Scaling up STEP-UP in Colorado

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School districts in the Pikes Peak Region of Colorado have implemented many externally-funded initiatives over the years. The people who were involved in planning the Local Systemic Change initiative frankly dismissed those prior initiatives as "miserable failures with little accomplished and nothing sustained." In contrast, district-level administrators from the five participating Pikes Peak districts agreed that most STEP-UP practices should be sustained by the districts at the conclusion of the National Science Foundation project. STEP-UP stands for the Science Teacher Enhancement Project—Unifying the Pikes Peak Region, and according to its hardboiled Collaborative Council, STEP-UP stands "above the pack."

The five districts involved in the STEP-UP collaboration varied considerably—in enrollment, in economic characteristics, in levels of student achievement, and in perspectives on science education. The governing body for the initiative (called the Collaborative Council) included the project's two principal investigators, the project coordinator, the assistant superintendent or K–12 science supervisor from each of the five participating districts, and representatives from the key external partners, Hewlett Packard (now Agilent Technologies, Inc.) and Colorado College. The distinguishing characteristics of the Pikes Peak Local Systemic Change initiative were the collaborative nature of the five-district STEP-UP project, the efforts to ensure consistently high-quality professional development, and the extraordinarily high turnover of teachers and leadership which required the project to address sustainability issues from the very beginning.

Previously, in the Pikes Peak Region

In the early 1990s, Hewlett Packard gave the five school districts in Colorado's Pikes Peak Region three-year grants that allowed the districts to investigate and purchase science kits that most closely matched the Colorado Model Science Standards. Hewlett-Packard encouraged the districts to use the Full Option Science System (FOSS), Science and Technology for Children (STC), and the Insights programs in the elementary grades.

During the summer of 1995, each of these districts sent one or two representatives to the week-long training conducted by the National Science Resource Center on *The Five Elements of Elementary Science Reform*. Known as *The Big 5*, these elements are: (1) exemplary science materials; (2) a system for refurbishing kit materials after each use; (3) ongoing professional development; (4) administrative and community support; and (5) assessments aligned with academic standards. District representatives were introduced to deeper understanding of inquiry-based instruction and the importance of implementing all of *The Big 5* elements to achieve systemic reform of science education.

One of the districts committed to fully implementing all of these elements and, in the fall of 1995, hired a full-time director for its Science Resource Center. The director continued the partnership with Hewlett Packard and expanded it to include a faculty member from Colorado College who had a national reputation in science education and inquiry/constructivist teaching.

The Harrison-Colorado College-Hewlett-Packard partnership laid the foundation for the STEP-UP collaboration. Staff from the five districts met several times during the school year to discuss issues related to elementary science, and funding was sought from the National Science Foundation to expand the work to the four other districts in the Pikes Peak Region. The proposed project did not receive Local Systemic Change funding in the first two attempts, in 1997 and 1998, but did in 2000.

By 1998, the Colorado Department of Education had completed the adoption of standards for all content areas. Teachers in the region's schools felt overwhelmed by the number and magnitude of the new standards, and many responded by slighting or ignoring some of the standards altogether. The Harrison district appointed the director of the Science Resource Center to facilitate a task force charged with finding a way to make the standards more manageable. The task force's final recommendation was to integrate mathematics and literacy standards using science as the content core. The Colorado Department of Higher Education funded a Harrison-Colorado College proposal to support the Standards-based Integrated Curricular Strategies project to pilot this recommendation. Forty Harrison elementary classroom teachers and eight teachers from surrounding districts participated in 150 hours of professional development in this pilot project during the 1999–2000 school year.

By 2000, the five Pikes Peak districts were using more than 40 different FOSS, STC, and Insights science kits in the elementary grades, with the proportion of students receiving kit-based science instruction varying from 30 to 95 percent. Three districts had established centers for refurbishing the kits, but only Harrison had a Science Resource Center implementing all of *The Big 5* elements. A few regional kit trainings were offered, but professional development was consistently required only in the Harrison district.

The science-kit policies and practices varied widely among the five districts. The number of kits taught at each grade level ranged from a teach-what-you-like looseness to strict requirements. One district required teachers to use four kits, allowing only six weeks for completing each nine-week unit. Another district required three kits, allowing 9–10 weeks for each. Similarly, the means of selecting science kits varied among the districts. In one district, under a sort of one-day beauty contest, interested teachers could look at the sample kits, then, in effect, vote for the kits they liked. Three districts used the Colorado Model Science Standards as the basis for kit selection. One of these districts piloted the standards-matched kits to determine depth of student conceptual understanding, and rolled-out implementation one kit per grade, per year, in conjunction with its five-year strategic plan for continuous improvement of curriculum and professional development. Three district school boards adopted the science kits as the official science curriculum; teachers in the other two districts could teach what they wanted.

