Researching the Sustainability of Reform

LAKEVILLE

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ACKNOWLEDGMENTS

Foremost, we would like to thank the site leaders in each of the study's sites for their support, hard work, and frankness throughout the data collection process. We are grateful to the teachers, principals, district administrators, and many others who spoke with us. We also would like to acknowledge the input and support of the RSR advisory members, and we would like to thank EDC staff members Judi Sandler and Karen Worth for their thoughtful attention and support throughout this work. Additionally, we would like to thank EDC staff members Keith Suranna, Daphne Northrop, and Silvia Tracanna for their assistance in revising these reports and the tireless efforts of Kerry Ouellet in the editing and layout process.

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This material is based upon work supported by the National Science Foundation (NSF) under Grant No. REC-9805078.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

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PROJECT OVERVIEW

The *Researching the Sustainability of Reform (RSR)* project focused on the question of how to maintain the gains of an initial educational change process and support continuing reform over time. Within the broader study of sustainability, the research paid particular attention to systemwide approaches to science education reform as well as to the role that external funds can play in initiating reforms that are sustained. The research was conducted by staff of the Center for Science Education at Education Development Center, Inc. (EDC), in Newton, Mass., in collaboration with staff at the Caltech Pre-College Science Initiative (CAPSI) in Pasadena, Calif. This research was supported by a grant from the National Science Foundation and was directed by Dr. Jeanne Rose Century at EDC and Dr. Jerome Pine at CAPSI.

The goal of this study was to identify and document factors in school systems that contribute to sustained educational change in science education. The purpose was to provide districts now engaged in improving their science education programs and districts that are considering doing so in the future with information to help them more strategically and effectively build an infrastructure for long-term improvement.

Specifically, this study focused on nine communities with K–6 science education programs begun from nearly 10 to 30 years ago. These communities differed in their sources of funding as well as the longevity of their programs. This study investigated how, and the extent to which, these communities have sustained their science education programs and the factors that have contributed to this sustainability.

Through on-site interviews and observations, surveys, case studies, and document analysis, the study investigated the districts' efforts in the following areas:

- Current status of the science program compared with initial goals
- System context and external conditions that have an impact on lasting change
- Strategies for achieving program goals and building district capacity to improve
- The influence of practitioner and system capacity on sustainability
- External funds as a catalyst for widespread, lasting reform

The findings of the research include nine descriptive site summaries and a cross-site report. The site summaries were designed primarily to provide the reader with a description of the origins, implementation, and evolution of each of the nine science programs. They also offer a brief analytic section that is designed to provide the reader with a bridge to the cross-site report. The cross-site report draws from all nine sites to identify common themes and recurring issues relevant to sustainability. It is primarily analytic while offering concrete supporting examples drawn from the nine sites. The cross-site report also includes a discussion of implications of the findings for funders, reformers, and practitioners.

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SUMMARY OF RESEARCH METHODOLOGY

Research Questions

The study was guided by the global research question: What factors contribute to or inhibit the sustainability of a districtwide hands-on science program? Within this broad question, the research focused on several sub-questions: (1) What is the current status of the science education program within the system and how does that compare with the initial goals and implementation of the program? (2) What conditions and contexts surrounding a science education reform effort impact the sustainability of the reform? (3) What decisions have practitioners made and what strategies have they used to bring about enduring change and build capacity for continuous growth? (4) How has the capacity of the practitioners in the system and the capacity of the system itself affected the sustainability of the reform? and (5) What is the role of external funds as a catalyst and/or support for lasting, widespread reform?

Research Design & Analysis

To answer these questions, the study utilized a multi-site case study methodology that made full use of primary and secondary data sources and accounted for the uniqueness of each community while allowing for cross-site generalizations. The primary data was gathered using qualitative approaches including semi-structured interviews, focus group interviews, observations, and document analysis. This data was supplemented with quantitative data collected through an informal survey administered to a random sample of 100 teachers and all principals at each site.

Some members of the research team had previous experience working with some sites. To alleviate bias, researchers gathered data in sites with which they had no prior interactions. Throughout the process of analyzing data, researchers were careful to address the potential of bias as a result of their experience with hands-on curriculum and any interactions with sites previous to this study.

Site Selection

The study focused on nine school districts[1] that have established an elementary science program reflecting the standards developed by the National Research Council and the American Association for the Advancement of Science. The districts fall into two main groups: those that began their science education reform efforts in the 1960s and early 1970s, and those that began their efforts from the mid-1980s into the 1990s. Four of the nine communities are in the former group. Of those four, two have had enduring science education programs and the other two had programs that were strong for a number of years, waned over time, and are currently in a process of renewal. These communities were of particular importance to the study as they shed light on the long-term development of science education programs and on how the "trajectories" of reform efforts vary over many years.

The remaining five communities fall into three sub-groups: Two had funds from the National Science Foundation that had been expended before the research began; one received funds from the National Science Foundation that were expended immediately prior to the beginning of the research; and two initiated their science reform efforts without significant external funding. Together, these districts represent a range of size and geographical location as well as years of participation in reform.

1 All district and individual names are pseudonyms.

Site Visits

Teams of two researchers made several site visits to each of the nine sites over two and one half years of data collection. Each site was visited at least three times with each visit lasting two to four days. In the initial phase of the research, researchers conducted "pre-visits" and phone interviews that enabled them to obtain an overview of the history of the site, discuss data collection procedures, and identify important issues and additional data sources/key individuals to interview. These pre-visits allowed researchers to construct a timeline of the science program, identify critical events in the life of the program, and identify major players both inside and outside the district. This initial contact also included discussions of logistical issues (e.g., timing for site visits), potential schools and classrooms to visit, and tentative scheduling of individuals to interview on-site.

Following the pre-visit, site visits typically consisted of interviews with key district personnel including the superintendent, assistant superintendent, assessment specialist, director of professional development, director of curriculum and instruction, budget manager, science coordinator, Title I and Federal Grants administrators, mathematics and language arts subject matter coordinators, technology program director, and special education director. In addition, researchers conducted teacher focus groups as well as interviews with key stakeholders, such as school board members, union representatives, and community members. Researchers also conducted a minimum of 20 observations of science instruction in at least 10 schools and conducted interviews with the teachers observed and their principals. Researchers also observed professional development sessions and reviewed documents on-site.

Interview and Observation Protocols[2]

Interview protocols were designed to gain information about the goals/vision of the district science program, actual classroom practice, professional development, support for teaching science, sustainability of the district science program, and other key critical issues that had an impact on the science program or the district. Interview protocols were adapted to the individual/group being interviewed. The interviews also explored the factors an individual thought contributed to sustainability of the science program, what factors supported or jeopardized the program, and what they envisioned for the future of the district's science program. Individuals were also given the opportunity to discuss any other issues that they thought were relevant that the interview had not explored.

Researchers conducted observations of science classes to gain a clearer understanding of the current status of the district science program. The objective of an observation was to obtain a "snapshot" of instruction, to contribute to a larger understanding of the school district's practices and goals, and to document the use of hands-on investigation and/or inquiry methods of teaching science. Researchers normally observed an entire science class in grades K–6 that varied in length from approximately 30 minutes to an hour depending on the lesson. Researchers used a semi-structured observation protocol to document the structure of the lesson and capture the teacher's instructional strategies.

Principal and Teacher Surveys

Researchers administered two surveys: the first to all principals in each of eight district sites and the second to a random sample of 100 teachers in each of the eight district sites[3]. The purpose of the surveys was to supplement the qualitative findings of the study by providing additional data on the current status of the program.

2 For a list of interviews and observations conducted at this site, see Appendix A.

3 One district, Montview, chose to abstain from participation in the survey.

These data may not accurately reflect actual districtwide practice. (For a summary of the survey data, see Appendix B.) Survey development followed a three-step process: (1) Researchers conducted a review of other similar instruments; (2) surveys were piloted and interviews were conducted with pilot participants; and (3) a survey expert reviewed the surveys and provided feedback so final revisions could be made.

The surveys provided corroboration of qualitative data and helped guide future qualitative data gathering. They were designed to answer the following questions: (1) What are the respondents' understandings of the current science program? (2) What importance do respondents place upon the science program and what priority does it get within the other areas? (3) What are the respondents doing to implement/support the science program? (4) What factors are important in sustaining an effective science program? The surveys included items about teacher/principal background and experience, school instructional practice, curriculum and materials, professional development, principal practice, teacher classroom practice, influences on science, support for science, and sustainability of science.

For more detailed information about the methodology of this project, please refer to the cross-site report.

OVERVIEW OF PROJECT SITES

	GLENWOOD*	LAKEVILLE	HUDSON††	MONTVIEW‡	BAYVIEW	GARDEN CITY	SYCAMORE	BENTON	BOLTON
SIZE									
Sq. Miles	47†	76	200	800	55	800	25	15	320
# elem. students	27,000	12,000	43,151	47,087	5,849	28,000	6,400	4,300	27,000
# elem. schools	77	23	50	92	23	52	30	15	60
# elem. classroom teachers	1,300	778	1,630	1,978	600	1,300	300	200	1,144
RESOURCES									
Per pupil expenditure	5,668	4,996	5,122	4,443	5,973	5,046	6,500	13,296	6,508
Teacher starting salary	$31,172	$35,573	$27,686	$25,832	$27,467	$27,718	$29,892	$34,116	$32,600
NSF funds?	yes	yes	yes	no	no	no	no	yes	yes
DEMOGRAPHICS									
% students eligible for free and reduced price lunch	66%	70%	41%	18%	40%	32%	65%	39%	30%
% white	13	17	68	85	57	69	69	41	62
% African American	18	34	3	1	12	28	12	34	9
% Hispanic	21	45	23	11	10	0	11	14	6
% Asian/Pacific Islander	27 (Chinese)	4	2	3	18	0	8	10	9
% Native American	21	0	4	0	3	0	0	0	13
% Other	0	0	0	0	0	3	0	1	1
OTHER INFORMATION									
Year program began	1989	1986	1974	1968	1966	1989	1988	1994	1977

* District names are pseudonyms.
† Figures are for years ranging from 1998–2000. During this time demographics and expenditures shifted and were calculated in a variety of ways.
†† The Hudson site report offers the reader an additional detailed description of a classroom science lesson.
‡ The Montview site report is unique in that it emphasizes the historical development of the program and the circumstances that influenced and shaped its evolution.

LAKEVILLE
EXECUTIVE SUMMARY

INTRODUCTION

The Lakeville Community School District (LCSD)[1] K–6 elementary science program, known as Science the Hands-On Way (SHOW), is among the best known in the country. SHOW was launched in the late 1980s, and drew upon lessons from the top hands-on science programs in the United States. The program also established some new standards of practice, many of which were eventually adopted in other districts with the assistance of its institutional partner at Grossen University (GU), called the GU Science Outreach (GUSO). The use of volunteer scientists, a full menu of teacher professional development (ranging from initial kit trainings to science content explorations), the use of science notebooks, and the parent and stakeholder educational activities all distinguished the Lakeville program through the 1990s. The program was remarkable, also, for simply having succeeded in a district where the majority of students come from economically disadvantaged backgrounds, and during a period of severe fiscal uncertainty in the state.

