Going to Scale in a Large, Fast-Growing District: Las Vegas, Nevada

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The Clark County School District was funded by the National Science Foundation to improve elementary mathematics and science education during a period of unprecedented enrollment growth. Between 1992 and 2006, this school district serving the greater Las Vegas area grew from the fifteenth to the fifth largest district in the nation.

The Mathematics and Science Enhancement initiative, called MASE, provided intensive, professional development opportunities in a range of settings, in all cases based on a set of beliefs about how children and adults learn, and high expectations for educators and students. This chapter describes how the project evolved while addressing the challenges of growth-induced teacher and administrator mobility, and a mixed tradition of choice, site-base management, and central control.

The MASE Local Systemic Change story includes MASE I, MASE II, and MASE SMT–Science, Mathematics and Technology, all supported by National Science Foundation grants. All aspects of the three phases of the MASE project were grounded in an inquiry process. The project employed strategies for building leadership capacity, engaging teachers and principals, and developing advocacy. These strategies may be applicable to other settings, even where explosive population growth is not the norm.

The School District

The Clark County School District is located in the high desert of southern Nevada, isolated from other population areas. Centered in the city of Las Vegas, the district includes nearly 8,000 square miles of urban, suburban, and surrounding rural areas. During the MASE project, the district experienced a 6 percent annual growth rate, building an average of 11 new schools each year.

To meet the needs of its rapidly growing and increasingly racially, economically, and culturally diverse student population, the Clark County district hired hundreds, and sometimes thousands, of new teachers each year between 1991 and 2005. New and experienced teachers were recruited from most states and many nations; their preparation and previous teacher induction programs varied widely.

The composition of the student population changed considerably over the life of the MASE projects. By 2005, minority groups, including an increasing number of English language learners, became the majority population. The district faced increasing pressure to improve student achievement and decrease the achievement gap.

Table 1
Percent of Students Eligible for Free or Reduced-Price Lunch, and By Race/Ethnicity, Clark County School District, Nevada

	Percent of Students					
	Eligible for free or reduced price lunch	African American	Asian	Hispanic	Native American	White
1990–91	21	14.0	6.1	24.0	1.0	55.0
2005–06	36	14.3	8.5	37.0	0.8	39.4

District Organization

Clark County's Elementary Education Division was organized into five geographic regions, each having a regional superintendent, thus creating a three-tiered—district, region, and school—management structure. The elementary schools used site-based management, but within the district's top-down hierarchy.

District policies, organizational structures, and ways of working changed over time as district and regional superintendents changed, and as teachers and principals moved to staff the steady stream of new schools that opened each year. District teachers and administrators shared a common commitment to help children learn, however, there were varying ideas about how to do so.

While endorsing decision-making at the school and regional levels, the district controlled many decisions that influenced science and mathematics education. The district developed the Curriculum Essentials Frameworks used by all K–5 teachers as the basis for planning instruction for each content area, selecting curricular materials aligned to district and state standards, and preparing students for state and local assessments. Staff at individual schools selected textbooks and curricular materials from district-adopted, state-approved lists that were purchased with district funds, and school staff decided how to use the materials in their classrooms. In 1995, schools could choose from *Investigations in Number, Data, and Space*®, and two mathematics textbooks; and for science, from *Full Option Science System* modules and two science textbooks.

Priorities were identified and improvement initiatives originated at different levels—sometimes at the district level, other times at the regional or school level. The elementary schools of greater Las Vegas operated within a professional culture characterized by change, but also by choice, within changing limits.

Professional Development

Each year, before school started, the district conducted meetings for selected subject-matter representatives from each school. The purposes of these sessions were to communicate district priorities, launch new curriculum documents, and share instructional strategies. The building representatives, in turn, were expected to communicate this information to the teachers in their schools. There was seldom enough time for these representatives to fully share this information with their colleagues.

During the year, school leaders requested that district curriculum specialists provide 30-minute before-school sessions or to meet with the principal and teachers. These school-based sessions

were typically one-time events lacking sufficient intensity or duration to have much effect on teaching practice. Teachers had little release time during the school day to meet together to learn about, plan for, or reflect on instructional practice. The situation changed in the mid 1990s, when the state provided four professional development days so school staff members would have more time for professional meetings.

Initial Mathematics and Science Improvement Efforts

Beginning in 1986, several efforts to improve mathematics and science education were initiated in the Clark County School District. These independent initiatives originated from different parts of the organization—the Elementary Education Division, the Department of Curriculum and Instruction, and individual regions or schools. Efforts might target common needs but strategies often varied.

