizing on the energy and enthusiasm of these "pioneers" (and ideally evidence of impact on student learning) in providing momentum for the MSP's work with other teachers. These are not features of the current MSP plan, and the team would be well served to consider what they lose without these features and what they gain by implementing the plan as they originally envisioned it.

The New Visions MSP is just getting underway, which means that giving some attention to forecasting contingencies is particularly useful. In their MSP plan, they are banking on a district-wide committee to identify the gaps in the development of algebraic thinking in the current curriculum. What if this committee overlooks some of the important gaps? Or gets mired in disagreements and takes longer than anticipated to complete the review? What impact will that have on rolling out the professional development? What will that mean for the next steps of their plan?

Leveraging Opportunities in "New Visions"
The MSP leadership team is targeting teachers within a system that is moving toward school-based management where schools have control over teacher planning time and professional development. The MSP will get more mileage from their efforts if they can link their work to what is underway, or planned, at the school level. In this way, the participating teachers will not run the risk of being isolated from school-based activities as they work with MSP faculty. And, the MSP can both capitalize on existing efforts at the school level and provide support for those efforts. If improving mathematics achievement is a stated goal for schools, then the MSP can join forces with schools through their intervention around new instructional materials, particularly as the MSP team works to gather data to show impact on students' mathematics learning.

Developing Coherence within "New Visions"
The leadership team is planning to use district resources to work with elementary teachers, and MSP resources to work with middle and high school teachers. On paper, this is meant as a coherent strategy, but the MSP will need to be proactive in ensuring that there is real coherence among these activities. For example, the MSP plans to work with secondary teachers to identify how ideas addressed at the elementary level could be built upon in the higher grades. This plan requires that they be explicit about the links between elementary and secondary curricula; utilizing (or developing) a theory of how key mathematical ideas develop, K–12; and supporting interaction among teachers at different grade levels. This effort to articulate ideas K–12 is a powerful way to build coherence, but only if it goes beyond the exchange of lists of topics that someone "should teach" at each elementary or secondary grade. Similarly, given that many of the district's new teachers come from the partner university, it will be important to link course revisions at the IHE to the K–12 work. Finally, the work with key stakeholders offers the promise of contributing to coherence within the reform system, if these actions draw on the efforts underway with elementary and secondary teachers.

Aiming for Sustainability of "New Visions"
The MSP leadership team has already begun to articulate their sustainability plans by identifying next steps in their interventions. For example, they anticipate that improving the university pre-service and lateral entry programs, especially increasing prospective teachers' ability to work with diverse learners, will mean that future teachers will be better equipped to address the needs of all students in the district. However, the MSP needs to articulate the level of professional development that will be needed to continue improvements over time, and how the available resources can be used to support those activities. Similarly, the vagueness of the MSP's ideas for sustaining changes at the IHE level signals a need to think this piece through in detail, articulating a theory of change that goes well beyond recognizing the issue and hoping for the best. In these ways, the MSP leadership team can be working toward the sustainability of their efforts beyond the current MSP funding.

Using Evidence of Quality and Impact of "New Visions"
The plans of the New Visions MSP are a set of hypotheses: "If we articulate a vision of algebra across the K–12 curriculum, and review current curriculum and instruction in relation to that vision, and provide materials and professional development to teachers to address gaps we identify, then classroom practice will improve across the board and more students will be able to succeed in algebra." The New Visions MSP can gather evidence to test the various hypotheses, and use that evidence to make decisions about mid-course corrections as well as to garner stakeholder support for the initiatives. It may be, for example, that the discussions of student work in the elementary grades teacher study groups are not focused on the mathematics to the extent envisioned, and that interviews with the facilitators—themselves classroom teachers—indicate that they are not comfortable leading discussions of mathematics with their peers. Based on this evidence, the MSP may decide to abandon the examination of student work, or to integrate it into the professional development workshops conducted by the university mathematicians and mathematics educators. As another example, it may turn out that a subset of middle school teachers embraces the idea of algebra for all, leading to many more of their students succeeding in algebra in the 8th grade. This evidence of student success could be used as a powerful existence proof to cultivate the commitment of other teachers in the district.

Conclusion

This *Handbook* is intended to assist MSP leadership teams in the challenging and vitally important work of strategic leadership as they strive toward excellent and equitable mathematics and science education in their partner districts and institutions of higher education. Given the many challenges they face, MSP leadership teams must be focused and savvy in their efforts, developing working partnerships; considering how to design and implement effective interventions; ensuring stakeholder support for the reforms; working to align influential IHE and district policies with the reform vision; and figuring out how to scale up their efforts while maintaining a high standard of quality.