SHOW received National Science Foundation (NSF) funding from 1990–1997 to support the use of resource teachers in the classroom, districtwide professional development, kit development, and the expansion of the SHOW program across the district. Since the conclusion of NSF financial support, SHOW has struggled to regain sure financial footing. Tight budgets have precipitated a winnowing-away of the science staff, classroom supports, and professional development at a time when high teacher turnover necessitates these services more than ever. Increased emphasis on monitoring of school performance at the state level has resulted in changes in the state science frameworks, and has created uncertainty among some about the value of a hands-on science program. After an unpleasant battle with and within the school board in 2000, supplemental elementary science textbooks were introduced in the district in the 2001–02 school year, portending an uncertain future for SHOW. Lakeville demonstrates a sobering truth—that even a strong program such as SHOW can become vulnerable after years of success.

CONTEXT

Community Overview

LCSD is a medium-sized district, with 23 elementary schools, and 5 middle and high schools. The 76-square-mile district includes not only the city of

1 Any individual, organization, or corporation named in this report has been given a pseudonym.

Lakeville, but also two neighboring communities. Nearly 14,000 students were enrolled in grades K–6 in 2000–2001, a number that has been steadily increasing over the past decade. Culturally and linguistically diverse students comprise the vast majority of the school populations, with 45 percent Hispanic, 34 percent African American, 17 percent white, and 4 percent Asian, Pacific Islander, or other. Family income levels vary widely, and a large percentage of those with higher incomes send their children to private schools. As a consequence, the majority of elementary students in LCSD come from low- and middle-income homes, with nearly three-quarters eligible for free or reduced lunch.

Budget

Like many other school districts highly dependent upon state funding, LCSD suffered budget cuts and salary freezes for an extended period during the 1980s, and has only recently begun to recover. Central administrators suggest that they still offer competitive salaries and benefits to compete with neighboring districts in spite of additional pressures their neighboring counterparts do not have. LCSD now sees itself in a period of slow recovery, partly due to vigorous efforts to acquire external grants and donations. Per pupil expenditures rose from $5,764 in 1998–99 to $7,003 in 2000–01, an increase of 21 percent.

Issues of Local Importance

Turnover in Leadership: In addition to its budget woes, LCSD has struggled through a series of changes in leadership. Not only have individual deputy and assistant superintendents come and gone, but the numbers and roles of the central administrative structure have been altered by shifting leadership at the top. Difficulties in the area of curriculum and instruction have been further complicated by not having a deputy or assistant superintendent position.

Crisis in Public Confidence: The recent instability of the school district has exacerbated a crisis in public confidence in the school board. In 1999–2000, the board argued about whether to adopt the district-based science frameworks or the state science frameworks. Although the board ultimately voted to keep the district science frameworks, they passed a resolution that allowed textbooks to be used as supplements to the kit-based program. While this incident illustrated the community's strong commitment to the program, it was in some ways a hollow victory, since the acceptance of texts into the program placed opponents one step closer to undermining the program's core philosophy.

PROGRAM HISTORY AND DEVELOPMENT

Early Years

In 1981, Spencer LaBel, a professor of biology at GU and a resident of Lakeville, was concerned about the quality of the science program. LaBel approached Geronimo Diaz, another professor at GU who had been involved in elementary science reform. Together they decided to look at how they might revamp the district's elementary science program. They knew that they wanted children to learn science not from a textbook, but from hands-on experience. Their plan involved developing an inquiry-based curriculum and beginning by trying to implement it at a single school.

At Horace Mann Elementary School (the pilot school), Paige Wolters, a "hot shot" language arts teacher who had been on sabbatical during the 1983–84 school year, was recruited for the position of school improvement coordinator. The position emphasized science, and although science was not her area of expertise, Wolters stepped in with her usual commitment. Her science room became known as the "Mann School Discovery Room."

By the end of the first year, the program leaders had fashioned a pilot school model that could be replicated in the other schools and would eventually be adapted in other districts. The elements of the model included a pilot school coordinator, pioneer teachers (at least one teacher per grade level at the school who agreed to pilot the kits), kits and training sessions, an associated GU scientist, and an experienced Mann teacher who had taught the kit twice, known as the lead teacher.

The program expanded to five new schools geographically spread across the community, a few of which were among those having the lowest test scores in the district. The administration believed that success in these schools would build a stronger case for scaling up across the remaining schools. Elementary curriculum and textbook funds paid for science materials, and Eisenhower money was used for most of the initial kit trainings. The administrative support from the district was strong, not only in terms of providing key financial resources, but also in enabling Wolters to move from a "school improvement teacher" at the Mann school to a districtwide "teacher on special assignment," serving as the K–6 science resource support person and program coordinator.

Second Generation

Between 1985 and 1990, LaBel and Diaz secured grants from Community Bank, NASA, the Sloan Foundation, and the state's Eisenhower funds. Then, in January 1990, LCSD administrators and GU scientists collaborated on a proposal to NSF, and Lakeville won a $694,000 grant. The grant funded the expansion of the scaled down program to the districtwide pro-

gram now known as SHOW. Additional resource teachers and support staff were hired for the 1990–91 school year and, soon thereafter, two positions related to kit assembly were ensured. Between 1990–94, the program expanded first to 10 schools and then eventually to all 23. Thereafter, the program began to get attention outside of LCSD. This public success brought much-needed pride and credibility to the district, but planted seeds of internal resentment.

Recent Developments

With the conclusion of the NSF grant in 1997, the SHOW program has struggled to maintain its services in an atmosphere of reduced financial and political support. The district has been able to produce only limited support for the resource teachers and professional development. A series of rancorous board meetings in 2001 challenged the district science standards and program for the first time, resulting in the initiation of a textbook adoption process that was concluded with the addition of textbooks for the science program for grades 4–8.

THE CURRENT PROGRAM

Curriculum

The SHOW program involves a core group of four units, or kits, per grade level K–6. Each grade has one kit from each of four strands: physical science, life science, earth and space science, and science and technology. Unifying themes, such as the diversity of living things or form and function, are reinforced across grade levels. For each unit, the program articulates what LCSD refers to as themes, unifying concepts, and grade-level concepts. Moreover, the LCSD science standard framework is used to elaborate on the activities, skills, and understandings associated with each unit. The science standards relate to scientific tools and technologies, earth and space science concepts, physical science concepts, scientific connections and applications, scientific investigations and experimentation, and scientific communication. The framework guides are detailed and thoughtful, and conclude with connections to language arts and mathematics and suggested methods of assessment.

Materials Center

The materials center is housed at the SHOW office, which is attached to the district warehouse. The 1,220 SHOW kits are now part of the existing district delivery system. During the NSF period there were two kit refurbishers, but now there is only one. This person's responsibilities include keeping an inventory of materials, assembling the kits, preparing guidelines for kit use, and getting re-stocked kits ready for delivery.

Science Notebooks

Science notebooks have been used in SHOW from the very beginning. Notebooks are used as scientists use them—to record questions, procedures, data and observations, what happened, and next steps. Moreover, the notebooks are a resource for report writing. The science notebooks are a key link to the literacy priorities of the district, and the department works diligently to connect the notebooks to reinforcement of writing skills. This connection is so compelling, and the literacy movement so universal in the United States, that Lakeville has exported its knowledge of science notebooks to other districts.

Alignment with State Standards

The Lakeville Board of Education approves the subject standards for LCSD, which are required to be aligned with state standards. This alignment was originally close, but recent revisions focused the state standards more on content, rote learning, and traditional textbooks. In contrast, the LCSD science standards are aligned with the national standards that emphasize content and process skills, the scientific method, and higher level thinking skills.

Instruction

Many teachers believe that students learn better by doing and, thus, like the hands-on and discovery-oriented approach of the kits. Some teachers, however, believe that this kind of learning should not be the exclusive way that students learn science—that there was a place for the content learning from text-based resources. "Books give content and the kits give experience," said one teacher.

Teachers' goals for their science classrooms are generally aligned with those of the science department, although they are more fragmented. One educator said that she wants her students to understand scientific content and concepts through seeing and doing it themselves. Another appreciated that SHOW enables all children to be successful in some way, to work in groups towards a common goal, and builds on the student's prior knowledge. Another teacher felt that students should be engaged in exploration, critical thinking, and the scientific process.

Assessment

The district does not have a formal assessment process for science at the elementary levels. Students are assessed in reading, writing, spelling, and math annually in grades 3–9 with the Stanford 9 (SAT9) test, which is administered in May. In addition, some students with limited English proficiency are tested in Spanish with the Spanish Assessment of Basic Education (SABE/2). Science is included in the SAT9 test in grade 9.

The SHOW guide proposes that teachers assess student work by using the science lab notebooks and performance assessments. The guides recommend that the notebooks be used to examine students' mastery of concepts and content, their investigations, interpretations, and conclusions. Teachers say they use the notebooks in a variety of ways, and those who rely heavily on them for grading are articulate about their criteria, including the thoroughness of observational notes and the clarity of conclusions.

Proposed performance assessments include embedded and end-of-unit assessments, class discussions, project-based work, and presentations of work. Teachers select which assessments they want to use. One science resource teacher pointed out that teachers will need training in the use of these, but budget cuts have made that impossible.

Professional Development

During the period of NSF funding, professional development for teachers was rich and varied, reinforcing the key themes of hands-on science and the inquiry process. It included mandatory in-service trainings for the teachers and their principals through a two-week summer academy, release days (with substitutes), and weekend trainings, for a total of 13 days per teacher. Teachers did not receive kits until they were trained. This staff development was reinforced through classroom visits and supports from the four science resource teachers. Lead teachers still speak nostalgically about the training they received. A key trainer at the PDC says that SHOW was the premier training model for the district because the coordinators organized the initial in-service, follow-up supports, and opportunities for teachers to talk about their classroom practice.

Kit trainings have retained their original model and, whenever possible, are co-led by teachers and a GU scientist. Over 100 volunteers from GU and the local scientific community work with LCSD. In the past, SHOW had conducted kit trainings four times a year, during which teachers could receive training in any of 28 science kits. Unfortunately, this model has disintegrated in the past year with the loss of funding. Volunteer scientists are not always well recruited, as the scientist liaison is no longer paid for this effort, and the SHOW coordinator must make these arrangements via e-mail in her spare time.

DECISION MAKING AND LEADERSHIP

District-Level Decisions

Administrators and the school board have long supported the SHOW program, although the main leaders from the outset have been from GU and a team that included Wolters and other key resource and lead teachers. Wolters' central role cannot be overemphasized, especially when one con-

siders that she has had eight bosses between 1990 and 2001. Save one, no assistant superintendent has actively encouraged the teaching of elementary science with LCSD principals. This impediment between the science department and central administrators can be explained to some degree by the different levels of expectations that each holds for the SHOW program, and what each is willing to live with.

School-Level Decisions

SHOW leaders always have understood the importance of a principal's support in ensuring that science is taught in individual schools. The principals remain key to the SHOW program, but it is a challenge to keep them aware and involved in the program. Wolters tries to keep principals updated on national trends and the link between science and other curricular priorities through the principals' regular district meetings; however turnover among principals in recent years has diminished school-level support.

Science Coordinator & GU Decisions

Wolters' talents as a trainer, manager, thinker, and advocate within the district have been central to the evolution of SHOW and its current status. She has remained committed to the program and the district in the difficult period following the loss of NSF funding. Without Wolters, everyone agreed that the future of the program would be jeopardized.