During the late 1980s, the district K–5 Mathematics-Science Specialist conducted half-day, research-based sessions for school mathematics representatives on how children learn mathematics, and on instructional strategies to improve student understanding of mathematics concepts. The district then piloted a mathematics program on teaching for conceptual understanding in nine schools. The 1989 publication of the *Standards for School Mathematics* by the National Council of Teachers of Mathematics (NCTM) increased support for this work. As demand for professional development increased, the Superintendent of Elementary Education and K–5 Mathematics-Science Specialist decided that additional teacher leaders were required if the professional development needs of this large and growing district were to be addressed.

In 1991, elementary division leaders agreed to pool funds from the federal Dwight D. Eisenhower (IKE) Education Act to provide centralized professional development in mathematics and science. Five Teachers on Special Assignment (TOSAs**)** were hired to work with the K–5 Mathematics-Science Specialist to provide common learning experiences at all K–5 schools, working full time with teachers and administrators in the district. The TOSAs were knowledgeable about mathematics and science content, how children learn, and inquiry-based science; at the same time, they considered themselves learners as well as leaders.

The IKE project provided school-based professional development for all elementary teachers in the district. Mathematics achievement was measured by district and state tests, thereby receiving greater emphasis than science. At the same time, as one district administrator said, “We also wanted to focus on science because it was the right thing to do for children.”

TOSAs facilitated professional development in mathematics and science four days at each elementary school every year from 1991 to 1995. They developed teacher awareness of NCTM Standards and current research, and involved teachers in mathematics and science instructional approaches aligned with current research on how children learn.

TOSAs facilitated 30-minute on-site, before-school awareness sessions for all elementary teachers in the district. During the day, TOSAs presented classroom demonstration lessons, met with groups of teachers, and sometimes with principals. Classroom-based lessons provided teachers and principals with a vision of standards-based teaching and learning, and knowledge that all children could engage in rigorous mathematics and science. The level of student

reasoning and engagement, and the multiple ways students solved new and challenging problems often surprised teachers and principals. Lessons illustrated the importance of teacher content knowledge, student dialogue, productive questions, and knowing when to ask questions and when to provide information. The IKE classroom-based delivery of practice-based professional development became the centerpiece of future MASE projects.

The IKE program was Clark County's first coordinated, school-based professional development for all elementary teachers in the district. The 1991–95 IKE program demonstrated the value of working with teachers across the district and the potential of classroom-based professional development for stimulating substantive dialogue to change teaching practice. From 1995 to 2002, IKE TOSAs supported non-Project schools.

During this same period, a series of small externally funded projects contributed to Clark County's experience and knowledge about what works. Integrating professional development and a *Full Option Science System (FOSS)* summer session for students illustrated the value of including students in professional development sessions. A field-trip program for underserved students demonstrated that *all* children can learn when presented with engaging and challenging opportunities led by caring adults who believe each child *can* learn. Computer programs and other technology supported student interests and inclination to share their findings with their peers. Planning and running mathematics-science sessions for parents generated support and advocacy among teachers as well as parents. Family Math and Science Nights would be replicated at district and school levels during the Local Systemic Change Initiatives.

MASE I: A Need for Leadership Development

The Clark County School District required additional resources in order to advance its science and mathematics improvement efforts. The district was awarded a National Science Foundation teacher enhancement grant to develop science and mathematics leadership in the district. This first MASE grant positioned the district to receive two subsequent Local Systemic Change grants from the National Science Foundation that supported MASE II and MASE – Science, Mathematics and Technology.

Beginning in 1992, MASE I provided professional development opportunities, including time for participants to interact with their colleagues and nationally recognized experts in the fields of mathematics and science. This three-year MASE I project had two components: building district leadership capacity and creating school-based awareness. MASE I developed four cadres of K–2 or 3–5 science or mathematics Teacher Leaders. In addition, every elementary school in the district had an awareness team that included the principal, one primary teacher, and one intermediate teacher. The ultimate, long-term goal was to ensure opportunity for all students to become scientifically and mathematically literate.

Instead of sending a relatively small number of Teacher Leaders to out-of-district leadership development, MASE I provided professional development for a far larger number of teachers on-site within the district. This decision was based on two reasons. First, participation of a larger number of teachers was deemed necessary in order to have an impact on such a large and

growing district. And, the project was intended to achieve change at a deep level, requiring professional development over an extended period of time for this large group of teachers.

Implementation of MASE I

MASE I Teacher Leaders attended one-week professional development sessions each summer and four two-day sessions during each school year from 1992 to 1995. School awareness teams attended four half-day sessions of professional development each year.