We encourage MSP teams to consider how to apply the general principles of strategic leadership as they go about this work in their particular initiatives: Is there a need for the leadership team to be more deliberate in making decisions about, and monitoring the results of, trade-offs? What steps should to be taken to position the MSP to be aware of, and able to leverage, opportunities that arise? Are you working to ensure coherence within the reform system as you roll out and refine the interventions, and as you take advantage of emerging opportunities? Is the MSP leadership team using the lens of sustainability throughout, being clear about which parts of the initiative are meant as catalysts, and which should be sustained, and developing the capacity and the resources needed to sustain the latter? How can the MSP use evidence to improve the quality and impact of the MSP efforts as well as to build a broader base of support for improving mathematics/science education?

The goals of the MSP program are ambitious: ensure that all students, K–12, participate and succeed in powerful mathematics and science experiences; improve the K–12 teacher workforce; and enhance our general understanding of how students learn mathematics and science. It is our hope that this *Handbook* will be helpful to current and prospective MSP leadership teams as they work to achieve these important goals.

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Appendix A

Literature Review on Designing and Implementing Interventions

Literature Review on Designing and Implementing Interventions

MSPs have a range of choices when they design direct interventions to achieve their reform vision. They can choose to emphasize professional development for K–12 teachers and for Institutes of Higher Education (IHE) faculty, pre-service education for teachers, including revising courses, or the implementation of new curriculum materials.

The implementation of new, standards-based curricula is an important way that MSPs can directly intervene in the process of large-scale reform. There are many resources available to guide the process of selecting instructional materials for mathematics curricula (Goldsmith & Kantrov, 2000; ASSM & NCSM, 1993). Goldsmith et al. (1998) created a guidebook for selecting and implementing "standards-based," mathematics curricula. Similar resources exist for examining and selecting science curriculum materials (AAAS, 1993; BSCS, 1996; NRC, 1999). The Office of Educational Research and Improvement (1997), in conjunction with the Third International Mathematics and Science Study (TIMSS), also published an interactive guidebook that presents different ways of analyzing curriculum materials.

The intervention of choice for previous large-scale reform projects in mathematics and science education seems to be professional development for in-service teachers (Zucker et al., 1998). Professional development and mentoring programs also are used at the IHE-level. In their study of 22 IHEs, Zahoriski and Cognard (1999) discuss how faculty development programs helped to change the way post-secondary faculty members defined their roles in the learning process. Based on their work in New York City's Community School District #2, Elmore and Burney (1999) offer a set of organizing principles about the process of large-scale change and how professional development contributes to that process. Similarly, Heck et al. (2003) share lessons on designing and implementing large-scale reform based on the experiences of the Statewide Systemic Initiatives program.

Other work looks more broadly at how professional development efforts can best be organized. These resources can be applied to K–12 or IHE faculty professional development. Massell (1998) offers a set of policy strategies for creating a stronger professional development infrastructure; recommends that standards be set for professional development and training; and urges the adoption of effective-practices models. Corcoran (1995) provides a framework for reviewing existing professional development policies and practices, and offers guiding principles for the development or modification of professional development practices as well. Other writers (Elmore, 2002; Cohen & Ball, 1999; Fuhrman, 1994) examine the problems and possibilities that the designers of interventions must navigate if they are to provide professional development successfully.

Another segment of the literature on professional development deals not so much with guidelines and cautions for successful program development, but with broadening our view of what makes for effective professional development. Little (1993) critiques the limits of the traditional training paradigm, the business-as-usual large-scale training approach, and calls for a broadening of how to think about professional development. Teacher collaboratives and networks and a host of other collaborative efforts fall under her expanded notion of professional development.

Loucks-Horsley et al. (1998) offer a detailed guide for developing professional development practices that emphasize this broadened view of professional development, describing how to introduce such strategies as coaching and mentoring, teacher networks, action research, and professional networks. Much has been written in recent years about the role of teacher leadership as a professional development strategy of particular promise, emphasizing the power of teacher-to-teacher learning (Burney et al., 2003; Crowther, et al., 2002; Lord & Miller, 2000; Katzenmeyer & Moller, 1996).