The leadership of GU/GUSO co-directors Spencer LaBel and Geronimo Diaz has been central to the program. The strength and resilience of their vision was evident throughout the evolution of the program and during its political and financial upheavals. The two have supported Wolters in her struggles to maintain the program and her staff, helped fundraise, raised the profile of the SHOW program into a nationally recognized program, and offered ongoing moral support to district supporters.

RESOURCES AND SUPPORT

FUNDING

When the NSF grant ended, the district took on the cost of two resource teachers and a limited amount of the training (partly through Eisenhower monies). The district has always paid the science coordinator, but until 1998, this was a "teacher on special assignment." Only recently was the position changed to an administrative one. The district has also always paid for one kit builder/media assistant, one clerical typist, and for kit refurbishment.

The overall science budget for 2000–01 was $415,000, including salaries for six people, instructional monies, and learning materials. Money coming through the district originates in the operational budget as well as external

grants, or in fundraising done by the Lakeville Educational Foundation. Nearly 30 percent was obtained through external sources by the foundation in 2000–01. GUSO has pursued funding in concert with LCSD, but has been the fiduciary agent in grants such as those given by NSF.

Community and Partnerships

Central administrators in Lakeville uniformly express their appreciation for GU support, and their central role in promoting hands-on elementary science. They also feel that GUSO and the district need to work on their relationship, as there have been challenging times in their collaboration. A former school board member and supporter of SHOW said, "There has been some pain in it for both sides, like a good marriage."

ACCOUNTABILITY

Although there are mechanisms in place for student accountability in the district, the SHOW program has historically relied on resource teachers and school principals to informally monitor the program and offer incentives for educators to use the kits. During the NSF period, this "soft" accountability was complemented by mandatory districtwide staff development in science. In the early period, when the SHOW program was being introduced, considerable attention was paid to science, and care was taken to see which teachers were using the kits so that they could be targeted for assistance. However, in 2001, competing district priorities suggested that science was being taught less, but there was no direct evidence.

EQUAL ACCESS TO SCIENCE

One of the great strengths of the elementary science program is that it has been recognized as delivering a standardized program to all students throughout LCSD. During the NSF period, all teachers were required to attend trainings and implement the kits. Even though there was not clear accountability for this initial implementation, teachers received extensive support in terms of access to trainings and materials, classroom-based supports, and expectations that the kits would be taught. Many members of the community testified at the June 13, 2000 board meeting, and emphasized the deep impact of SHOW on LCSD's poor students and culturally and linguistically diverse (CLD) children. Principals from schools with large populations of CLD students expressed their support for the program and the fact that students with little science influence at home are now articulating an interest at the Mann School.

SUMMARY

The Lakeville program has endured a 15-year roller coaster ride of support from the initiation of the partnership with GU in 1985 to the 2000 challenge from the school board. At the beginning and into its maturation, the program enjoyed commitment from sources internal to and external from the district, and a steady stream of large and small external grants complemented by modest district commitments. Later, it felt the impact of the loss of support through the reduction of funding for science program staff but, more importantly, through the departure of the assistant superintendent who had been a strong advocate and source of stability. And through it all, the GU leaders, Diaz and LaBel with their colleague and friend Wolters, worked to promote and grow the program while responding to the expected and unexpected challenges that inevitably arose.

Now the program rests in uncertainty. In the wake of the school board challenge, the district adopted supplemental texts that some view as contrary to the program's intent, leaving key leaders frustrated and disillusioned. They had successfully navigated the program through the turbulence of changing funding, leadership, and curricular priorities, but found that a single factor—accountability—could pose a serious threat to the program's future. They also found that data on the impact of the program was necessary, not only for their own decision making, but also to help them effectively represent it to others.

Looking back, program leaders could not have predicted many of the challenges that the program endured or the supports that emerged to strengthen it. There may, yet again, be unexpected supports that will reinforce the program's foundation and enable it to weather the next 15 years of district change. Sometimes a program's sustainability is only evident with hindsight.

LAKEVILLE

INTRODUCTION

The Lakeville Community School District (LCSD)[1] K–6 elementary science program, known as Science the Hands-On Way (SHOW), is among the best known in the country. SHOW was launched in the late 1980s, and drew upon lessons from the top hands-on science programs in the U.S. The program also established some new standards of practice, many of which were eventually adopted in other districts with the assistance of its institutional partner at Grossen University (GU), called the GU Science Outreach (GUSO). The use of volunteer scientists, a full menu of teacher professional development (ranging from initial kit trainings to science content explorations), the use of science notebooks, and the parent and stakeholder educational activities all distinguished the Lakeville program through the 1990s. The program was remarkable, also, for simply having succeeded in a district where the majority of students come from economically disadvantaged backgrounds, and during a period of severe fiscal uncertainty in the state.

SUSTAINABILITY: THE ABILITY OF A PROGRAM TO MAINTAIN ITS CORE BELIEFS AND VALUES AND USE THEM TO GUIDE PROGRAM ADAPTATIONS TO CHANGES AND PRESSURES OVER TIME.

SHOW received National Science Foundation (NSF) funding from 1990–1997 to support the use of resource teachers in the classroom, districtwide professional development, kit development, and the expansion of the SHOW program across the district. Since the conclusion of NSF financial support, SHOW has struggled to regain sure financial footing. Tight budgets have precipitated a winnowing-away of the science staff, classroom supports, and professional development at a time when high teacher turnover necessitates these services more than ever. Increased emphasis on monitoring of school performance at the state level has resulted in changes in the state science frameworks, and created uncertainty among some about the value of a hands-on science program. After an unpleasant battle with and within the school board in 2000, supplemental elementary science textbooks were introduced in the district in the 2001–2002 school year, portending an uncertain future for SHOW.

Lakeville demonstrates a sobering truth that even a strong program such as SHOW can become vulnerable after years of success.

CONTEXT

Community Overview

Lakeville is located on the outskirts of the downtown area of a major U.S. city. The cultural tapestry is rich. Within its population of 125,000, one can

1 Any individual, organization, or corporation named in this report has been given a pseudonym.

SIZE	
Sq. miles	76
# elem. students	12,000
# elem. schools	23
# elem. classroom teachers	778
RESOURCES	
Per pupil expenditure	4,996
Teacher starting salary	$35,573
NSF funds?	yes
DEMOGRAPHICS	
% students eligible for free/reduced price lunch	70%
% white	17
% African American	34
% Hispanic	45
% Asian/Pacific Islander	4
% Native American	0
% Other	0
YEAR CURRENT PROGRAM BEGAN	1986

Figures are for years ranging from 1998–2000. During this time demographics and expenditures shifted and were calculated in a variety of ways.

find neighborhoods rich in Hispanic, African American, Armenian, Anglo, and Asian culture. The district has upscale neighborhoods, public housing, and most everything in between. These contrasts are part of the charm of the city, but also part of the challenge to public education.

Family income levels vary widely, and a large percentage of those with higher incomes send their children to private schools. As a consequence, the majority of elementary students in LCSD come from low- and middle-income homes, with nearly three-quarters eligible for free or reduced lunch. A former LCSD administrator said that 72 percent of the students in the system live on one-third of the land in Lakeville.

LCSD is a medium-sized district, with 23 elementary schools, 5 middle schools, and 3 high schools. The 76-square-mile district includes not only the city of Lakeville, but also two neighboring communities.[2] Nearly 14,000 students were enrolled in grades K–6 in 2000–2001, a number that has been steadily increasing over the last decade. Of these, nearly one-third is receiving English as Second Language instruction. Over 25 different languages are spoken among students' families. Culturally and linguistically diverse students comprise the vast majority of the school populations, with 45 percent Hispanic, 34 percent African American, 17 percent white, and 4 percent Asian, Pacific Islander, or other. In the schools that are predominantly Hispanic, bilingual education and literacy issues are a main focus of the curriculum. The State Department of Education has taken a strong hand in promoting basic literacy and math skills through state frameworks and regular testing, and bilingual Spanish classrooms have become nearly extinct in the district.

Like many other school districts highly dependent upon state funding, LCSD suffered budget cuts and salary freezes for an extended period during the 1980s, and has only recently begun to recover. Central administrators suggest that they still offer competitive salaries and benefits to compete with neighboring districts in spite of additional pressures their neighboring counterparts do not have. In 2000–2001, the district spent more than $1 million on security-related services. LCSD also has a large nursing staff and a large special education program.

Pressures to find qualified teachers have continued to mount for the district. In recent years, the state passed legislation that reduced class sizes to 20 in grades K–3. As a result, a significant portion of the newly hired staff are uncredentialed or beginning teachers; 25 percent of new hires were "emergency credentialed" in 1998–1999, and approximately 35 percent in 2000–2001. Further, annual teacher turnover rates in recent years have been high and many teachers have been transferred to new grade levels. As a

2 Unless otherwise noted, "Lakeville" will refer not to the city but to the district incorporating Lakeville and its neighboring communities.

result, as many as 250 of the 823 elementary teachers each year require training because they are new to the curriculum taught at their grade level.

Budget

LCSD's financial woes began in the 1970s when the state went into receivership; this was followed by a statewide recession during the 1980s. During this period of extended financial stress, the district's plight grew progressively worse. At first, the state was unable to increase its contributions to districts and, eventually, the state was not even able to transfer the amounts already designated for the districts. (For example, a district might receive only $4,000 of the $4,300 promised in state contributions.) Districts all over the state tightened their budgets and lived with shortages deep into the 1990s.

In Lakeville, the timing of the NSF grant was fortuitous, given the fiscal problems of the state. At that time, science was the only subject area that had a central coordinator, as it was required by the grant. The initial NSF grant of nearly $700,000 arrived in 1990, and with it came the opportunity to hire various support staff.

LCSD now sees itself in a period of slow recovery, partly due to vigorous efforts to acquire external grants and donations. Per pupil expenditures rose from $5,764 in 1998–1999 to $7,003 in 2000–2001, an increase of 21 percent. The success of the Lakeville Educational Foundation, the fundraising arm of the district, has ensured that some basic general education services are supported. Partnerships like those with GUSO at Grossen University, which bring in both technical expertise and resources, continue to be essential for introducing innovation and reform.

Issues of Local Importance

Turnover in Leadership: In addition to its budget woes, LCSD has struggled through a series of changes in central office leadership. After six years of a stable superintendency in the first part of the 1990s (the period of the NSF grant), a new superintendent joined the district in 1996. She left after three years and was replaced by an interim superintendent (the board of education was unable to select a successor). This person stayed until the beginning of the 2001–2002 school year.

Turnover has had an impact on other central office positions as well. The science coordinator had had nine supervisors in 11 years. There were eight business officers in five years. Not only have individual deputy and assistant superintendents come and gone, but the numbers and roles of the central administrative structure have been altered by shifting leadership at the top. Difficulties in the area of curriculum and instruction have been further complicated by not having a deputy or assistant superintendent position.

Turnover has also disrupted the schools as the movement of principals and teachers poses new challenges. With one-quarter of new hires receiving

emergency credentialing in recent years, teacher quality is an ongoing concern. In the late 1990s, the district established a Professional Development Center (PDC) with staff who work closely with a credit-granting organization, Saint Maximilian State University. Together, they assist educators in their progression from pre-intern to credentialed teacher status.