Representatives from the five districts met together to discuss and learn from each other about implementation issues. These regional meetings were the foundation of the STEP-UP Collaborative Council which tackled issues of policy uniformity and implementation of *The Big 5*. The Council's motto was: "If the practice is good for children in one district, then *all* children deserve the same opportunities."

Implementing the Reform

The STEP-UP project adopted strategies, implemented programs, and instituted practices designed to lead to systemic change and a lasting impact on science instruction in the elementary grades. The basic philosophy and overall project design remained the same over the six-year initiative. STEP-UP leaders made some modifications to the project based on the implementation experience in order to better meet participant needs, to adjust to changing political demands, and to benefit from improved understanding of what it takes to achieve long-lasting systemic change.

The leaders of the STEP-UP collaboration attribute the project's success to specific approaches, policies, and practices that they believe can be replicated in other schools and districts. Implementation of *The Big 5 Elements of Elementary Science Reform* was the foundation of STEP-UP success. Integrating literacy and mathematics standards using science content directly addressed competing instructional priorities in the schools. The project provided a range of research-based professional development offerings for new and experienced teachers, as well as for teacher leaders. All stakeholders in the STEP-UP project were committed to having an impact on student achievement. And, STEP-UP leaders recognized the importance of interpersonal relationships and relentless champions to the success of project operations and sustainability. These replicable aspects of STEP-UP are discussed below.

Replicable: The Big 5

Different aspects of the STEP-UP project—not isolated but linked and interrelated—contributed to scaling up science reform in the Pikes Peak Region of Colorado. *The Big 5* are the five elements identified by the National Science Resources Center (NSRC) as critical to elementary science reform. These five elements, all of which must be present, are the pillars of sustainability. The first is exemplary science materials that meet NSRC criteria. STEP-UP employed the Science and Technology for Children, Full Option Science System, and Insights science kits. The second critical element is a working system (that does *not* rely on classroom teachers) for refurbishing kit materials after each use. Ongoing professional development is the third element needed to sustain reform. Generally science-shy, elementary school teachers need to develop their understanding of the science content and pedagogy, the skills needed to implement the curricular materials, and to have classroom support as they change their instructional practice. Fourth, successful reform requires administrative and community support. University and business partnerships committed to improved elementary science bolstered the confidence of Pikes Peak Region school boards and district leaders that they were doing the right thing. Finally, assessments aligned with academic standards provide accountability that the kits were well taught.

Replicable: Integrating Literacy and Mathematics Standards Using Science Content

Colorado teachers were reacting strongly to the state's new curriculum standards in 2000, when the Pikes Peak Region started to implement its Local Systemic Change project. Teachers were overwhelmed by the demands imposed by the standards. Under pressure from high-stakes literacy and mathematics testing, some teachers responded, often directed by their principals, by teaching *only* reading, writing, and mathematics. Other teachers reverted to teaching what they had always taught, or just what they wanted to teach, claiming these topics *were* standards-based. In effect, a lot of teachers tossed the standards because it did not seem possible to address all of them.

In this context, the notion of integrating literacy, mathematics, and science standards was very appealing to standards-conscious teachers. Using the inherently interesting content of science to enhance learning in literacy and mathematics was compelling as well. The STEP-UP project incorporated this integrated approach as a major element of the project design. (Connecting science and literacy was not an entirely new idea. Harrison leaders discovered from other sites at the 1995 Next Steps Institute that distributing related literature with science kits resulted in a higher level of kit implementation, so the district's Science Resource Center included Literature Connections, a tub of approximately 50 related trade books, with each science kit.)

From the outset, STEP-UP leaders were determined that this compromise of sorts would not undermine science inquiry and the modeling of good science teaching. STEP-UP was committed to inquiry-based science instruction and the goal of making science sense. For example, research indicated that science notebooks seemed to improve writing achievement (Klentschy, 2003; Stokes, St. John, and Fyfe, 2002; Klentschy and Molina-DeLa Torre, 2003; Bredderman, 1983, 1985). However, the primary goal of STEP-UP was to improve the understanding of science through the use of notebooks, *not* for notebook activities to develop literacy or mathematics skills. At any point when the STEP-UP leadership determined that an adaptation to or extension of the project design was necessary, the proposed adaptation was critiqued based on the project's inquiry model. Would the proposed change model the IDEA2 inquiry model—invite, discover, elaborate, act on/assess?