Table 2
MASE I, 1992–1995
Number of Participants and Hours of Professional Development Completed

	Number of Participants	Hours Completed
Teacher Leaders	70 mathematics, 70 science	100–130
Site Liaisons	250	20–60
Administrators	44	6–76

All MASE professional development modeled the kind of learner-centered instruction teachers were expected to implement in their elementary classrooms. This approach provided participants with a vision of standards-based instruction by engaging them in standards-based learning and allowing time for them to reflect on the process. Making learning make sense to the learner was emphasized. Project consultants were selected—three FOSS science developers[1] and two leaders in mathematics education[2]—based on their capacity to generate enthusiasm for learning and change, thoughtful reflection, and deep understanding of standards-based instruction and how children learn.

The K–2 and 3–5 science and K–2 district mathematics leadership groups initially focused on instructional practice and how children learn as they participated in and studied the *FOSS* curriculum and *Developing Number Concept*s lessons. Then, they examined the important content ideas underlying the lessons. The 3–5 mathematics teachers first engaged in mathematics as learners, reflected on their own learning, and then considered implications for teaching and student learning.[3] All Teacher Leaders were expected to restructure their own classrooms during the three-year project; strengthen their knowledge of content, how children learn, and instructional approaches; and develop confidence as leaders and change agents, then share the process with others. MASE Project Leaders actively participated in the leadership sessions.

[1] Lawrence Hall of Science, University of California, Berkeley.

[2] Mathematical Perspectives Teacher Development Center and Mathematical Education Collaborative.

[3] Curricular materials included: *FOSS* K–5 units; *Developing Number Concept*s; Pattern Menus from the Patterns, Functions and Algebraic Reasoning Course, Mathematics Education Collaborative; and replacement units: *Seeing Fractions: A Unit for the Upper Elementary Grades* and *Math By All Means: Multiplication, Grade 3*.

Inquiry processes supported the growth of Teachers Leaders as learners and decision- makers. The *way* they worked was equally important as *what* they learned. Project norms emerged: fully questioning instructional practice; testing ideas and strategies in the classroom with students; collecting and sharing evidence-based results; and engaging in continuous debate and ongoing collaboration. Rich discussions often continued outside sessions and informed decision-making.

Over the course of MASE I, the culture within the four Teacher Leader cadres slowly shifted from a group of individuals into a learning community, a transformation that shaped the culture and standards of the next two phases of the MASE project. As these learning communities evolved, participants became increasingly engaged as learners, sharing problems, seeking explanations and solutions when studying content, considering new instructional strategies and reflecting on practice. Willingness to read, discuss and reflect on professional articles grew over time. Sharing challenges and success stories about student learning became the norm. Networks formed within the cadres that continued after the grant ended.

After the mathematics consultants worked with the Teacher Leaders, MASE and IKE leaders initiated what became a district-wide focus on Number Talks.[4] Number Talks helped children solve computation problems based on their understanding of important mathematical ideas related to numbers, number relationships, and operations. TOSAs helped teachers implement Number Talks with their students 10–15 minutes three or four times a week, in addition to regular mathematics instruction. Teachers reported that their students improved their ability to reason with numbers and to solve computation problems. Teachers previously uninvolved with MASE saw that teaching for understanding helped students develop skills, as well as concept understanding, as they made sense of mathematics.

The school awareness teams participated in mathematics lessons as the basis for expanding their understanding of standards-based teaching and how children think and learn mathematics. The teachers on the awareness teams were asked to apply selected lessons[5] with their students, share results with colleagues at their schools, and work with the principal to maintain communication within the school about standards-based teaching and learning. Principals observed classroom lessons to gain an understanding of standards-based instruction.

Reflections on MASE I

Substantive change happens over long periods of time and affects both those directly and those indirectly involved. Teacher Leaders experienced the various stages of change during the three-year project. Many Teacher Leaders found the science and mathematics content challenging as they were expected to deeply understand the conceptual foundations of elementary mathematics and science.

[4] Number Talks: Grades K–2, Mathematical Perspectives Teacher Development Center; Grades 3–5, Mathematical Education Collaborative.

[5] Curricular materials included: Pattern Menus from the Patterns, Functions and Algebraic Reasoning Course, Mathematics Education Collaborative; and replacement units: *Seeing Fractions: A Unit for the Upper Elementary Grades* and *Math By All Means: Multiplication, Grade 3*.

MASE Project Leaders observed that change seemed safer for teachers who had both supportive principals and a network of colleagues also involved in the change process. With each innovation, teachers followed an implementation cycle: first experiencing and reflecting as learners; next discussing implementation of new instructional practices; and finally testing and developing expertise in new approaches.

Teacher Leader participation was stable throughout the three-year project, but mobility and choice influenced participation on the school awareness teams. Growth in the greater Las Vegas area meant new school teams each year. Teachers without experience as liaisons joined existing school teams, and experienced liaisons were not always selected as members of teams in their new schools. As a result, school teams that were not stable did not benefit from long-term professional development as planned. Still, teacher and administrator mobility served to spread awareness about the MASE project and teaching for understanding throughout the district.