Crisis in Public Confidence: The recent instability of the school district has exacerbated a crisis in public confidence in the school board. In 1998, the city established the Reform Task Force to explore a ballot movement to reform the city charter. Issues included allowing the mayor to be elected citywide and changing the election process for the school board members. Instead of dealing with governance, the task force ended up being, as one former board member remarked, an "inquisition" on how the whole school district functioned.

One outcome of this district turbulence was the establishment of a Task Force on Education. This task force included 12 representative stakeholders who worked together to create a report entitled, "Quality Now!" This report scrutinized school board operations, recommended publishing annual reports for the public, and suggested enlarging the board from five to seven members. Four out of the seven board members were newly elected in March 2001. The public also supported two other recommendations: a curriculum audit and a management audit. This progression of accountability reports has prolonged the unsettled atmosphere and has fed into the ongoing power and political struggles.

One such struggle focused on the science program in 1999–2000, when the board argued about whether to adopt the district-based science frameworks or the state science frameworks. (See "Alignment with state standards" section.) Although the board ultimately voted to keep the district science frameworks, they passed a resolution that allowed textbooks to be used as supplements to the kit-based program. While this incident illustrated the community's strong commitment to the program, it was in some ways a hollow victory, since the acceptance of texts into the program placed opponents one step closer to undermining the program's core philosophy.

PROGRAM HISTORY AND DEVELOPMENT[3]

Early Years

The SHOW program's origins are humble, resting with two individuals who had a simple, good idea. In 1981, Spencer LaBel, a professor of biology at GU and a resident of Lakeville, had a child entering the school system.

3 For a timeline of this site's history, see Appendix C.

Concerned about the quality of the science program, LaBel approached Geronimo Diaz, another professor at GU who had been involved in elementary science reform. Diaz knew the "movers and shakers" of the science reform effort and, at that time, was working with a middle school program that brought district students to GU. Together they decided to look at how they might revamp the district's elementary science program. They knew that they wanted children to learn science not from a textbook, but from doing it—just as graduate students at GU learned by working in the lab as scientists. Their plan involved developing an inquiry-based curriculum and beginning by trying to implement it in a single school.

Emboldened with their core idea, the GU professors went about learning what like-minded educators were doing in other districts. In 1985, Diaz attended the kick-off conference of the National Science Resource Center. The center was funded by the National Academy for the Sciences and the Smithsonian Institute, and its mission was to promote inquiry-based science curriculum. While there, Diaz reconnected with science reformers and learned of five districts that had kit-based science programs. In the months following the NSRC meeting, he and LaBel visited four of the districts and began to forge connections with administrators at LCSD. LaBel met with the superintendent and the district science coordinator, who suggested that they develop a pilot program at the Horace Mann Elementary School. The president of GU donated $25,000 to launch the effort.

At the pilot school, Paige Wolters, a "hot shot" language arts teacher who had been on sabbatical during the 1983–1984 school year, had been recruited for the position of school improvement coordinator. Though science was not her area of expertise, the position emphasized science so Wolters stepped in with her usual commitment. Her science room became known as the "Mann School Discovery Room."

The work at this school and the team that developed became the driving force for the reform of the district's elementary science program.

As the work got underway, Wolters, Diaz, and LaBel visited Mesa, Ariz., a district nationally recognized for its excellent science program, to investigate its kit-based science program. There, the director of the program gave them some key advice: Science educators need teaching materials and professional development. One of their staff developers came to Lakeville and presented the kit program to the pilot school teachers. Twenty-one of the 23 Mann schoolteachers expressed their support and agreed to teach one unit in their classrooms. The work at this school and the team that developed became the driving force for the reform of the district's elementary science program. Wolters, Diaz, and LaBel agreed to use funds that would have gone to purchase kits that supplemented the textbooks to instead purchase 24 units from Mesa. There were enough kits for each grade K–5 at the Mann school to have four kits per year. The remaining funds were used to support other aspects of the pilot program.

The pilot program at the Mann School officially lasted for three years. In the first few months of the fall of 1986, LaBel and 10 graduate students and post-doctoral fellows offered kit trainings to Mann teachers. The teachers were "continually raising questions and expanding their knowledge about content and about using inquiry-based teaching approaches with elementary students."[4] Then, in the spring of 1987, the Mann teachers began to use the kits in their classrooms. Through the following school year, the teachers taught kit lessons, and felt that the kits had a positive impact on their students.

By the end of the first year, the program leaders had fashioned a pilot school model that could be replicated in the other schools.

By the end of the first year, the program leaders had fashioned a pilot school model that could be replicated in the other schools and would eventually be adapted in other districts. The elements of the model included a pilot school coordinator, pioneer teachers (at least one teacher per grade level at the school who agreed to pilot the kits), kits and training sessions, an associated GU scientist, and an experienced Mann teacher who had taught the kit twice, known as the lead teacher.

The program was poised to expand. Diaz and LaBel agreed to write proposals to NSF, and the district provided funds for the immediate expansion to other schools. The program expanded to five new schools geographically spread across the community, a few of which were among those having the lowest test scores in the district. The administration believed that success in these schools would build a stronger case for scaling up across the remaining schools. Elementary curriculum and textbook funds paid for science materials, and Eisenhower money was used for most of the initial kit trainings. The administrative support from the district was strong, not only in terms of providing key financial resources, but also in enabling Wolters to move from a "school improvement teacher" at the Mann school to a districtwide "teacher on special assignment" serving as the K–6 science resource support person and program coordinator.

Wolters was now the de facto science coordinator, and she oversaw the expansion of the pilot program. The new effort began with one teacher per grade level, each of whom piloted one unit. At the district level, the leadership team was in place, including the districtwide science resource support person, associate superintendent, GU scientists, and one Mann teacher.[5]

In the spring of 1990, Wolters, Mann schoolteachers, and GU scientists focused on providing kit trainings in the five new schools. Professional development through a summer academy was supplemented by in-service and classroom support during the school year. Principals from across the district also were involved in mandatory monthly trainings.

4 Inverness Research Associates, "A Brief History of the [Lakeville Community School District's SHOW] Program," report to [Lakeville] Center Leadership Teams, January 21, 2000, p. 4.

5 Ibid., pp. 2, 5.

A post-doctoral researcher in LaBel's lab at GU volunteered to recruit and coordinate "science trainers" among graduate students and post-docs to work on professional development. The selection process was key, since they wanted people who could relate well to teachers, and who also would allow teachers to retain control of the classrooms. This person, the scientist liaison, and Wolters developed a three-hour training program.

One teacher per grade level at the five new pilot schools began teaching the kits, and the science coordinator or a new resource teacher visited every school one day per week, "dissect[ing] the various elements of the lesson, noting its successes as well as those places where the teaching might have gone differently, or where further questioning or modeling might have deepened students' thinking."[6] Principals were (and remain) responsible for monitoring teachers' implementation of district curricular priorities; so after visiting teachers, the resource teachers would meet with the principal and review the visit. After the spring experiences, these pilot teachers agreed to carry on the following year, and a few of these pioneer teachers began to train their grade-level peers.

Second Generation

Between 1985 and 1990, LaBel and Diaz secured grants from Community Bank, NASA, the Sloan Foundation, and the state's Eisenhower funds. Then, in January 1990, LCSD administrators and GU scientists collaborated on a proposal to NSF, and Lakeville won a $694,000 grant. Diaz noted that the districtwide grant they received was "before the LSCs [Local Systemic Change grants, a program supported by NSF] were invented" and that the LSCs were developed, in part, because of Lakeville's successful demonstration of the importance of extensive professional development and other support systems. The Lakeville NSF program officer wrote the program announcement.

The grant funded the expansion of the scaled down program to the districtwide program now known as Science the Hands-On Way (SHOW). Additional resource teachers and support staff were hired for the 1990–1991 school year and, soon thereafter, two positions related to kit assembly were assured. Between 1990 and 1994, the program expanded first to 10 schools and then eventually to all 23.

In each cohort of new schools to join the program, SHOW worked first with volunteer teachers, and then involved all teachers in the school. This took place over a four-year period, when the program became mandatory. Resource teachers (RT) operated like "coaches," doing demonstration lessons, coaxing, sharing articles, and assisting teachers. In some cases, the RTs also gave feedback to principals on teacher performance. It was a pleasant

6 Inverness Research Associates, "A Brief History of the [Lakeville Community School District's SHOW] Program," report to [Lakeville] Center Leadership Teams, January 21, 2000, p. 6.

experience for teachers, who received RT support in the classroom and were paid to attend the summer academy and other professional development activities. SHOW also enabled vertical grade-level articulation—building on key concepts from grade to grade—which normally did not happen in the district. Reflecting on these times, an RT commented, "It was different—a different role for teachers," and both teachers and students generally found the hands-on approach to be an engaging learning process.

"It was different—a different role for teachers."

NSF extended the grant, originally written for four years, to six years with supplements for evaluation, in-service support, and expansion to the sixth grade. The award eventually totaled over $1 million. The K–5 program moved into sixth grade at the elementary schools, and then an additional three-year grant was added to help the middle schools develop a curriculum and professional development similar to the elementary program. An Eisenhower grant focusing on assessment was also procured.

The assistant superintendent for instruction became an ardent supporter of the program.

The assistant superintendent for instruction became an ardent supporter of the program, with its focus on teacher enhancement. A core leadership team, including the assistant superintendent, Wolters, and GUSO leaders, would shepherd the SHOW program through the district in the ensuing years. The assistant superintendent earmarked $50,000 in additional monies each year to support kit refurbishment for SHOW. He also procured space for the materials center.

The program began to get attention outside of LCSD. This public success was a mixed blessing. It brought much-needed pride and credibility to the district, but planted seeds of internal resentment. According to a recent assistant superintendent, the attention and support for the science program began to irk non-science teachers. All the Eisenhower monies were going to science, with no support for RTs in either math or reading. At the same time, the superintendent and the supportive assistant superintendent left the district, leaving the program without an advocate within central administration. Although the GU partnership brought interest and credibility to the program, the district's growing dependency upon GUSO inadvertently forestalled other institutional partnerships that would have diversified SHOW's support across the Lakeville community.

This public success was a mixed blessing. It brought much-needed pride and credibility to the district, but planted seeds of internal resentment.

Recent Developments

With the conclusion of the NSF grant in 1997, the SHOW program has struggled to maintain its services in an atmosphere of reduced financial and political support. The district has been able to produce only limited support for the RTs and professional development. A series of rancorous board meetings in 2001 challenged the district science standards and program for the first time, resulting in the initiation of a textbook adoption process that was concluded with the addition of textbooks for the science program for grades 4–8. (See "Alignment with State Standards" section.) The value of the SHOW program was not questioned, but the quality of what is sustained remains unknown.

THE CURRENT PROGRAM

Curriculum[7]

The LCSD science program uses an inquiry-based approach to teaching elementary science. Students learn scientific concepts by repeating experiments performed by early scientists. The teacher becomes a facilitator, helping the students to understand what they believe and how they formed these opinions, and to question the evidence that supports these beliefs.[8]

The SHOW program involves a core group of four units, or kits, per grade level K–6. Each grade has one kit from each of four strands: physical science, life science, earth and space science, and science and technology. Unifying themes, such as the diversity of living things or form and function, are reinforced across grade levels. For each unit, the program articulates what LCSD refers to as themes, unifying concepts, and grade-level concepts. Moreover, the LCSD science standard framework is used to elaborate on the activities, skills, and understandings associated with each unit. The science standards relate to scientific tools and technologies, earth and space science concepts, physical science concepts, scientific connections and applications, scientific investigations and experimentation, and scientific communication. The framework guides are detailed and thoughtful, and conclude with connections to language arts and mathematics, and suggested methods of assessment.