In 2001, after STEP-UP leaders and Science Resource Teachers were trained by expert staff from Valle Imperial school district in El Centro, California, the project developed and implemented two related Instructional Strategies Sessions on the Power of the Science Notebook and Responding to the Science Notebook. These Instructional Strategies Sessions were the primary STEP-UP vehicle for integrating literacy and mathematics standards with science content. Developed originally for new teachers, these sessions were opened to experienced teachers after the first year. The five strands included: Integrating Literacy and Science (three sessions); Integrating Literacy and Math (two sessions); Inquiry (four sessions); Equity (two sessions); and Assessment (one session and six hours of mentoring).

All of the STEP-UP Instructional Strategies Sessions followed the IDEA2 framework, originally developed by the Educational Development Center and expanded to include assessment. Strategies from each strand were used to reinforce what was learned in other strands. Science notebooks, for example, were explicitly taught in Power of the Science Notebook and were part of all other strand sessions, even if participants had not previously taken Power of the Science

Notebook. In this way, teachers had additional opportunities to develop skillful use of notebooks, or they were introduced to notebooks and perhaps enticed into taking the notebook strand. The project developed rubrics to assist teachers in deepening implementation of notebooks with their students.

STEP-UP employed a number of different incentives to encourage teacher participation in project professional development activities. First, STEP-UP Instructional Strategies Sessions were structured so that teachers completed each strand with sufficient practice and skill to implement the new strategies in their classrooms. After they implemented the strategies in the classroom, teachers were convinced that their students' performance would improve on the Colorado State Assessment Program literacy and mathematics tests. Science Resource Teachers mentored and supported teachers in implementing the new strategies with their students. To receive graduate-level credit from Colorado College, teachers had to submit a reflective paper and student work samples as evidence they had used the new strategies in their classrooms.

The STEP-UP Collaborative Council knew that students learning kit-based science in other states had improved their literacy and mathematics scores on standardized tests, but the Council wanted to see the results with Colorado students. Local teachers were able to provide anecdotal evidence about increased student achievement after implementing STEP-UP strategies, and elementary schools reported improved performance on the state's writing assessment after all the teachers had participated in the Power of the Science Notebook sessions. However, STEP-UP staff, Collaborative Council, and the region's elementary school teachers wanted to conduct their own research study for clear accountability.

Replicable: STEP-UP Professional Development

The Pikes Peak Region Local Systemic Change project originally had three separate tiers of professional development organized according to teacher experience and leadership potential. In all courses, teachers were treated as classroom experts and provided research-based professional development drawing on the practices recommended in *Designing Professional Development for Teachers of Science and Mathematics* (Loucks-Horsley, Henson, Love, & Stiles, 1998). STEP-UP courses in all three tiers followed the IDEA2 instructional framework—Invite, Discover, Elaborate, Action/Assess. Teachers were taught this model both implicitly and explicitly sothey could implement it with their students. Tier I was designed for new teachers. Teachers participated in three, four-hour kit trainings and six, three-hour Instructional Strategy Session of their choice, and received 15 hours of mentoring. The five participating districts recommended classroom teachers with established ability in teaching science to become kit trainers. The STEP-UP Science Resource Teachers conducted these Training of Trainer sessions, which were modified over time to incorporate use of science notebooks, conceptual storylines, and assessment. Every four-hour kit training session included: materials management, experience with all the lessons in the kit, one or two discussions about particular lessons, and a focus on the major concepts to be developed during the nine-week units. In addition, all new teachers were expected to attend one three-hour Introduction to Kit-Based Science, during which they worked through the entire Floating and Sinking kit to see how concepts were developed and why skipping lessons interrupted this development.

During the project's first year, experienced teachers said they thought they too could improve their science knowledge and pedagogical skills by participating in Tier I Instructional Strategy Sessions and receiving mentoring services, so these options were made available within Tier II as well. Over the course of the project, all five districts in the region came to mandate that all new teachers participate in Tier I professional development activities as part of their induction program.

Designed for experienced teachers, Tier II professional development included 33- and 45-hour lab-based or field-based science content courses, during which teachers learned science by being scientists. The science content courses included: Matter Matters, Constancy and Change in Physical Science, Cool Chemistry, Constancy and Change in Life Science, Interdependence in Life Science, Winter Ecology, Fire Ecology, Order and Chaos in Earth Science, Interdependence In Life and Earth Science, Constancy and Change in Earth Science, and Mountains to Molehills: Mountain-building in the Pikes Peak Region. These courses were conducted in the field or lab, such as the Garden of the Gods, Beidlman Nature Center, Fountain Nature Center, Catamount Ranch, the volcano region of New Mexico, and various outcroppings, creeks, and arid areas. As teachers became accustomed to the interactive and inquiry-based courses, they loved the experience of discovering a new, effective way of teaching. Many teachers reported that they found teaching and learning to be fun again and were reminded why they chose education as a career.