In keeping with the district culture of choice, school team participation was encouraged, not mandated. Teachers from a majority of the schools participated in the school team sessions all three years; approximately half of the principals participated as well.

MASE teachers and principals observed their students engaged in rigorous mathematics and science, learning with understanding, solving computation problems, and scoring well on local and state tests. They became believers and advocates for teaching for understanding. One teacher wrote, "The children open their minds by exploring concepts in different ways. Many lower- and middle-performing students are learning at a similar rate as the upper level students."

There were those within and outside the district who advocated that basics should come first in mathematics, that students must master their number facts and follow set procedures to solve computation problems. Conversations reflected the national dialogue about how to teach mathematics. District staff and the MASE Project Leaders addressed this debate by communicating what students should know and do, using everyday language rather than reform language. The district sought a balanced curriculum that included all mathematical strands, in alignment with state standards. The balanced curriculum included teaching for understanding, concept development, and fluency with number facts and computation.

MASE I developed a pool of strong and emerging leaders, strengthening their capacity to design and implement effective professional learning experiences for adults and children. The process redefined what it meant to be a leader within the district, in the school and in the classroom, and what it meant to be a workshop leader; it revealed the importance of supporting all the ways that teachers lead, not just as workshop leaders, but also in roles not usually considered leadership positions.

MASE II: Building a Critical Mass of Leaders

By 1995, the Clark County School District serving the greater Las Vegas area had grown to be the tenth largest district in the nation, with nearly one-third of the students eligible to receive free or reduced-price lunch. In 1995, a total of 86,432 students were enrolled in kindergarten through fifth grade in 127 elementary schools. The National Science Foundation funded the Local Systemic Change initiative, called MASE II, a project which was explicitly designed with the rapid growth of the district in mind. This grant enabled the district to invest in and develop knowledgeable and committed leaders at all levels of the district as Project leaders initiated school-based change in project schools. From 1995 to 2002, grant funds were used to build the capacity of a critical mass of teachers to assume responsibility for continued change in mathematics and science teaching and learning in the elementary grades.

Implementation of MASE II

The MASE II Local Systemic Change project focused on the school as the unit of change. All of the elementary schools in the Clark County School District were eligible to apply to join the MASE II project. MASE project designers estimated that MASE II funds would involve about 2000 teachers in 60 of the district's 127 elementary schools over the five-year project.

The MASE II project plan employed a start-small, scale-up strategy, with ten schools participating in the first year, 20 schools added in the second year, and 30 more schools in the third year, eventually involving slightly more than 2000 teachers. Phasing the three cohorts of schools into operation allowed time to test components of the plan, make adjustments, and develop infrastructure to support the project as it was scaled up. Half of the schools focused on science and the other half focused on mathematics.

If all teachers who actively engaged in sustained, high-quality professional development had the support of the school principal, their colleagues and community, and were supported by excellent curricular materials, the project design team hypothesized that a transformation in mathematics and science instruction would occur. MASE school models would form the basis for extending change across all the elementary schools in the district.

At least 80 percent of the school faculty had to agree to fully participate in the MASE II initiative. Schools interested in joining the project had to adopt *Investigations in Number, Data, and Space* mathematics or *Full Option Science System (FOSS)* science curricula and agree to develop a supportive school community.

Many principals were interested in having their teachers participate in professional development for *FOSS* and *Investigations* and in building learning communities within their schools. In schools identified by the state as needing improvement, principals were seeking support to address state and district mandates. Principals used different strategies to enroll resistant teachers. Some waited to join the project in the second or third year so they had time to build support for MASE strategies and goals. Other principals made it clear that teachers had the choice of becoming part of a MASE school or finding another school with a different philosophy. In other schools, principals surrounded resistant teachers with MASE-minded teachers; eventually most teachers joined in the common effort to improve teaching and learning.

MASE II built on the successes of preceding initiatives. The practice-based professional development and district-wide involvement of the IKE and MASE I projects were continued in MASE II. MASE I leadership development and support components were continued and expanded. In an effort to achieve systemic change, systemic factors were also addressed. A research component would be added during the MASE-SMT project.

Table 3
Operational Components of the
IKE, MASE I, MASE II, and MASE-SMT Projects

	IKE	MASE I	MASE II	MASE-SMT
Practice-Based Professional Development	X	X	X	X
District-Wide Involvement	X	X	X	X
Building Leadership Capacity		X	X	X
Internal-External Support		X	X	X
Systemic Factors			X	X
Research				X

- **Practice-Based Professional Development**

MASE II continued the child-centered, classroom-based design of MASE I. Participants were invited to join an inquiry into how children learn—considering their initial understandings, collecting data, sharing their findings, and explaining and defending their reasoning. The MASE leadership team found that allowing participants time for dialogue, reflection, and examining the implications for teaching was essential to the change process.