The program model is unique in that it involves scientists in the training of teachers. When the program was fully staffed, there were four full-time science resource teachers available to support elementary teachers in an ongoing manner. These RTs provided an integral role, observing classes, supporting teachers, and providing other classroom assistance related to materials management. After the end of NSF funding, the district continued to support two of the four RTs for the elementary level.

The program model is unique in that it involves scientists in the training of teachers.

Wolters says that she would like teachers to teach science three times a week, and she believes this was the case in 1995. However, with increased state accountability for the demonstration of achievement in literacy and mathematics skills at the elementary level, it seems, based on observations of the science coordinator and her staff, that the amount of science taught has decreased. Those teachers responding to the survey administered as part of this research project collectively averaged about an hour and a half per week on science. About half reported frequent use of science-related literature and nonfiction books, and although just about three-quarters of the respondents recognize that they are supposed to be teaching four kits a year, a little over half are able to do so, and less than a quarter finish the kits

7 For an overview of the curriculum units used at this site, see Appendix D.
8 From the parents' and teachers' guide to the LCSD science framework.

from start to finish. Half the teachers using kits reported that they are picking and choosing the parts they teach.

LCSD teachers receive clear messages from the district and their principals that literacy and math skills are of the highest priority at the elementary level. These subject areas are tested annually beginning in third grade. Statewide literacy testing has cast LCSD, with its high proportion of speakers with limited English proficiency, in a poor light. In 1999–2000, Lakeville high school juniors came in at the 29th percentile in reading and the 30th percentile in science, lower than students in the major city close to Lakeville.

A teacher's afternoon schedule must somehow include not only science, but also social studies, health, physical education, and any other subjects offered at the school.

The superintendent of LCSD during the 1996–1997 and 1999–2000 school years said that there is "very clear district leadership" regarding literacy, and that some schools may teach reading as much as 90 minutes of the day. More specifically, these subjects are expected to be taught before lunch. Thus, a teacher's afternoon schedule must somehow include not only science, but also social studies, health, physical education, and any other subjects offered at the school. These district priorities have been reflected in their hiring practices. In 1998–1999, four literacy coaches and a literacy program specialist were hired.

Materials Center

Until the SHOW program received NSF funding, Wolters patched together an informal system for kit assembly and delivery. Sometimes she assembled the kits herself (often with the assistance of college students), school bus drivers and/or support staff delivered them, and principals made sure that their teachers collected the kits. The NSF monies covered the cost of two staff people to assemble kits.

The materials center is housed at the SHOW office, which is attached to the district warehouse. The 1,220 SHOW kits are now part of the existing district delivery system. During the NSF period there were two kit refurbishers, but now there is only one. This person tracks informal kit use and shares this information with the RTs. Her other responsibilities include keeping an inventory of materials, assembling the kits, preparing guidelines for kit use, and getting re-stocked kits ready for delivery.

The science notebooks are a key link to the literacy priorities of the district.

Ideally, Wolters says, there should be one kit refurbisher for every 400 kits, or 4.36 staff people. She has been short-staffed and has received funds for work-study students to assist. In 2001, the materials center hired five part-time women from the "Welfare to Work" program, and students from a city-funded program for at-risk youth. Wolters uses textbook money to cover refurbishment costs, which totaled over $86,000 in 2000–2001.

Science Notebooks

Science notebooks have been used in SHOW from the very beginning. Notebooks are used as scientists use them—to record questions, procedures, data and observations, what happened, and next steps. Moreover, the

notebooks are a resource for report writing. The science notebooks are a key link to the literacy priorities of the district, and the department works diligently to connect the notebooks to reinforcement of writing skills. This connection is so compelling, and the literacy movement so universal in the U.S., that Lakeville has exported their knowledge of science notebooks to other districts.

Teachers value the notebooks, particularly when they are used for longer written pieces rather than as substitutes for worksheets. One English language development teacher, who works primarily in Spanish with her students, commented that she appreciated the use of science notebooks because, "Writing is good—it helps them remember what they have done."

The science department has also urged teachers to use the science notebooks as the basis for student grading and has provided them with rubrics. However, not all have done so. Some teachers did not grade the notebooks at all; others used them as a simple indication of participation; whereas others used the notebooks as the primary source for their grading.

Alignment with State Standards

The Lakeville Board of Education approves the subject standards for LCSD, which are required to be aligned with state standards. This alignment was originally close, but recent revisions focused the state standards more on content, rote learning, and traditional textbooks. In contrast, the LCSD science standards are aligned with the national standards that emphasize content and process skills, the scientific method, and higher level thinking skills. The LCSD standards also include a framework with support for teacher training and curriculum.

Until recently, the board of education had approved science, as well as other district standards, without discussion. But in 2000, an unusual drama played out in Lakeville that illustrates one way accountability plays a role in sustainability. A university professor—also a leader of a national conservative organization that fights the math standards and a parent of a former student in the district—challenged the district's science framework. His allies included two key school board members on the panel of five. The professor accused the SHOW approach as being non-rigorous and said that "doing hands-on science without teaching to read is sick."[9] He pointed out that Lakeville's high school juniors came in the 30th percentile in science in the 1999–2000 standardized tests. He also assailed a weak point of the SHOW program—that there was no hard research or data to demonstrate student learning. Another school board member said he was concerned that low test scores could cause the district to go into receivership.

Clay Boats

Third graders are seated on the floor, preparing to do a lesson on clay boats. The teacher does a quick review of the previous day's work, and presents the challenges for the day: How much "cargo" can the boats hold, and why are these amounts different? The children discuss this among themselves, and a few hands go up: "Big boats will carry more because they have more space." The children are instructed to take out their science notebooks and write down the question, as well as their predictions. The teacher uses the overhead projector to assist the students in writing the question and their predictions. "Write down how many paper clips, disks, or teddy bears that your boat will hold." She passes a small amount of each cargo to each table so that the children can feel how

9 This quotation is taken from an article on the LCSD science program published on May 25, 2000 in one of the newspapers of the major city close to Lakeville.

heavy each of these is and make a prediction. She walks around the room as children are writing, questioning them about their predictions. One girl offers that her boat will hold "more paper clips because they don't weigh as much." When the students have finished writing, they return to their boats to test their predictions.

The controversy expanded to reveal concerns about the partnership with GUSO and how, in some ways, that partnership was a burden to the sustainability of the program. Opponents claimed that GUSO had played too powerful a role in shaping the district's science program. Some raised questions about GUSO's financial self interest in promoting the Lakeville program, suggesting that GUSO had exploited their "experiment" with LCSD and developed a "sellable project" for their own gain. The atmosphere around the standards struggle was sour and demoralizing for the SHOW staff. These debates preceded a June 13, 2000 school board meeting at which the board had to decide whether to retain the LCSD standards or adopt the state standards. The assistant superintendent for instruction took a clear stand in support of the district standards. In a moving articulation of support for SHOW, 40 community members—students, teachers, parents, principals, and scientists—gathered before the board to express their personal stories in support of the program. The outpouring of support persuaded a key person on the board to change his position, and the district framework prevailed. A board member who had been a steadfast supporter of the program, called it "utterly astounding, wonderful, and moving…. It was what swayed the swing vote on the board. For me, it was worth all the hassle and diatribe." The meeting was reported on in a major U.S. newspaper in which Lakeville was lauded for refusing to be rolled over by the state standards. In Lakeville "…a school board has bucked the trend, voting defiantly last week to adopt its own science standards rather than the state's."[10]

In some ways, that partnership was a burden to the sustainability of the program.

Although the district science standards were retained, the board attached conditions: To ensure alignment of the district with state science content standards, the science department must review textbooks that could become part of the content standards in grades 4–12, as well as science assessment. The assistant superintendent for instruction recommended this measure.

In 2000–2001, LCSD initiated a textbook adoption process in science, and texts were selected for grades 4–8. This process, overseen by the director of learning materials, was intended to identify texts from the state adoption list that would both meet the state's science standards and the district's. Wolters believes that the books are not closely aligned with the kits and feels that most teachers are not using them. She says, "I think that the introduction of textbooks [in 2001] was a message to the teachers that the district didn't value the kits."

"I think that the introduction of textbooks was a message to the teachers that the district didn't value the kits."

It remains to be seen if and how these textbooks and the kits will coexist in the classroom. Many teachers, principals, and board members believe that the textbooks are not a threat and, instead, will bring a genuine "balance" to the program. However, one school board member believes that the textbooks will serve as an alternative to the kits, rather than a supplement.

10 This quotation is taken from an article on the LCSD science program published on June 21, 2000 in a major U.S. newspaper.

Wolters' believes that introduction of the textbooks could threaten the hands-on science program in two ways: (1) Science teaching is already hampered by competing curricular priorities, and any use of textbooks will whittle away the time students spend doing hands-on activities. And (2), textbooks will provide some teachers with an excuse not to use the kits at all. "The worry is that as soon as you give them a textbook, those teachers who didn't feel very confident with teaching science would say, well okay, I can have them read the chapter and then I am doing what the board wants me to do," said Wolters.

Instruction

Researchers observed 22 K–6 classrooms in 11 schools, representing a range of language, socioeconomic, and ethnic compositions. Researchers observed teachers who represented "good practice" according to the science coordinator. Not surprisingly, the lessons and observations demonstrated a broad range of success.

All of the science classes featured some small-group work; nearly all the classrooms had science on display: charts, graphs and maps, or small areas of the room dedicated to the current science unit, with related materials, structures, small animals, or science-oriented literature. In several classrooms, charts included headings such as "What I know," "What I would like to know," and "What I learned." Language arts and mathematics, however, tended to dominate the classroom decor.

Science notebooks were evident in the vast majority of classrooms. In some classrooms, students used their notebooks to record their predictions, describe their science work, and draw their conclusions. In other cases, students copied in and completed graphs or other pre-structured work related to their science unit. It might be appropriate to conclude that teachers' use of these science notebooks directly reflected the degree to which they structured student science experiences. In classrooms that fostered a more open-ended inquiry approach, students were more likely to use notebooks to independently create their hypothesis and scientific notes, much like the lab scientists who inspired the SHOW program model.

Teaching Philosophy

Almost all the teachers interviewed said they believe that students learn better by doing and liked the hands-on and discovery-oriented approach of the kits. Some teachers, however, believed that this kind of learning should not be the exclusive way that students learn science—that there was a place for the content learning from text-based resources. "Books give content and the kits give experience," said one teacher.