Change at the IHE-level often entails reforming pre-service education and disciplinary courses, restructuring the coursework for various degrees, and aligning faculty reward systems with the reform vision. The Boyer Commission (1998) discusses the failings of many American research universities and makes ten recommendations for improving undergraduate education at these institutions, including reforming undergraduate coursework, administration policies, faculty incentive systems, and partnership practices.

A goal in current large-scale reform initiatives is to establish a K–16 "alignment," meaning that students experience a smooth transition from elementary to secondary to post-secondary education (Schneider, 2003; Krueger & Rainwater, 2003). Resources suggest various ways of facilitating this alignment with interventions, including developing common language for, and shared expectations of, proficiency (Schneider, 2003); aligning assessments and standards across education levels; improving college preparation at the secondary level; and improving teacher preparation at the IHE level (Krueger & Rainwater, 2003).

Some research on large-scale reform in mathematics and science education focuses on the role of pre-service teacher education as a central ingredient in successful reform. Darling-Hammond and Ball (1998) and others have called for the redesign of teacher education and induction, and improvements in the overall quality of such programs. Haag and Smith (2002) discuss the reform efforts in one IHE's teacher preparation program and the various political obstacles that can impede interventions in this area.

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Appendix B

Literature Review on Garnering Stakeholder Support

Literature Review on Garnering Stakeholder Support

Past studies of large-scale reform efforts have shown that within almost every large-scale initiative there are key players whose support is critical to achieving reform goals. Project leadership needs to engage these players, or stakeholders, with the vision and interventions of the reform. There are several steps to achieving the buy-in of various stakeholder groups. First, a project must determine who the key stakeholders are and then, work to communicate the reform vision to these stakeholders.

Merlino (2002) discusses how the Local Systemic Change (LSC) projects had to work with the constraints of both "external and internal constituents." These stakeholder groups often had conflicting goals and motivations that had to be recognized to allow the project to move forward with its goals.

MSPs, by their very definition, have a large number of "internal" stakeholder groups; they are collaborations between two large groups of stakeholders, those working for Institutes of Higher Education (IHEs) and those involved with K–12 districts. Within these larger groups are smaller factions, which sometimes have competing interests. Therefore, MSP leadership teams must work to understand all of the stakeholders involved in this collaboration in order to begin aligning expectations and reform goals.

"K–16 collaboration" is a major trend in educational reform (McRobbie, 2004; Krueger & Rainwater, 2003). While these partnerships can be effective mechanisms for implementing reform goals, there is likely to be differences of opinions due to organizational differences (Katz et al., 2002). Therefore, leadership teams must define their objectives clearly. Ohana (2003) writes about how differences in values among universities and K-12 schools can erode reform goals, and the ways partnerships can overcome these differences. Danzberger et al. (1996) identifies promising practices when working to build partnerships; the authors describe the "practices that support partnership-building and practices that represent partnership activities." These practices vary based on the organizations involved.

Typically, the higher education and K–12 systems influence each other in two different areas: teacher preparation at the college level and college preparation at the secondary school level (Kleiman, 2001). Olson (2001) describes the way IHEs often want to influence high school student preparation and the problems that can arise when the two systems have different expectations for students (Schneider, 2003).

In order to garner support from stakeholder groups, leaders of reform initiatives need to understand the motivations of each group. For example, initiatives have to take into account the rewards systems in place in most research universities and the faculty culture of IHEs (Haag & Smith, 2002; Zahorski & Cognard, 1999). Research findings suggest that tenure and promotion policies that are contingent upon "research productivity" often impede teaching-oriented reform in IHEs (Zahorski & Cognard, 1999; The Boyer Commission, 1998).

Within a given IHE, different stakeholder groups can often exist. These various groups can have conflicting motivations and interests based on different departments and schools, tenure tracks, and administrative policies (Project Kaleidoscope, 1999). The Kellogg Commission on the Future of State and Land-Grant Universities (2001) noted "the many cultures of the university" and suggested ways to connect these cultures for shared improvement.

There are numerous studies detailing the stakeholder groups within K–12 districts. Past studies of large-scale reform initiatives suggest that involving principals is often a critical factor for the buy-in of other stakeholder groups, such as teachers (Boyd et al., 2003). Other studies show how projects built capacity for principals by having them serve in key positions within the initiative (Hightower, 2002; Richardson, 2002).

It is also important that reform efforts encourage the buy-in of K–12 teachers. Datnow (2000) discusses how the trend in educational reform to adopt initiatives from external organizations can lead to situations where teachers do not actively understand or participate in the reform process. She discusses the importance of and procedures for ensuring staff buy-in.