The school principal and teachers in MASE schools took part in intensive professional development. Substitutes covered classrooms to release teachers to attend the professional development sessions; Saturday sessions were held for teachers who preferred not to be absent from their classrooms.

To meet the needs of the range of new and experienced learners, MASE professional development provided differentiated offerings within each of four domains: how children learn; science and mathematics content; instructional strategies; and study of curricular materials, including embedded assessment. All MASE II teachers were required to participate in 100 or more hours of professional development, including sessions from each of the four domains.

During the first year of participation, each teacher was required to attend a series of one-day grade-level Structured Use Workshops on the subject of focus for their MASE II involvement, centered on either the *FOSS* modules or *Investigations in Number, Data, and Space*® units they were teaching. Teachers studied the curricular materials, related content, how children learn, embedded assessment, and how to implement the module or unit. They implemented the science module or mathematics unit with their students, then shared their experiences and findings at the next session.

After completing year-one requirements, teachers considered their needs and school priorities when choosing future courses, selecting from practice-based sessions, including: classroom lessons and looking at student work; and project-wide sessions, such as subject matter content, science and literacy, inquiry, and assessment**.** These professional development sessions helped teachers to reshape their vision of mathematics and science, develop a deeper understanding of content, and examine and employ new instructional approaches. Many teachers reported it was three or more years before they were confident in their changed practice.

Classroom-based sessions supported teachers in the process of change. MASE Project Leaders found that inquiry was a means of engaging teachers and building professional learning communities that promoted dialogue and informed decision-making. While observing classroom-based sessions, one member of the MASE Advisory Board noticed how little MASE TOSAs talked, how much the students talked during the lesson, and that participating teachers had no qualms about speaking during the briefing sessions.

MASE II offerings included a range of topics including a series of content sessions and the Inquiry Institute. MASE content workshops used professional development curricula designed with the support of the National Science Foundation: *Bridges to the Mathematics Classroom, Developing Mathematical Ideas,*[6] *Animals, Force* and *Motion,*[7] *Entomology, and Geology.*[8] To prepare to lead these sessions, leaders participated in Leadership Development Institutes facilitated by developers and also field-tested some of the programs.

From 1996 through 2002, project consultants conducted the Inquiry Institute[9] each summer. Participants were immersed in scientific inquiry during this intensive 11-day professional development experience. Each participant conducted an individual inquiry, maintained a science notebook, learned content, and presented findings to colleagues. Workshop leaders were particularly encouraged to attend the Inquiry Institute.

Principals

Principal participation in professional development was critical to project success at the school level. Principals had committed to attending four, half-day project sessions each year, and they requested an additional two meetings each year, focused on supporting teachers as they changed their instructional practice. Principals observed classroom lessons and videotapes, observed and interacted with teachers at their schools, and subsequently discussed as a group what they had observed, the challenges they perceived, and possible solutions.

The goal of the principal leadership sessions was for principals to reach a level of understanding sufficient to support change and to maintain the MASE vision of standards-based instruction. Principals reported that it was not easy when so many teachers were so often out of the building,

[6] The Consortium for Mathematics and Its Applications and TERC.

[7] Caltech, the Precollege Science Initiative.

[8] Buffalo Public Schools and First Hand Learning, Inc., TEAM 2000, the Buffalo Local Systemic Change Initiative.

[9] Workshop Center, City College of New York.

yet they valued the professional development their teachers were receiving. In the spring of the first year, one principal noted a big difference: "Teachers are starting to talk mathematics in the hallways and during lunch."

MASE-SMT: Extending and Sustaining Continuous Improvement

By 2000 the Clark County School District had 159 elementary schools and was the fifth largest district in the country. Adding new schools generated mobility at all levels. Attendance zones changed as new schools were built, often moving students to different schools. Teachers and administrators moved in waves to staff new schools, opening vacancies in existing schools that required many new hires each spring. Up to one-third of all teachers and principals changed schools each year.

During MASE II, the project leadership team came to view the transiency within the district as both a strength and a weakness. The capacity of some schools weakened as teachers and administrators left their schools. Yet this movement introduced MASE instructional approaches and curriculum resources to schools that had not been directly involved in the project. This flow-through-effect was a means of dissemination that helped move the whole district toward standards-based teaching and learning. Largely as a result of the flow-through-effect, MASE shifted from a school-change model to a diffusion model.