Teachers' goals for their science classrooms were generally aligned with those of the science department, although they were more fragmented. One educator said that she wanted her students to understand scientific content and concepts through seeing and doing it themselves. Another appreciated that SHOW enabled all children to be successful in some way, to work in

Water Pollution

It is near the end of the day, and the teacher is preparing her first graders for a lesson on water pollution. They will be working in pairs and pouring water through coffee filters to remove debris. The children will add different kinds of "polluting" ingredients to the cups: leaves, dirt, sand, and rocks. The children are excited about the activity and are attentive as the teacher prepares them for the activity. The teacher begins by reminding them about their previous work with air pollution. "Can you remember what particles in the air make pollution?" Various students pipe up: "dust," "pollen," "smoke," "chemicals." She reminds the children about their previous experiment with air pollution, when they used a particle detector. The teacher then leads them on an imaginary trip to their own homes, and to their

faucets. "Where do you think that water comes from?" she queries. The teacher continues, leading the children from their faucets to rivers, and they begin to consider the ways in which rivers become polluted, and the ways in which water is cleaned at a plant before coming out of their faucets. When she is finished, the students move into pairs and begin their experiments.

groups towards a common goal, and built on the student's prior knowledge. Another teacher felt that students should be engaged in exploration, critical thinking, and the scientific process.

The district science leadership produced a detailed document for parents and teachers about the LCSD framework and the multi-faceted goals intended for student learning. Individually developed for each grade level, these elaborate 20-page documents describe the overarching curriculum for the district, the SHOW philosophy, core science concepts, general goals for the program, and the areas to be covered in that particular grade. The booklets are comprehensive and detailed, reflecting the thoughtfulness of this highly evolved science program. Few teachers were able to capture such complexity in their personal presentation of their goals for the science program.

Resource Teachers in the Classroom

Although some teachers thought that kit training might not be essential for implementing every kit, all felt that the RT was an essential part of the SHOW program. Lakeville's RTs are the primary support of new teachers. Based on knowledge of which schools have relatively high numbers of inexperienced teachers, RTs approach the administrator and discuss the kind of supports that might be provided over the course of a quarter, and to whom. The minimum goal, according to one RT, is to have the new teacher open the kit and get started. But RTs more often do much more: visit classrooms, demonstrate lessons, help with kits, offer advice about classroom management, and anything else that a new teacher might need.

Resource Teachers might also offer schoolwide staff development on science notebooks, or visit experienced teachers who ask for extra assistance or feedback in science. Teachers consistently voice their appreciation of the RTs, and the ways in which they respectfully encourage their colleagues to move forward in their science teaching.

Teachers believe that students learn better by doing and liked the hands-on and discovery-oriented approach of the kits. Some teachers, however, believed that this kind of learning should not be the exclusive way that students learn science.

Assessment

The district does not have a formal assessment process for science at the elementary levels. Students are assessed in reading, writing, spelling, and math annually in grades 3–9 with the Stanford 9 (SAT9) test. The SAT9 is administered in May, and at least one teacher indicated that she begins preparing her students for this as early as January. In addition, some students with limited English proficiency are tested in Spanish with the Spanish Assessment of Basic Education (SABE/2). Science is included in the SAT9 tests in grade 9.

The director of assessment for LCSD, who has held that position since 1973, pointed out that the science achievement test administered at the high school level since 1998 is "contrary to what SHOW has been doing." He says that state testing is increasingly content oriented, and that most districts,

including Lakeville, do not have the resources to fund authentic assessments. Wolters' view is that a standardized science test at the elementary level would have elevated the importance of science as a subject and helped fill a need for data about effectiveness of the science program.

A standardized science test at the elementary level would have elevated the importance of science as a subject and helped fill a need for data.

The SHOW guide proposes that teachers assess student work by using the science lab notebooks and performance assessments. The guides recommend that the notebooks be used to examine students' mastery of concepts and content, their investigations, interpretations, and conclusions. Teachers say they use the notebooks in a variety of ways, and those who rely heavily on them for grading are articulate about their criteria, including the thoroughness of observational notes and the clarity of conclusions.

Proposed performance assessments include embedded and end-of-unit assessments, class discussions, project-based work, and presentations of work. Teachers select which assessments they want to use. One RT pointed out that teachers would need training in the use of these, but budget cuts have made that impossible.

SHOW and GUSO leaders have long been aware of the need to develop assessment tools that teachers could use. The original kits had end-of-unit assessments, but the district wanted more in-depth measures to evaluate students' science understanding and to use in teachers' professional development. In the early 1990s, a professor from a Midwestern state university received NSF monies to work with the program in developing embedded assessments. An assessment team, comprised of the professor, an RT, three teachers, and a scientist, made some progress. However, at the end of two years, the performance assessments were not completed for every unit. Problems arose due to personality differences and "complex scoring mechanisms that teachers did not understand."

This left the SHOW program in a difficult position. The newspaper article that reported the June 2000 board vote had noted the program's glaring vulnerability: "Although the highly acclaimed program is over a decade old, there are as yet no external measures of the understanding that pupils gain —a strange lapse for dissident educators challenging state standards."[11]

Both the end-of-unit and embedded assessments are distributed with many of the kits, but it is not known how often teachers use these. SHOW has not been able to have them administered in a way that would allow the program to collect districtwide impact data. At the June 2000 board meeting, members recommended that the science staff work with the LCSD research staff to develop appropriate science assessments, which took place in 2001. As of the end of the 2001–2002 school year, these had not yet been implemented.

11 This quotation is taken from an article on the LCSD science program published on June 21, 2000 in a major US newspaper.

Professional Development

LCSD has a Professional Development Center (PDC), which was established in 1995 with Ford Foundation funds, in part to address the problem of high teacher turnover in the district. The PDC is currently supported through a combination of district and external monies. At least half of the staff is devoted to programs related to pre-interns, interns, and beginning teachers—a dramatic indication of the seriousness of the credentialed teacher shortage in the district.[12]

The PDC has a section of their budget dedicated to math and science. PDC provides financial support for SHOW trainings, advertises SHOW trainings in their professional development calendar, and also collaborates with them on certain trainings. One of the key trainers models her own pre-intern work on the SHOW program, where she received her first significant personal professional development experience during the summer academy.

During the period of NSF funding, professional development for teachers was rich and varied, reinforcing the key themes of hands-on science and the inquiry process. It included mandatory in-service trainings for the teachers and their principals through a two-week summer academy, release days (with substitutes), and weekend trainings, for a total of 13 days per teacher. Teachers did not receive kits until they were trained. This staff development was reinforced through classroom visits and supports from the four science resource teachers. The principal of one school noted, "We had the Rolls Royce of training." Lead teachers still speak nostalgically about the training they received. A key trainer at the PDC says that SHOW was the premier training model for the district because the coordinators organized the initial in-service, follow-up supports, and opportunities for teachers to talk about their classroom practice.

Lead teachers still speak nostalgically about the training they received.

Kit trainings have retained their original model and, whenever possible, are co-led by teachers and a GU scientist. Over 100 volunteers from GU and the local scientific community work with LCSD. In the past, SHOW had conducted kit trainings four times a year, during which teachers could receive training in any of 28 science kits. Unfortunately, this model has disintegrated in the last year with the loss of funding. Volunteer scientists are not always well recruited, as the scientist liaison is no longer paid for this effort, and the SHOW coordinator must make these arrangements via e-mail in her spare time.

Staffing Levels

With the conclusion of the NSF funding, the district absorbed the costs for two resource teachers at the elementary level and one for grades 7–12, but

12 The state requires that non-credentialed teachers enroll in a program that will eventually lead them to certification. The route is complicated and labor intensive. The educator has pre-intern status for one year, has intern status for two years, and participates in the beginning teacher program for two years.

this has resulted in a net loss of support services for the program. LCSD is able to commit only to entry-level training for teachers who are new to the district or new to a grade. Wolters says, "We think there should be one resource teacher for every 150 teachers. There are 823 pre-K–6 grade teachers, and 80 secondary teachers teaching five periods a day. That means we should have at least five science resource teachers for grades pre-K–12. Instead, we have three plus me for all the teachers in the district." As of 2002, there are now only two RTs, one kit builder, a half-time clerk, and one coordinator for pre-K–12.

Each year GUSO and the Lakeville Educational Foundation have had to devise clever solutions for funding the science resource teacher positions. In some cases, these teachers must even share their time between LCSD and other districts. As of 2000–2001, the district had three RTs in addition to Wolters—which felt like a deficit to the SHOW program, but is generous compared with other districts.

With the reduced staff, the science program has struggled to retain its level of services, and the needs continue to increase. For the last few years, the number of new hires has ranged from 126 to 240, and many teachers also have shifted between grade levels. Wolters pointed out that LCSD has lost many of its educators who had been experienced lead teacher trainers on the kits. She says that she would need an additional $50,000 to train the more experienced teachers and "take them to the same level of expertise."

The former supportive assistant superintendent noted that in the past they have developed capacity and leadership from strong professional development, and that this leadership development has not continued at the rate that it needed to in Lakeville. He pointed out that Paige Wolters may be the only champion of SHOW within the district, and that without her, the program may not be able to sustain itself. Another condition affecting districtwide professional development has been the reduction of professional development days from eight days to three days in recent years. SHOW has been forced to move their kit trainings to Saturdays, with teachers receiving pay. Attendance at all professional development events is now voluntary, and attendance has been low. In the second quarter of 2000–2001, approximately 100 teachers needed kit training, but there were more lead teachers present (18) than workshop attendees. Moreover, in the 1999–2000 school year, one of the quarterly kit trainings was cancelled due to lack of funds. In 2000–2001, only two of the quarterly kit trainings took place. Consequently, many new teachers are not receiving kit training. In the survey administered by this research project, only about a third of the respondents indicated that they had been trained in use of four kits, and another third were trained in one kit or fewer. This places a heavy burden on a new teacher to start using a kit with the support only of the instructional guide and possibly a resource teacher.

The science department has devised several survival strategies to cope with these circumstances. One is to link science with the districtwide literacy agenda by emphasizing the use of science notebooks. All trainings contain a component that stresses that teachers require their students to keep science notebooks. According to one RT, these notebooks allow students to develop "consistency of thinking and writing in science." The science notebooks can also be used as part of the student assessment, although as previously mentioned, teachers vary widely in their use of science notebooks.

Another SHOW strategy for coping with their reduced capacity has been the introduction of "demonstration schools," beginning in 1999 with the Thoreau School. In 2000–2001, there were three demonstration schools, one per quarter. In demonstration schools, individual teachers volunteer to have their science teaching observed by teams of teachers from four to seven other schools over the course of a two-day period. Individual members of the observer team write observations and critical questions/reflections. At a later point, the observed teacher meets with the team (using a sub), and selective parts of the notes are shared. In addition, the teacher brings along the students' notebooks. The teachers are supposed to go back and present to their staff what they gained from the experience. The science department hopes that the principals from these other schools will then call and request that this service be provided for all teachers at their school.

DECISION MAKING AND LEADERSHIP

District-Level Decisions

Administrators and the school board have long supported the SHOW program, although the main leaders from the outset have been from GU and a team that included Wolters and other key resource and lead teachers. Wolters' central role cannot be overemphasized, especially when one considers that she has had eight bosses between 1990 and 2001. The supportive assistant superintendent, who was in the district from 1984–1996, was an exception; he raised additional district resources for SHOW and used his influence to require principals to participate in monthly science sessions. Before and after him, no assistant superintendent has actively encouraged the teaching of elementary science with LCSD principals.

The Lakeville program was in a crucial stage of development in the mid-1990s, just about the time that "the hard questions" began to be asked.

Wolters feels that the Lakeville program was in a crucial stage of development in the mid-1990s, just about the time that "the hard questions" began to be asked about the true quality of the classroom science teaching. GUSO was moving on to support elementary science reform in other districts throughout the state. She believes that stronger support from a leader within LCSD could have kept up the momentum, and more elements of the program would have been absorbed into the district budget.