Because guidance counselors often influence students' course selection and other college preparations, reform efforts also seek to influence these stakeholders. Some researchers suggest that schools and districts take a "systemic approach" to school counseling, with IHEs preparing school counseling students in this comprehensive approach (Rowley et al., 2002).

With so many groups in play that are internal to the reform process, it might be easy for reform leadership to ignore the stakeholder groups that are external to the project's "direct" interventions. However, prior research shows that external stakeholder groups can have a large impact on reform efforts. Lietz et al. (2001) writes that community colleges should act as stakeholders in K–12 educational reform initiatives and gives examples of some institutions that are developing reform-oriented programs and practices.

Parents are often recognized as critical players in large-scale reform, and project leadership teams sometimes create programs or outreach efforts to facilitate their buy-in. Giles (1998) describes the ways in which urban school reform efforts seek to involve parents, and the ways in which these efforts help to promote the reform goals. Parents as a group, however, sometimes hold conflicting ideas about educational reform (Shumow, 1997), and these differences of opinion can negatively impact a reform effort if they are not addressed (Fried, 1998).

Prior research has also shown the ways in which reform initiatives inform local and state policies, engaging these policy-making organizations as stakeholders (Smith et al., 1997). Frascella (2002) writes about the ways in which a LSC project compromised with, and ultimately engaged, district and state policy-making organizations.

Regardless of who the key players are, every initiative benefits from the recognition and active engagement of its critical stakeholders. MSPs can build off of the work of past reform efforts to better understand the nature of collaboration within a large-scale initiative.

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Appendix C

Literature Review on Aligning Policy

Literature Review on Aligning Policy

An important aspect of educational reform is seeking to understand, and work within, the educational policy landscape. No reform project exists in isolation. Therefore, MSPs must understand the policies that influence each major stakeholder group and strategically work to align these relevant policies with the reform vision. A number of authors, when assessing past systemic reform efforts, report that attention to, and alignment with, relevant policies often becomes a critical factor in the success and sustainability of impacts on teaching and learning (Hamilton et al., 2003; Smith & O'Day, 1991).

Prior research has identified three policy areas critical to institutional reform efforts: curriculum, teacher development, and assessment (Cohen & Hill, 2000). Other researchers further divide these policy categories by "tiers" of influence, looking at school, district, and state policies (Fullan et al., 2001). In reform at the institution of higher education (IHE) level, important policy areas usually include coursework and faculty incentive policies (The Boyer Commission, 1998).

In the Statewide Systemic Initiatives (SSIs), most projects placed a priority on changing state policies to support the initiatives (CCSSO, 2000). Those projects that took note of the policy landscape and worked within it were able to more successfully implement interventions and sustain reform efforts (Heck et al., 2003; Zucker at al., 1998). Haag and Smith (2002) take a different approach in stressing the importance of attending to the internal political struggles that are unavoidable in complex systemic reform initiatives. This "micropolitical" lens is used to examine the restructuring of IHE teacher preparation programs.

In addition to describing successful policy alignment, some authors offer cautionary tales about the detriment of ignoring, or being unable to affect, policies that conflict with project goals. Bohlin (2002) describes how the impacts of the Local Systemic Change (LSC) program in California were swiftly dismantled due to conflicting state policies. The new state policies brought a change in focus for mathematics education and disenfranchised the teachers who had previously experienced positive impacts during the LSC reform years (Bohlin, 2002; Weiss et al., 2002). Ohana (2003) writes about the policies internal to school-university partnerships that, if conflicting, can roadblock reform. McMillan (1978) stresses the importance of thinking strategically about which existing policies will directly challenge reform efforts and which polices will provide opportunities for alignment

O'Day & Smith (1993) describe the "idealized" model of systemic reform to include aligned policies at the state level in order to support interventions within schools and with teachers. Not all MSPs will be in the position to immediately start influencing external policies. Projects can, however, work to understand the cultures, policies, and motivations among the various stakeholders in order to build, as Fullan (2002) describes it, "program coherence," a critical step to large-scale sustainability. Promotion and tenure policies within IHEs are often noted as a critical alignment point in K-16 reform. The traditional roles and incentive structures for IHE faculty often do not coincide with "reform-based" practices (Zahorski & Cognard, 1999; The

Boyer Commission, 1998). If these policies do not change to incorporate reform goals, it can be very difficult for IHE faculty to buy in to the initiatives.