Tier II science content courses were co-taught by a scientist and a Science Resource Teacher who jointly developed the course in relation to a specific kit curriculum. Each member of the team brought his or her expertise to the partnership. When working with a scientist who was skilled in learning and pedagogy, the Science Resource Teacher assumed a facilitating role. In courses where the scientist's expertise was primarily content, the Science Resource Teacher played a more active role in making inquiry pedagogy explicit. This team model was so successful that Agilent (formerly Hewlett-Packard) and others in the region's business community continued this teaching partnership following the end of the National Science Foundation grant.

The Tier II 45-hour science content course, or the 33-hour science content course supplemented by 12 hours of Critical Friends work, mentoring, or Instructional Strategies Sessions, earned the Tier II teacher either in-service credit or three Colorado College graduate-level credit hours, both of which counted toward salary increments and recertification. Colorado College's community-outreach philosophy and long history of support for science education made it an ideal collaborative partner in this initiative. Project staff actively promoted the benefits of this partnership, telling teachers that STEP-UP courses were the best deal in town—great professional development, at an all-time low cost, at a great university.

Incorporating particular instructional strategies from Robert Marzano's *What Works in Classroom Instruction* (2000, 2003) contributed to the success of the Tier II science content courses. The Constancy and Change in Life Science course, for example, applied the probing-questions strategy, and the Order and Chaos in Earth Science course incorporated Marzano's non-linguistic forms of representation. Incorporating Marzano's classroom strategies into the

science content courses followed the STEP-UP model in which teachers personally experienced the learning strategy before using it with their students.

The science content courses enabled participating teachers to move from being science-shy to science-savvy. STEP-UP purposely offered many earth and physical science content courses while limiting the number of life science courses, so teachers would have to take at least one earth or physical science course to complete the 130 hours required to receive the STEP-UP stipend. Teachers discovered that physical science was not as difficult as they had imagined, and their questions about physical science often kept the instructor from taking a break. When teachers completed 45 hours of STEP-UP professional development, they received a $1,000 stipend. The stipends ended in 2005, so districts emphasized other incentives for continued participation in STEP-UP courses, including completion of induction requirements, earning salary increments and credit for recertification, and leadership development opportunities.

Tier III of the STEP-UP professional development was designed to develop the capacity of future elementary science leaders. In addition to providing 91 teachers with scholarships to earn a Master of Arts degree in Integrated Natural Sciences, Tier III professional development activities included: leadership development in assessment and inquiry; professional development of kit trainers to ensure uniform, high-quality training across kits, publishers, schools, and districts; special training for teacher leaders in the schools; and the 90-hour Principals' Institute. Tier III participants were honored at award ceremonies, earned stipends, and were recognized for the additional responsibilities they assumed.

Forty-five principals from the five districts participated in the Principals' Institute. They learned about content through inquiry, inquiry assessment practices, action research, using data to create action plans, professional mentoring, and supervision of inquiry. STEP-UP staff observed significant changes in teaching practice in schools where principals had attended the STEP-UP Principals' Institute, confirming the shared project belief that "Where the principal goes, there go the teachers."

The Pikes Peak Local Systemic Change initiative was implemented during a time of enormous pressure to improve student performance on state assessments. Many districts in Colorado responded by purchasing heavily-scripted curricula, assigning Resource Teachers to see that teachers followed the scripts, and allowing little teacher discretion in making instructional decisions. The underlying philosophy of STEP-UP ran counter to this trend by allowing teachers to make decisions about professional development based on their assessment of their own and their students' needs. Teachers found the STEP-UP professional development courses both helpful to their professional growth and applicable to their classroom practice. STEP-UP was widely recognized and appreciated as a project that respected teachers, supported their growth, and offered meaningful choice.

Replicable: Focus on Progress

STEP-UP implementation was not a single event or series of events, but an ongoing process. From this point of view, superficial implementation was an entry point on a continuum that could lead to expert implementation. STEP-UP Science Resource Teachers developed a continuum for implementation of science kits, a continuum for implementation of inquiry-based instruction, and

a continuum for implementation of science notebooks. Using the Concerns-Based Adoption Model (Loucks-Horsley, 1990), the Science Resource Teachers identified the steps on the way to expert implementation, and devised plans for moving teachers to increasingly expert practice. Classroom teachers used the continua in reflecting on their practice. The STEP-UP research study found that students of teachers who changed their beliefs and implemented good science teaching practices experienced improved achievement in reading, writing, and mathematics.