Throughout the 1990s, the district absorbed the costs of two elementary science resource teachers, provided space for the SHOW office and materials

center, supported two kit builders, found kit replenishment funds, and provided some funding for the initial science training of new teachers. The SHOW program is clearly institutionalized and is expanding into the middle and high school grades. Still, SHOW advocates are disappointed that LCSD's support has not made up for the loss of NSF funding. Even the recent interim superintendent admitted that the district needs to spend more money on the science program, but that the monies are not there. He pointed out that the only way to get it is to take it from another program. If SHOW's quality of teaching is being threatened by the cutbacks in staff development, it seems unlikely that there will be someone in the district office to advocate for greater expenditures.

This impediment between the science department and central administrators can be explained to some degree by the different levels of expectations that each holds for the SHOW program, and what each is willing to live with. For example, Wolters suggested in 2000 that communication needed to improve between the science department and the central office. She was concerned that the assistant superintendent for instruction was not proactive about garnering additional district support because she did not understand what would happen to the science program with the end of NSF funding. This same assistant superintendent, on the other hand, considered herself informed, and said that she was "constantly meeting" with Wolters and knew her concerns. The science department was assuming that the proverbial glass would remain half empty; the central administration seemed to assume that the science department funding eventually would return to normal levels. However, the assistant superintendent described the science program as "the most expensive in the schools," taking into account the cost for materials replenishment.

School-Level Decisions

SHOW leaders always have understood the importance of a principal's support in ensuring that science is taught in individual schools. During the pilot school expansion period in the late 1980s, principals worked closely with Wolters to support the introduction of the kits with their teachers. During the period of central administrative political support in LCSD, principals were required to attend monthly meetings, where they participated in science activities and discussions about the approach and the program. Over the course of 10 years, these meetings were reduced to four times a year, then offered only for new principals, and finally no "science only" meetings were organized for school administrators.

SHOW leaders always have understood the importance of a principal's support in ensuring that science is taught in individual schools.

The principals remain key to the SHOW program, but it is a challenge to keep them aware and involved in the program. Wolters tries to keep principals updated on national trends and the link between science and other curricular priorities through the principals' regular district meetings. Now, the SHOW program offers trainings only to new teachers, and other teachers receive support from resource teachers only if they are based in a

demonstration school and request it. Principals receive a per-pupil allocation for instructional materials and staff development, but these are not used for science. Curricular standards—which one can observe on English- and Spanish-language posters in every school building—are visual evidence of the testing and "back to basics" emphasis currently on the minds of administrators. The science program, with its lower status, receives only one paragraph on these posters. In addition, turnover among principals in recent years has diminished school-level support.

Science Coordinator Decisions

Wolters' talents as a trainer, manager, thinker, and advocate within the district have been central to the evolution of SHOW and its current status. She has remained committed to the program and the district in the difficult period following the loss of NSF funding. Without Wolters, everyone agreed that the future of the program would be jeopardized.

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Wolters remains the main anchor of the program in spite of the fact that her authority, as well as her support, is limited. Three RTs, who also have longevity with the SHOW program, assist Wolters and together they cope with reduced staff capacity, reduced funding, and the philosophical pressures brought about by the state standards and testing that were epitomized in the textbook adoption initiated in 2000–2001. They must continuously reintroduce SHOW to new principals and negotiate to enter schools and provide classroom assistance to new teachers.

Unfortunately, with so few active allies for science among central administrators, it is unclear how well Wolters will be able to protect and maintain SHOW in the coming years. If the district requires Wolters to take on textbook adoption and the development of assessment measures, she will have little time to work with teachers. Follow-up staff and leadership development that had been the signature of the program is already nearing extinction.

GU Decisions

The leadership of GU/GUSO co-directors Spencer LaBel and Geronimo Diaz has been central to the program. The strength and resilience of their vision was evident throughout the evolution of the program and during its political and financial upheavals. The two, with their strong personalities and careful thoughtfulness, have supported Wolters in her struggles to maintain the program and her staff, helped fundraise, raised the profile of the SHOW program into a nationally recognized program, and offered ongoing moral support to district supporters. As political and financial obstacles have arisen in the Lakeville school district, GUSO has gone to the front lines to defend the program. However, following years of struggle, capped by the fateful June 2000 board meeting, GUSO leaders have become disillusioned and pessimistic. As a result, they are currently not as involved as they were, but yet still remain external resources.

RESOURCES AND SUPPORT

Funding

District Funding

When the NSF grant ended, the district took on the cost of two RTs and a limited amount of the training (partly through Eisenhower monies). The district has always paid the science coordinator, but until 1998 this was a "teacher on special assignment." Only recently was the position changed to an administrative one. The district has also always paid for one kit builder/media assistant, one clerical typist, and for kit refurbishment.

The overall science budget for 2000–2001 was $415,000, including salaries for six people, instructional monies, and learning materials. Money coming through the district originates in both the operational budget as well as external grants, such as the Eisenhower, or fundraising done by the Lakeville Educational Foundation. Nearly 30 percent was obtained through external sources by the foundation in 2000–2001. GUSO has pursued funding in concert with LCSD, but has been the fiduciary agent in grants such as those given by NSF. For a few years following the ending of the NSF grant, GUSO subsidized salaries for the two RTs whose salaries had not been absorbed by the district. (See GUSO section below.)

SHOW advocates have been disappointed that the district has not committed to three, rather than two, RTs at the elementary school level, and that funds are available only for in-service training of new teachers. In 1999–2000, the district allotted $50,000 for teacher training, which was shared between the science and math departments. Wolters pointed out that in this same year, over $300,000 was spent on literacy. Wolters and others feel that SHOW "should not be a program sustained by outside money. It has to be a line item in the district budget."

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The director of the Lakeville Educational Foundation says that she is able to raise money for the science efforts, but that the district needs to support it more from the general budget. For example, the grades 7–10 effort will require an additional resource teacher, another person at the materials center, and staff development for secondary teachers. The director is optimistic that additional funds could be obtained for the training of K–6 teachers.

GU/GUSO Funding

Until the mid-1990s when the Lakeville Educational Foundation began fundraising successfully for the district, external money for the SHOW program came almost exclusively from NSF grants through GUSO at GU. GU allows only a nominal overhead to be charged for subcontracted work, so the monies could be spent in large part on direct services. Wolters and her

original resource teacher were paid out of such grants. Following the conclusion of the NSF elementary science project, GUSO helped to temporarily maintain all four RT positions by supplementing their work with subcontracts to work in other nearby districts through their "Lakeville Center for Improving Elementary Science Education."

Since launching the SHOW program, GUSO has moved on to work in elementary science reform in other districts and, more recently, to concentrate on extending the inquiry-oriented, kit-based science into the middle school. The "7–10" project is another joint project between LCSD and GUSO focusing on curricular development.

The GUSO idea to replicate and extend the Lakeville model was both logical and financially practical. Since 1996, GUSO has received $6 million in grant money from NSF. Approximately half of this money has been spent directly within 12 districts in the state to assist leadership development in pilot schools in elementary hands-on science over a three-year period. This well-funded center also became one of many strategies used by GUSO to financially support elementary science staff in Lakeville, whose positions were jeopardized because of budget cuts in the district.

Diaz reports that reform efforts in many other districts supported by their center have been more successful than Lakeville, primarily because of strong support from central administrators. Consequently, the revised role for the center will be to support the consortium of districts with which they have been working, and to expand to neighboring districts with support of local monies.

Community and Partnerships

The "golden years" of the LCSD-GU partnership took place in the early 1990s, when central administration strongly supported the program. The core leadership team was the supportive assistant superintendent, Wolters, Diaz, and LaBel.

"We had to understand the cultural differences between the confrontational world of scientists and the nurturing world of education."

Diaz described the evolution of this team in a humorous manner. He said that the first "period of adjustment" was when everyone was learning to get along with one another personally. The second "period of adjustment" was when "we had to understand the cultural differences between the confrontational world of scientists and the nurturing world of education." Ultimately, the group became like a family.

Even as GUSO shifted its focus into the middle grades and into other communities, GUSO scientists continued to support Wolters in crucial meetings, such as district budget meetings. Diaz recalls:

> We no longer had a sort of job we were all doing together. We more or less had an ongoing relationship in which we tried to

> put out fires...When the center money stopped supporting her [Wolters] seriously, which was two years ago, it got harder. And then everything else fell apart [referring to the school board struggle in 2000].

Central administrators in Lakeville uniformly express their appreciation for GU support, and their central role in promoting hands-on elementary science. They also feel that GUSO and the district need to work on their relationship, as there have been challenging times in their collaboration. A former school board member and supporter of SHOW said, "There has been some pain in it for both sides, like a good marriage."

In retrospect, Diaz cannot see how the GUSO relationship might have worked differently with the district. He acknowledged that a program needs district support to become stable and that "supporting from the outside doesn't work." The interim superintendent pointed out that, "We don't give the support to the program because GU does it." GUSO feels that without their prolonged partnership with LCSD, not only would the SHOW program not have succeeded, it would have stumbled sooner. On the other hand, the former assistant superintendent felt that the science program should have extended its base of support within the science and technology sectors of Lakeville.

ACCOUNTABILITY

District-Level

Although there are mechanisms in place for student accountability in the district, the SHOW program has historically relied on resource teachers and school principals to informally monitor the program and offer incentives for educators to use the kits. During the NSF period, this "soft" accountability was complemented by mandatory districtwide staff development in science. In the early period, when the SHOW program was being introduced, considerable attention was paid to science, and care was taken to see which teachers were using the kits so that they could be targeted for assistance.

Wolters feels that the energy and enthusiasm for the innovation was an incentive for many teachers to attempt and persist in using the kits. However, by the mid-1990s, around the time when the NSF grant concluded, the teachers had reached a new stage. On the heels of the initial implementation, teachers needed follow-up work in the classroom so that they could work on the quality and depth of their science teaching. Wolters described the work of resource teachers at that time:

> We were saying: "Okay, so you have been teaching it, is there any value in what you are doing?…You have been teaching this for five years now. Do you know what the main points of the lesson are? How do you know if the kids are learning anything? Have you given them a performance test lately and how come

Energy and enthusiasm for the innovation was an incentive for many teachers to attempt and persist in using the kits.

they are not getting good scores? What is that you are not doing that is not helping the kids get to the next level?"

Without district support for the full panel of resource teachers, this kind of follow-up support was possible for only a small number of teachers. Moreover, with reduced contact with teachers and their principals in schools and trainings, RTs could no longer keep their fingers on the pulse of what was happening in science lessons. In 2001, competing district priorities suggested that science was being taught less, but there was no direct evidence.

State-Level

The State Department of Education has recently instituted an Accountability for Program Improvement (API) system that ranks schools on the basis of SAT9 math and language arts scores. There are monetary rewards for schools that have high scores, and which improve their scores significantly. Some feel that this system ends up rewarding those schools and districts that are already advantaged because of overall teacher quality. Better schools often attract better teachers, including those with more experience and further training.

SHOW has opted to focus its limited staff resources on a small number of demonstration schools. This work still entails the voluntary participation of individual teachers at the school, and there is no guarantee that the principal will be concerned with the quality or quantity of science lessons offered to students.