Changing Context

The state and district contexts were shifting, as they were nationally, toward high-stakes testing. The Nevada legislature mandated new content and performance standards and an accountability program based on norm-referenced tests.

The newly-appointed Clark County superintendent identified three priorities—all students reading by third grade, algebra for all eighth grade students, and decreasing the dropout rate. The superintendent reorganized the district into five K–12 geographic regions that had common curriculum standards, but greater autonomy and accountability for student achievement. Although the new district superintendent supported MASE, teachers and administrators were distracted by the reorganization and accountability demands. Improving literacy became a competing priority, and many schools seemed to hold off on mathematics and science education reforms while the regions established priorities and regional cultures evolved.

Implementing MASE-SMT

The National Science Foundation awarded the Clark County School District a second, smaller Local Systemic Change grant to fund the Mathematics and Science Enhancement K–5 Using Technology (MASE-SMT) project. The student-centered, teaching-for-understanding focus remained unchanged; helping teachers integrate instructional technology into mathematics and science instruction was added as a goal; and the demand for student achievement intensified. Working with schools having underserved and underrepresented populations was a project priority.

MASE-SMT added a research component to the five MASE II design components: practice-based professional development, building leadership capacity, district-wide involvement, internal and external support, and systemic factors. MASE-SMT was planned to accomplish three goals: to extend the work of MASE; to deepen district capacity to sustain on-going improvement; and to research the impact of MASE-SMT.

A total of 32 schools participated in MASE-SMT over the five-year project: 6 schools were selected to be Collaborative Learning Centers in the first year; 12 new schools were added in the second year; and 14 more schools in the third year. The Collaborative Learning Center Schools were MASE II schools selected to become models of best practice and to host on-site MASE professional development over the course of the project. Teachers at Collaborative Learning Center Schools were expected to become proficient in mathematics and science and to strengthen the school culture of inquiry and shared leadership. Teachers at all MASE schools were expected to fully implement the district's standards-based curricula, *FOSS* and/or *Investigations*.

- **Extending the Work of MASE II**

MASE-SMT built on and extended the expertise, processes, and products already in place as a result of MASE II. Extending meant going to scale by involving additional teachers and principals with MASE, deepening the knowledge base, gaining expertise, and moving the work to new levels. It also meant continuing to build leadership capacity.

Practice-Based Professional Development

As in MASE II, MASE-SMT teachers participated in Structured Use Workshops during their first project year. They then selected professional development sessions from the MASE-SMT course list to complete 130 hours of professional development. MASE courses were continually updated and new courses developed and implemented. MASE-SMT teachers chose from practice-based sessions and project-wide offerings including courses such as: Inquiry Into Liquids, Foundations of Algebraic Thinking, Classroom-based Science or Mathematics Sessions, Science Assessment, and Data and Technology Applications.

In the fourth year of MASE-SMT, site-based sessions included examination of student work and classroom-based observations as project leaders helped teachers gain expertise with standards-based teaching and learning. Classroom-based sessions focused on observing how students explained their thinking, use of productive questions, and instructional decision-making. Project leaders, principals and project evaluators developed the Observing for Evidence of Learning protocol. Teachers in Collaborative Learning Center Schools field-tested the protocol, which was intended to promote collaborative and productive dialogue to help teacher teams refine their teaching practice. They found that the student-centered protocol was more likely to generate productive dialogue and change.

Twenty-nine school teams were prepared to begin using the Observing for Evidence of Learning protocol with colleagues in their schools in the fall of 2004. A new district prohibition against using substitute teachers to release teachers for professional development meant that many school plans were rewritten. Other schools tried to complete plans to implement classroom-based lessons using the protocol. Teachers who could not attend sessions outside the school day were discouraged. MASE had routinely relied on substitutes to reach all teachers, so the loss of

substitute release time was a severe setback. School-based professional development in the final year of the project varied widely: from a low of 22 to a high of 1,684 contact hours, with a school average of 575 contact hours.

Building Leadership Capacity

MASE leadership development concentrated on expanding the number and deepening the knowledge of teachers, principals, district administrators, and MASE leaders. Leadership-development experiences were based on the beliefs that leaders lead in a variety of ways, that all teachers have the potential to lead, and that leaders lead by example. The aim was to build leadership capacity within each teacher to support improved science and mathematics instruction for all students.

As MASE teachers and principals participated in professional development, restructured their practice, and gained confidence in standards-based instruction, they assumed school leadership roles, working formally and informally with colleagues and parents. MASE leadership sessions were open to MASE Teachers on Special Assignment (TOSAs), Teacher Leaders[10] willing to lead workshops, and principals and district administrators. Emerging workshop leaders typically enrolled in courses beyond what was required, asked probing questions, thought deeply about teaching and learning, challenged ideas, and initiated productive dialogue.