These implementation continua provided a means of assessing the quality of the professional development and other support services provided by the Science Resource Teachers. STEP-UP staff also received feedback from the project's external evaluation team; the project's Advisory Board of national and local experts in science, equity, and assessment; and from participating teachers at the conclusion of each course. This feedback was used to make improvements in the professional development offerings and to determine next steps in supporting teachers.

District leaders had reason to believe that STEP-UP was having a positive impact on student performance. The region's largest district administered the Terra Nova assessments in reading, writing, mathematics, and science. Student achievement results in reading, writing, and mathematics reflected the socio-economic levels of the schools in this district, but *not* in science. Students from one low-income school in which 100 percent of the teachers completed 130 hours of STEP-UP professional development outscored the district's highest-income schools on the science test. And on the first administration of the Colorado State Assessment Program (CSAP) in fifth grade science in the spring of 2006, students in four of the five districts scored higher on the science CSAP relative to the state as a whole than they did in reading, writing, and mathematics.

During the second year of the project, the National Science Foundation awarded the STEP-UP collaboration a supplemental grant to develop enhanced assessments for 22 science kits. Teams of scientists, kit trainers, Science Resource Teachers, assessment experts, and classroom teachers developed the assessment packages. The assessment package for each science kit included conceptual storylines with parallel assessment storylines. The storylines identified the major concepts to be taught, and when and how those concepts would be assessed. The packages included instructions and prompts for constructed responses to be used in formative assessments, a final performance assessment, scoring rubrics, and student exemplars aligned to state standards.

The assessments were piloted, field-tested, and revised before being implemented widely across the districts. Three districts required all of their teachers to participate in professional development on the new assessments. Teachers in the other two districts attended voluntarily. (One of those districts, however, required the assessments to be used as quarterly assessments, an instance of imposing requirements without providing the needed professional development.) The districts now all require the STEP-UP assessments; they have instituted systems to collect data, and three districts publish the results. It was particularly important to the STEP-UP leadership that the assessment project be a model of inquiry-based assessment in which students continued learning and doing science as they performed the assessments, and did not just regurgitate information for assessment purposes. In contrast to poor assessment practices which can lead to

poor science teaching, STEP-UP assessments were performance-based and inquiry-based and supported good science teaching and learning.

A substantial research base existed to demonstrate a strong relationship between inquiry-based science and improved literacy and mathematics achievement. Nevertheless, the STEP-UP Collaborative Council wanted to see results with *their* students, and approved the allocation of STEP-UP funds to conduct a research project examining the impact of STEP-UP professional development and instructional practices on elementary students' performance on the state assessments in reading, writing, and mathematics. The results showed significant positive correlations between the professional development on science notebooks, on science and literacy, and on science assessment and student performance on the Colorado State Assessment Program in reading, writing, and mathematics. The professional development on science and graphing was significantly correlated with student performance on the state writing and mathematics tests. The five districts in the region were already pleased with the STEP-UP program, and these research findings strengthened their belief in the importance of continuing STEP-UP professional development and teaching practices.

STEP-UP leaders continued to examine the project's effect on student achievement. The collaborating districts planned to analyze the impact of STEP-UP professional development and instruction on student performance on Colorado's first fifth-grade science assessment. Other planned research projects would examine: the transferability of STEP-UP Integration of Literacy and Science professional development and instructional practice to districts outside the region; and the relationship between use of STEP-UP performance assessments and minority achievement.

Replicable: People Make It Happen

Priorities and related pressures are always changing in school districts. Strong, enduring relationships among key players in the five districts and their external partners helped to maintain a focus on elementary science in a time of changing priorities and competing demands.

STEP-UP gathered a wide range of people at the table, each bringing his or her experience and expertise. The assessment project, for example, brought scientists, kit trainers, Science Resource Teachers, classroom teachers, and assessment experts together as equal partners. The team members developed a mutual respect for one another that served to advance and enrich the project and the partnership.

STEP-UP was extremely fortunate in its business partner, formerly Hewlett Packard and Agilent Technologies, Inc. since 2000, and its university partner, Colorado College. Both partners had a history of supporting science education in the region. Quarterly meetings with representatives from the districts, Agilent, and Colorado College kept all partners informed about the project and provided opportunities for collegial interaction and sharing valuable advice. For example, when one district started moving in a policy direction that would have been detrimental to science education, Agilent helped convince the district to stay the course. Another time, when STEP-UP staff feared that a district's reorganization would result in the elimination of the Science Resource Teachers, representatives from Agilent and Colorado College joined in obtaining

assurances that commitment to the project and these key positions would continue. District administrators and school boards *do* listen to major corporations and institutions.