The idea of shifting policies to complement reform goals is closely aligned with Elmore's (1996) notion of "going to scale," that is, deeply grounding the reform goals and interventions within the system until the majority of stakeholders regard "reform-friendly" practices as the status quo. To successfully "go to scale" and, in turn, sustain reform efforts, projects must think strategically about which policies exert the most influence over key stakeholders, and how, and to what extent these polices can be aligned with reform goals (Farrell & Hart, 1998; Goodland & Daly, 1996; MacDonald, 1996; Orians, 1990). Influencing shifts in relevant policies is critical to sustaining project goals beyond the funding (Furman, 1994; Clune, 1993).

Throughout the trajectory of an initiative, the work of surveying and aligning the policy landscape can play an integral role in the success of designing and implementing interventions, scaling up interventions with quality, understanding key stakeholders, and ultimately, sustaining the impacts of a program.

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Appendix D

Literature Review on Scaling Up Interventions

Literature Review on Scaling Up Interventions

In large-scale education reform initiatives like the MSPs, the complexity of the interventions, and of the interactions among stakeholder groups, makes scale-up work a daunting endeavor. However, prior research provides a number of ways of thinking about the nature of scaling up. Coburn (2003) looks at the nature of scale itself, drawing attention to four dimensions: depth, sustainability, spread of reform ideas, and ownership of reform in the community. Reform must stretch not only wide, but also deep in order to be sustained and meaningful. Others have similarly stressed that attending to scale up is a balancing act between depth and breadth, quality and reach, and short-term and long-term payoffs (Horizon et al., 1994).

Cuban (2001) adds the element of adaptability to the mix, urging reformers to judge the success of scale up efforts not only on their effectiveness and fidelity to the original intervention, but also on their adaptability in the face of changing conditions. Century & Levy (2002) also focus on the idea of adaptation. Their research shows that successful scale-up does not simply mean small-scale programs enacted on a larger scale; instead, effective programs evolve with time, maintaining the project vision but changing as they grow.

Structural capacity also needs to be in place within MSP partnering institutions, institutions of higher education (IHEs) and school districts, in order to facilitate the complex task of scaling up. The organizers of the Kellogg Commission on the Future of the State and Land-Grant Universities (2001) stress that in order to attain the ideal "engaged institution," defined as a partnership or "two way street" among IHEs and other learning institutions, supportive structural and incentive characteristics need to be in place. O'Day et al. (1995) describe how teacher knowledge, skills, dispositions, and views of self depend on supportive organizational structures such as state level instructional guidance and restructured (and therefore more supportive) school and district governance. Fullan et al. (2001) emphasize how important it is to pay attention to the role of the generic infrastructure in facilitating or preventing reform. Elmore (1996) identifies the central role of school organization and incentive structures in determining whether interventions can scale up with quality.

Spillane and Thompson (1997) also discuss the importance of human and social capital as key elements of local district capacity. They emphasize how vital it is for teachers and others to fully understand the new ideas that come with school reform in order to be effective communicators of these ideas to others. Ohana (2003) takes a similar approach when discussing university-school partnerships. She pinpoints "value" differences among various groups that can impede the scaling-up process. Borko et al. (2003) make the argument that scale up of school capacity—the people, the programs and the resources—takes time, indicating that increased capacity rather than dramatic changes in teaching and learning may be the most notable outcome for new reform efforts. Zahorski and Cognard (1999) focus on IHE faculty capacity-building, and structural changes that facilitate this capacity, as the critical components for scaling up postsecondary reform.

As reform initiatives enhance their human resources and overall infrastructure, it is important that they monitor progress in order to maintain quality and avoid fragmentation and overload

(Fullan, 2000). Similarly, Newmann et al. (2001) argue that too many unrelated improvement programs mean that little of value will be sustained; clear focus is essential. Evaluation and reflection have to be a part of the scaling up process in order to ensure quality of what is being scaled up and to ensure that needs are being met by the services being scaled up (Clune et al., 1997 a and b, Ohana, 2003).

For interventions to be scaled up in ways that simultaneously promise reach, depth and sustainability, many puzzle pieces must be in place. For example, organizers of the Success for All school change model write about the importance of attending to the technical, normative, political and socio-cultural dimensions of scaling up (Cooper et al., 1997). Often, attention to the broader landscape includes the need to put equity at the center of reform, with the understanding that reaching "all" includes the idea of reaching the traditionally underserved "equity" groups of concern (Clune et al., 1997 a and b).

Scaling Up Interventions Literature Review References

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