Leadership cadres were formed to build leadership in specific areas during MASE II and MASE-SMT. Workshop leaders joined one or more leadership cadres and were mentored by the TOSA facilitating each cadre. For example, three cadres were formed to build leadership capacity to support teachers as they implemented mathematics assessments aligned with standards-based instruction. A project consultant and TOSA worked with each cadre to deepen teacher understanding of content and how children think and learn. Teachers solved and analyzed assessment tasks and then implemented the tasks with their own students. They also learned to use the data to make instructional decisions.

During MASE II, the K–2 cadre field-tested and contributed to the development of an assessment program.[11] In the process, they developed and implemented professional development activities, including the annual Developing Number Sense conference, K–2 Number Talks sessions, a series of classroom-based lessons, and assessment workshops. K–2 leaders supported school-based assessment work during MASE-SMT.

The first 3–5 leadership cadre focused on developing two leadership teams: school teams that worked with teachers at their own building, and a district team that facilitated school-based planning with each school team and expanded the program by leading MARS[12] sessions for new school teams. The second leadership cadre focused on building capacity of teacher teams that

[10] Teachers working full time with students who facilitate professional sessions for colleagues.

[11] Assessing Math Concepts[11], Mathematical Perspectives Teacher Development Center.

[12] Mathematics Assessment Services from Michigan State University Balanced Assessments Items.

scored the annual year-end MARS assessments designed to collect data sets for the MASE-SMT student achievement study.

- **Sustaining On-going Improvement**

To sustain the MASE vision, core beliefs, and approaches within the changing district context and culture, both Local Systemic Change projects invested in people. MASE leaders would be prepared to ask questions, debate ideas, collect data, and make evidence-based decisions as the district context changed over time. Current and emerging leaders extended and deepened district capacity to sustain on-going improvement efforts by institutionalizing MASE principles, practices and products through three project components: district-wide involvement, internal and external support, and systemic factors.

District-Wide Involvement

The National Science Foundation Local Systemic Change grants provided high-quality professional development to roughly two-fifths of the district's elementary teachers during MASE II and to a smaller percentage during MASE-SMT. MASE and IKE TOSAs hosted annual MASE Mathematics-Science Conferences in each of the five regions during MASE II. These one-day conferences extended MASE professional development and practice beyond participating schools to all district teachers and administrators, thereby connecting them to the MASE project. The flow-through-effect of MASE teachers and principals moving to schools throughout the district benefited non-Project schools during MASE-SMT.

In addition, partnerships with various departments within the district resulted in MASE courses on using technical drawing to help elementary students observe and record their observations; integrating science, mathematics and technology; and connecting science and literacy. Each project year**,** one department purchased tradebooks aligned with FOSS modules and mathematics for each school library.

External Support

Collaborations with external experts enriched MASE II and MASE-SMT improvement efforts while supporting sustainability. MASE collaborated locally with University of Nevada, Las Vegas faculty, museums, and informal science educators and scientists in the Las Vegas area. Support also came from the National Science Foundation and from research and development centers, other experts, institutions, and Local Systemic Change projects across the country.

MASE staff sought innovative resources and established collaborations with professional development providers that furthered MASE goals. A number of projects supported by the National Science Foundations connected MASE Project Leaders, district administrators, principals, and teachers with resources and national improvement efforts. Team members who participated in leadership institutes and conferences outside the district were strategically selected. As a result, district-level support for MASE increased as the knowledge base of current and future district leaders expanded.

Project consultants, evaluators, and advisory board members met with and advised MASE Project Leaders, principals, and administrators throughout the Local Systemic Change Initiative. One district-level administrator stated that the most important aspect of MASE was the

continuous interactions with the range of experts that MASE brought to the district. These productive collaborations advanced project goals.

Systemic Factors
Project leaders linked MASE work directly to district priorities to improve K–5 mathematics and science instruction. MASE and district staff worked collaboratively to develop several important documents for district use. *Components of an Effective Mathematics Lesson* and *Components of an Effective Science Lesson* described elements of standards-based instruction in language that fostered productive communication and supported balanced instruction. These documents became part of the district's teacher evaluation process and were used in professional development sessions for teachers new to the district. The continuing influence of MASE professional development was seen in the development of district documents such as the *Power Standards and Benchmarks, the Guide for Mathematics Programs* and the annual revision of the *Curriculum Essentials Frameworks* for mathematics and science.

MASE and IKE TOSAs also drafted the document which became *The K–5 Science and Technology Handbook.* The handbook, a grade-level planning guide, supported implementation of *FOSS* science learning experiences and served as a reference for thinking about science, inquiry, science as a context for literacy, science assessment and other relevant topics. A 15-hour on-line course based on the handbook was launched in 2005 to support implementation of *FOSS* modules throughout the district.