Agilent also provided office space and supplies for STEP-UP staff, and meeting rooms and meals for STEP-UP courses. Agilent representatives often attended courses to let teachers know how important their work was to the future of industry in science, mathematics, technology, and engineering. This kind of morale boost was profoundly energizing.

Colorado College awarded graduate credits for 45-hour professional development courses at the bargain price of $10 per semester hour. These credits could be counted toward a Master's degree in three different graduate programs. Over the years, Colorado College prepared scientists who were experts in delivering field-based and lab-based science content through inquiry pedagogy. This cadre of science-inquiry experts was an invaluable resource in the Tier II science content courses and the assessment project.

Excellent instructional materials, high-quality professional development, strong administrative and external support all were essential to achieving systemic change. Still, it was the people who made it work. Human attributes and human relationships fueled the STEP-UP project and kept it going. Long-standing professional relationships between STEP-UP and district leaders smoothed implementation in the districts.

Participation in professional meetings got things started and kept things going. Attendance at the 1995 National Science Reform Conference introduced future leaders to the requirements of science reform and laid the groundwork for the Pikes Peak initiative. Several members of the Collaborative Council and Science Resource Teachers became steeped in the reform effort when they attended the Next Steps Institute run by the Association of Science Materials Centers. Professional and networking opportunities inspired STEP-UP and district staff to higher peaks.

Making time for district staff to meet and learn from one another also made a difference. For example, annual meetings of the Science Materials Managers from the five districts allowed them to discuss solutions to refurbishment problems and ways to ensure uniform practices across the districts. School and district leaders made it a point to recognize teachers, in front of their colleagues, when they completed their STEP-UP coursework. Superintendents of two districts thought professional development and networking was so worthwhile that they mandated that all of their elementary principals participate in the 90-hour STEP-UP Principals' Institute.

- **The Policymaking Body**

The five districts had agreed that the Collaborative Council, with representation from each of the districts, would serve as the policymaking body for the STEP-UP project. The Council adopted uniform practices and procedures governing the use of the science kits. All five districts required the teaching of two science kits in kindergarten and three in the other grades, one each in Life Science, Physical Science, and Earth Science. Kit selection was based on state standards. All districts required kit training for new teachers. The new-teacher induction programs included science kit training, mentoring, and other STEP-UP Instructional Strategy Sessions. All five districts established kit refurbishment centers that collaborated on the best ways to meet teacher and student needs.

The five districts participated in quarterly meetings, which included the project's principal investigators, the STEP-UP project coordinator, and the assistant superintendent or science supervisor from each of the five districts. These meetings provided a forum for developing regional positions on any aspect of elementary science. Over the course of the project, districts brought science education policy issues to this five-district Collaborative Council. Policy decisions benefited from a wider range of viewpoints and deeper consideration of the issues. The districts found that working collaboratively also maximized funding and personnel resources.

The membership of the Collaborative Council changed over time. Whenever new members joined the council, a conscientious effort was made to bring them up to speed on the project's history and current operations, and to develop their expertise in elementary science education. New members learned about the research base on which STEP-UP professional development and instructional practice was founded. They attended the Next Steps Institute and other conferences on science education; observed STEP-UP courses; read project evaluations; and were provided current data on their districts. In effect, STEP-UP leaders inducted new superintendents into the reform effort to such an extent that as four of them prepared to retire at the end of the 2004–05 school year, they said that STEP-UP was part of *their* legacy.

As the five participating districts made the transition from STEP-UP leadership, the Collaborative Council assumed responsibilities previously handled by project staff. The Council made a commitment to continue the collaborative relationship well into the future. For starters, the Collaborative Council has welcomed five new districts to the STEP-UP elementary science reform collaboration.

- **The Science Resource Teachers**

The job description for the initially six and increasing to 12 STEP-UP Science Resource Teachers could be summarized as: do anything that supports the teaching of hands-on, minds-on science. The STEP-UP Science Resource Teachers, all working under the supervision of the STEP-UP Project Coordinator, had great flexibility in how they supported elementary teachers in implementing science kits and building teacher capacity in science instruction. (In contrast, the Literacy Resource Teachers and Math Resource Teachers working in the five districts had more prescribed roles, generally limited to modeling instruction, discussing content, collecting lesson plans, and assuring that appropriates scripts were followed.)

STEP-UP developed the expertise of the Science Resource Teachers through professional training: at the five-day Next Steps Institute, sponsored by the Association of Science Materials Centers, Agilent, and other business partners; in Exploratorium courses on inquiry and assessment in San Francisco; through Critical Friends facilitation at the University of Colorado-Denver; and in cognitive coaching and other mentoring practices at the San Diego New Teacher Institute. The Science Resource Teachers also participated in ongoing conversations about and reflection on case studies and emerging research.

STEP-UP Science Resource Teachers tried to meet the elementary classroom teachers at their point of need, wherever that might be on the continuum from science-shy to science-savvy. For

new teachers, barriers to science instruction were often issues of organizing the schedule and classroom management, so the Science Resource Teachers helped new teachers to develop the scheduling and management skills they needed to teach the science kits. Then, the Science Resource Teachers focused their mentoring on the quality of science instruction.

Over the course of the STEP-UP project, classroom teachers came to view the Science Resource Teachers as their partners who collaborated with them, rather than telling them what to do. They called them the "resource teachers in the white hats." This perception greatly reduced resistance among teachers. Classroom teachers working with the most consistently and continually supportive Science Resource Teachers had the highest levels of participation in and satisfaction with STEP-UP activities, as reported in surveys and interviews.

The Science Resource Teachers provided teachers the support they needed in order to implement in their classrooms what they learned in the STEP-UP courses. Despite budget constraints and competing priorities, 4 of the 5 districts recognized the critical role of the Science Resource Teachers by assuming the costs for these positions in the year after the National Science Foundation funding ended and planned to continue doing so in the future.

Challenges to Going to Scale

When Participation Is Voluntary

The superintendents of the five districts said they would *require* teachers to participate in STEP-UP professional development, but most of them meant that they would *encourage* them to do so. Teacher participation was for the most part voluntary, and the STEP-UP and district leadership found ways to encourage and reward the volunteers.

There were concrete incentives for participation. Teachers who completed 130 hours of STEP-UP professional development received a $1,000 stipend and three graduate-level credits toward recertification. These rewards led many teachers to try their first STEP-UP course, and their satisfaction with the quality of the professional development convinced them to continue.

The Science Resource Teachers supported classroom teachers as they implemented the new inquiry form of science instruction. By collaborating without judging, the Science Resource Teachers helped diminish teacher resistance to changing their practice. The conceptual storylines and related assessments seemed to help teachers focus on student learning. We believe that by equipping teachers with a good grasp of the concepts is what enables them to move beyond rote conduct of kit activities; the assessment storylines and Critical Friends protocols both led to deeper implementation.

Many teachers were interested in the research study undertaken to look at the effect of STEP-UP professional development and science instruction on reading and mathematics test results. These teachers were eager to implement STEP-UP strategies and reap the harvest of improved student achievement. Other teachers were pleased to participate in a program that developed teacher knowledge and skills instead of implementing teacher-proof scripted programs. Once they experienced STEP-UP support, these teachers became passionate STEP-UP advocates.

Other policies also influenced teacher participation in and support of STEP-UP professional development. All of the districts incorporated STEP-UP professional development into their new teacher induction programs. Publicizing the percentage of participating teachers at each school, and recognizing principals who significantly improved their participation numbers served to encourage further participation in STEP-UP professional development courses.

Soon-to-be-retired teachers who resisted participating in STEP-UP professional development were simply left alone. The time and energy required of Science Resource Teachers to involve such recalcitrant teachers was judged to be better spent working with new teachers, with experienced teachers willing to change their practice, and with resisters who were not retiring anytime soon.

Teacher Turnover

The largest barrier to going to scale was the extremely high teacher turnover in the five districts. While the number of elementary teachers in the five participating districts at any given point was about 1,300, the project provided professional development services to more than 2,800 teachers during the period from 2000 to 2006. Teacher turnover was a problem across Colorado, but the problem was greatly exacerbated in Colorado Springs because of the large number of military spouses.

Competing Priorities

The amount of time mandated for reading, writing, and mathematics in many schools presented another major barrier to full implementation of inquiry-based science in the elementary schools. Colorado exerted enormous pressure on districts to improve student achievement in reading, writing, and mathematics, or else face state takeover; the pressure was greatest in the state's low-income, low-achieving schools, which included one-third of the STEP-UP schools. Competing demands for instructional attention often resulted in the slighting of science instruction. As the project worked towards its goal of providing high-quality science instruction in the elementary schools, it seemed—much like the myth of Sisyphus—that staff turnover and diversions of high-stakes testing forced the reform effort continuously to start over.