In 1999, the Nevada legislature established four regional professional development centers in Nevada to provide on-going professional development for teachers related to state standards for mathematics, science and literacy. One Center in this state support system for teachers was located in Clark County. MASE-SMT and Center leaders collaborated to develop professional development and influential district documents. MASE Teacher Leaders and TOSAs hired by the Center continued to provide science and mathematics workshops for all district teachers after MASE grant funding ended.

Efforts to launch a *FOSS* Replenishment Center that began in 1996, finally came to fruition in 2004 when the successful pilot involving 14 schools was expanded. By 2006, 57 MASE and non-project schools were involved. School staff and teachers no longer had to search for materials. The use of a replenishment system enabled all teachers at a grade level to collaborate as they taught the same module. More teachers used the modules, lessons were more focused, and students were enthusiastic about science.

Upgrades of district technology systems began in 1998. By 2002, capacity to communicate with MASE participants, register online, follow teachers from school to school, and collect data and draw reliable conclusions about student achievement had increased dramatically.

- **Research**

In 2001, the MASE student achievement study was designed to determine the extent to which project goals of improving instructional practice and student achievement were achieved. The Horizon Research, Inc. science test and the CTB/McGraw-Hill Balanced Assessment mathematics instruments were administered to students in MASE and non-Project schools.

Reports were generated separately for each content area. One part of the mathematics study related teacher practice to participation in MASE professional development. The results were disaggregated by gender, ethnicity, socioeconomic status, and other demographic variables.

Findings indicated that the majority of students experienced improved achievement in both science and mathematics after three years of MASE instruction. Students of teachers who participated extensively in MASE professional development performed significantly better in mathematics at the end of the fifth grade. The mathematics leaders successfully achieved two goals, providing professional development and improving student performance as a result. Male and female students experienced equal gains in science. Although significant differences existed in science achievement among racial/ethnic groups, gains achieved by minority students indicated that the achievement gap in science appeared to be closing.

MASE-SMT Project Leaders and University of Nevada, Las Vegas faculty jointly developed a second research study on the effects of inquiry-based professional development in mathematics and science. The study collected student work, including written assignments, projects, presentations, standardized test scores, and other assessments. Videotaped lessons were analyzed. Findings from this study informed decisions project leaders made as they implemented the MASE-SMT project.

Summary of Impact

Ultimately, 77 schools participated in the two Local Systemic Change projects. By 2002, MASE teachers were distributed among 167 of 172 elementary and 41 of 43 middle schools. In 2006, MASE teachers were in 170 of 192 elementary schools, 34 of 48 middle schools and 10 of 35 high schools, demonstrating the potential of the flow-through diffusion model as a dissemination tool.

Project leaders found that MASE had the greatest impact in schools where the principals created an atmosphere of open dialogue and joined teachers as learners in the MASE project. These MASE schools exhibited a high level of commitment, accepting challenges that were a natural part of change and the added burdens of participation.

However, the school as a unit of change model was effective only as long as committed principals remained at MASE schools. With principal (and teacher) mobility, the flow-through diffusion model disseminated MASE beliefs and approaches throughout the district. As MASE funding ended, not all district teachers had the opportunity to participate in over 100 hours of high-quality MASE professional development and the influx of new teachers continued. Still, the impact of the Local Systemic Change Initiative was evident.

A district-level administrator observed that teachers sold on MASE internalized the project's instructional principles and approaches. MASE alumni noted that the MASE projects provided them with time within the school day to be learners and thinkers and to focus on how to help children learn mathematics and science; they reported that their core beliefs had shifted and remained focused on children's thinking and teaching for understanding.

In 2001, a MASE student achievement study was designed to determine the extent to which project goals of improving instructional practice and student achievement were achieved. Findings indicated that the majority of students experienced improved achievement in both science and mathematics after three years of MASE instruction, with some indication of narrowing historical achievement gaps.

Lessons Learned

A number of important lessons were learned during the Local Systemic Change Initiative in Clark County that have implications for other districts that are working to go to scale with high quality professional development in mathematics and science. First, the multiple-strategy approach to professional development was well suited to the context of the district, as it provided differentiated offerings and allowed choice. Second, the knowledge gained in MASE professional development appeared to empower teachers both as learners and as leaders. Third, the practice-based approach to professional development, including the use of inquiry and the focus on children, was engaging to teachers, and seemed to increase their willingness to implement standards-based approaches. Fourth, external expertise provided the foundation for leadership development that enabled MASE TOSAs to become strong second- and third-generation leaders with the capacity to mentor future leaders. And finally, on-going, stable support and distributed leadership were important for systemic change to flourish.