Sustaining the Reform

The five districts in the Pikes Peak Region faced the daunting challenge of maintaining the vision, providing professional development and support, and continuing the collaborative relationships that sustained the reform in the face of high turnover among classroom teachers, administrators, and other leaders steeped in and committed to STEP-UP reform.

In the fall of 2004, the project leadership convened a special meeting on how the districts could sustain STEP-UP policies and practices after completion of the project. Each district sent a delegation that included: the superintendent, the district science supervisor or assistant superintendent, two elementary school principals, and two elementary teachers (one teaching in the primary grades and one in the intermediate grades). Agilent and Colorado College also sent representatives. The participants discussed their shared vision for science education in their

districts. Following this visioning meeting, the districts used the Managing Complex Change model[1] to develop their action plans for achieving this vision. These plans demonstrated a continued philosophical and financial commitment to STEP-UP principles and practices.

Professional development in elementary science was continued, but on a reduced schedule. Collaboratively funding regional kit trainings enabled the districts to cut costs and continue the professional development that was the foundation for elementary science reform. All Instructional Strategy Sessions continued to be taught, but teachers had to choose from fewer dates. Four of the 5 districts picked up the salaries of their Science Resource Teacher and were exploring business partnerships that might pay the scientists to co-teach the science content courses. The focus of the science content courses was shifting from experienced teachers to new teachers.

While financially supporting the regional kit trainings, the district having no Science Resource Teachers could no longer offer Instructional Strategy Sessions. The other four of the original districts and the five new districts invited to join the Collaborative Council were willing to pay their fair share for these courses. When the other districts stop sharing these professional development services at no cost, the STEP-UP reforms are unlikely to be sustained in the fifth original district.

Ongoing communication and interaction between and among STEP-UP leaders—Council members, project staff, individual superintendents, and other stakeholders—strengthened working relationships and the reform effort. When one district superintendent seriously considered eliminating district support for its STEP-UP Science Resource Teachers, STEP-UP leaders intervened; after reviewing the research showing improved results on state reading, writing, and mathematics tests by students taught by teachers who incorporated practices learned in STEP-UP professional development courses, the superintendent changed his mind.

In the year following the end of National Science Foundation support for the STEP-UP project, four of the five districts hired new superintendents. The Collaborative Council planned to provide orientation and training to induct new superintendents into the reform effort.

Developing science reform leaders is a continuing challenge. STEP-UP supported 91 teachers in earning Master's degrees in science education at Colorado College, 15 of these teachers retired, moved, or left their elementary schools to work in middle schools. Similarly, 10 of the 45 principals who participated in the STEP-UP Principals' Institute retired or moved to new districts. A majority of the 40 classroom teachers trained as kit trainers planned to retire in the next seven years. Leadership development of a new generation of teachers and administrators must remain a priority to sustain high-quality implementation of STEP-UP practices and policies.

In its original design and in operation, STEP-UP worked at all levels of the educational system to ensure a district focus on science. In the coming years, a real and constant vigilance will be

[1] The Managing Complex Change Model was copyrighted by Dr. Mary Lippitt, founder and president of Enterprise Management, Ltd. in 1987.

needed to keep elementary science as a priority, given the fierce competition for attention and resources. Each district will require a relentless advocate to address existing and anticipate new demands and to be a persuasive champion for elementary science.

References

Bredderman, T. (1983). Effects of activity-based elementary science student outcomes: A quantitative synthesis. *Review of Educational Research, 53(4),* 499-518.

Bredderman, T. (1985). Laboratory programs for elementary science: A meta-analysis on the effects of learning. *Science Education, (69(4*), 577-591.

Klentschy, M.P. (2003). The science-literacy connection. *California Curriculum News Report, 28(3).*

Klentschy, M. P. & Molina-De La Torre, E. M. (2004). Students' science notebooks and the inquiry process. In Saul, W., ed. *Border crossings: Essays on literacy and science.* Arlington, VA: NSTA Press.

Loucks-Horsely, S. et al. (1990). *Elementary school sciences for the '90s.* Andover, MA: The National Center for Improving Science Education: A Partnership of The Network, Inc. and Biological Sciences Curriculum Study.

Loucks-Horsley, S., Henson, P.W., Love, N., & Stiles, K.E. (1998). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, Ca.: Corwin Press, Inc.

Marzano, R. (2000). *What works in classroom instruction.* Republished in 2003 as *Classroom strategies that work* by the Association for Supervision and Curriculum Development.

Stokes, L., St. John, M., and Fyfe, J. (2002). *Writing for science, science for writing: A study of the Seattle Elementary Science Expository Writing and Science Notebooks Program.*