EQUAL ACCESS TO SCIENCE

Students in the Lakeville public schools are mostly Hispanic and African American, and many are poor. Twenty percent of the school-aged population, mostly from affluent families, attend private schools. Students from Hispanic communities are bused to schools in more affluent neighborhoods, and there is a waiting list of students to attend these "better schools."

One of the great strengths of the elementary science program is that it has been recognized as delivering a standardized program to all students throughout LCSD.

One of the great strengths of the elementary science program is that it has been recognized as delivering a standardized program to all students throughout LCSD. During the NSF period, all teachers were required to attend trainings and implement the kits. Even though there was not clear accountability for this initial implementation, teachers received extensive support in terms of access to trainings and materials, classroom-based supports, and expectations that the kits would be taught. Many members of the community testified at the June 13, 2000 board meeting, and emphasized the deep impact of SHOW on LCSD's poor students and culturally and linguistically diverse children. Principals from schools with large populations of culturally and linguistically diverse students expressed their support for the program and the fact that students with little science influence at home are now articulating at interest in the Mann School.

With decreased in-service and classroom support for the SHOW program and little accountability, science teaching becomes more dependent upon the motivations of individual educators in teaching science. Moreover, teachers with Spanish-speaking students are facing increased pressures to improve their students' English language skills, and their scores on the annual SAT9. They, more than other teachers, may end up teaching science less. This would be a genuine loss, because so many have seen the benefits of hands-on science for students with limited English proficiency.

ANALYSIS

The story of elementary science in Lakeville is, like any district program, complex. Many factors have contributed to and inhibited its sustainability over time. These factors fall into three general categories:

1) factors that pertain to the surrounding conditions-these describe the influences of the context in which the program operates;

2) factors that pertain to the science program components-these describe the role that concrete elements of the science programs (e.g., curriculum, professional development, leadership) have in contributing to or inhibiting sustainability; and

3) factors that pertain to the whole science program-these describe overarching contributors to and inhibitors of sustainability that affect the program in less tangible but still powerful ways.

These factors do not operate in isolation. They interact with each other, and shift in importance and influence over time. Factors that were particularly striking and pertinent in Lakeville are discussed below. For an in-depth discussion of all of the factors, see the cross-site report of this study[13].

Factors that Pertain to Surrounding Conditions

Science for All: Science Holds the Banner

The vast majority of Lakeville students are poor and face numerous obstacles to succeeding in school. Thus, one of the program goals for SHOW—"science literacy for all students"—speaks to a commitment to make program supports, such as professional development, available to every teacher. This commitment could be realized more easily during the NSF period.

At the school level, researcher observations and interviews revealed that SHOW was highly valued by many teachers, and particularly those working

13 The Executive Summary of the Cross-Site Report can be found in Appendix E.

with English as Second Language students. The SHOW literature highlights the work of culturally and linguistically diverse students in their science classes. The claims that SHOW is working for Lakeville simultaneously mean that it works with disadvantaged populations. This is a broad claim to equity—not a claim that works for a subset of the students. The district itself is a test proof—one that will become increasingly less convincing as teacher's ability to use the kits become more diverse (and lower). Thus, unfortunately, the "equitable" nature of the program that ensured kits for every classroom and equal access to staff development will be undermined by individual teacher's own predilections regarding the amount and kind of science to be taught.

The implementation of SHOW within LCSD may have ultimately worked better for selling the hands-on approach outside of the district than in sustaining the program within the district itself. This is because outside of Lakeville, program leaders could demonstrate that the SHOW model could work "despite" the district conditions. Whereas inside the district, these very conditions continued to erode the program. While grassroots support for the program is strong, low scores on standardized achievement tests mean that more attention will go to those subjects on the test. Thus, "science for all" has an attractive sound, but it may ultimately prove to be a hollow sound if science is not on these fateful tests.

Factors that Pertain to Science Program Components

Professional Development: A Low Floor and a High Ceiling

The professional development offered by LCSD has been extensive. The inquiry-oriented professional development made available during the NSF grant period was critical in shaping teachers' philosophy about how science should be taught. Teachers had the opportunity to become familiar with the kits on an ongoing basis. The trainings included practical treatment of assessment techniques and the use of science notebooks. Educators were also able to work with scientists who could familiarize them with key science content.

Educators were able to work with scientists who could familiarize them with key science content.

Over time, and much to the dismay of the science leaders, opportunities for professional development, the interest in participating in them, and the human resources for carrying them out have all diminished. The main culprits are shifting financial and political realities. Teachers now have access to fewer professional development days during their work week. The pool of lead teachers has shrunk as teachers retire or seek job opportunities elsewhere. Scientist collaborators are also less present, as there is no longer a paid staff member to coordinate this collaboration. District priorities are clearly focused on basic skills, and science has low priority, as it is not included within the battery of standardized tests at the elementary level.

As professional development opportunities are lost, the commitment, skill level, and philosophical understanding is compromised. In fact, circumstances would appear to be conspiring against the implementation of high quality professional development. Only a small proportion of new teachers are participating in kit trainings. These teachers are presumably relying on the guides included in the kits and follow-up support by resource teachers. There is a decreasing "floor" in terms of the amount and quality of the science that is being taught and an increasing gap between the capacity of new teachers and that of more experienced teachers. There also is a net loss of overall experience, as trained, experienced teachers retire or move to other districts. Thus, one could say that the program is being sustained in part, but it begs the question of what exactly is being sustained.

Accountability: We Regret to Inform You

Even with the consensus that the SHOW program has been a success, no documentation or research exists that demonstrates the impact of the program on students. As the state developed science frameworks, SHOW was left vulnerable in its defense of its hands-on, discovery-based approach. Teachers were using the science notebooks and embedded assessments to grade their students, but there was no concrete evidence that children were learning science at or above the minimum standards described in the state framework. Moreover, in the presence of high visibility tests in reading and math, the importance of science was diminished. Given the limited authority of the science coordinator, one wonders if the department would have been able to act on formal program accountability information had it been available.

As the state developed science frameworks, SHOW was left vulnerable in its defense of its hands-on, discovery-based approach.

There may well have been financial or political reasons why no substitute district assessment was organized until 2001, long after the failed work with the consultant from the Midwestern state university. As the LCSD case shows, the absence of concrete evidence, such as test scores, can make a program vulnerable to threats coming from countervailing teaching philosophies.

Partnerships: The Pluses and Minuses of Co-Dependency

The SHOW program is the product of a strong partnership between the district and the local university. The energy and vision of the GUSO leaders were central to creating, shaping, and supporting the program. As a team, LaBel, Diaz, and Wolters put Lakeville's efforts on the national map. GUSO's involvement was critical to supporting the program (both financially and psychologically) when district support eroded in the mid-1990s in the wake of major external turbulence.

Some suggest that the strong GUSO partnership may have turned into a crutch that the district used to avoid dedicating the internal funds to the program. Perhaps it would have been wise for the program to seek out other community-based support and to be less dependent upon GUSO. Perhaps the cooled relationship with central administrators was an inevitability of the district's financial conditions.

GUSO leaders have grown increasingly concerned, dissatisfied, and against those who were not supportive of the program. Their defense of Wolters and the program—in meetings and in letters—became more outspoken as the pressures mounted. These stresses have worn down GUSO leaders, who may be sometimes tempted to see the district leadership overall as ungrateful, counterproductive, and uninformed.

Factors that Pertain to the Whole Science Program

Wolters is keenly aware of the stages that teachers pass through in moving from a stage of initial rote use of the kits to one of true understanding.

Adaptation: Accommodating Shifts

Wolters has remained the science coordinator for the duration of the program. Being at the helm through many phases of the program's evolution has given her insight into both the overt and subtle changes that it has been through. Wolters is keenly aware of the stages that teachers pass through in moving from a stage of initial rote use of the kits to one of true understanding. She recognizes that after five years of innovation, teachers are not as motivated to improve their efforts. It has been frustrating for her to watch core NSF funding for the program recede just at the time when continued support was needed to bring LCSD to the next stage in innovation.

> In Lakeville, we already passed that initial enthusiasm when you do something new…That happens for about four or five years, trying to do it. ...When you get past the fun part and you get into the hard work, that is where the rubber hits the road.

The 15-year history of the SHOW program has also demonstrated the importance of constantly recruiting new supporters from among district and school administrators and the school board. SHOW conducted considerable outreach, including private meetings and public, monthly tours of the program, to achieve this goal. Although grassroots support for SHOW appears to remain strong, a steady stream of new teachers and principals continually needs introduction and cultivation. Moreover, the strongest central staff support came at the inception of the program. Since then, high turnover among central administrators has necessitated ongoing public relations work by the science coordinator to maintain the program. These turnovers, diminished budgets, and shifting district priorities have created a highly challenging environment for the science program.

In the 15 years since SHOW began, state and national education policies have been in a constant sate of upheaval and change. State science standards

took on special importance over the last decade, as did test-based accountability. Perhaps these shifts did not appear immediately threatening to the well-established SHOW program. If SHOW had been planted (rather than matured) in this environment, than administrators might have taken special precautions to strengthen against program vulnerability, for example, by ensuring that impact data was collected.

Philosophy: What Is Sustained?

Until recently, the LCSD science program has had an unchallenged, cohesive philosophy. It incorporated the pedagogy of teaching science, content and skill goals, and broader goals related to the impact of science learning on lifelong skills. These goals are clearly articulated in the extensive written materials developed for the program, outreach events, public tours, and training events organized for teachers. This attention to the articulation of philosophy is among the strongest across those sites studied in the project.

The grassroots support that emerged in response to the board challenge to the district science standards suggests that this philosophy has taken a firm hold. Few, if any, teachers would argue against a hands-on approach. Even the textbook adoption is not perceived as a direct threat. However, those teachers most knowledgeable about the program and the pedagogy of a discovery-based approach understand that the introduction of textbooks will, in fact, threaten the program's core.

Even if there is a consensus that science should be taught using a hands-on approach, this does not guarantee that science will be taught.

In addition to looking at the philosophy of the hands-on program, researchers explored the district's commitment to the science teaching itself. Researchers found a high dedication to teaching science among experienced, high-end users of the program. However, in general, teachers recognized that they were not in a position to teach science as much as they might want to, given district curricular priorities. Thus, even if there is a consensus that science should be taught using a hands-on approach, this does not guarantee that science will be taught.

Quality: The Elusive Standard

The RSR project defines program quality as "the extent to which its instruction and curricula facilitate positive attitudes toward, and student learning of, the elements of the scientific process and the basic concepts of the earth, physical, and life sciences." The SHOW program has, over time, implemented a sophisticated curriculum and training program designed to achieve quality. Moreover, contact with resource teachers and lead teachers has provided the science staff with ongoing, informal information about the implementation of the science program in the classroom. In the early years of the program, the primary focus was on getting teachers to use the kits. As the science support staff has been reduced and new teacher numbers soared, the focus has remained on "maintaining the floor" in terms of

kit use. Wolters says, "Now we are three [resource teachers], we get to schools very seldom, mostly by request, and don't see all of the teachers. We know who is teaching mostly because of the way the kits are returned."

In the absence of evidence of student learning, the school board based their judgment of quality on the alignment of the program with science standards.

Without formal district assessments or the inclusion of science on high stakes tests, no information exists on the science performance of students. In Lakeville, this has made the program more vulnerable to the charge that the program is not delivering high-quality science that relates to the state science framework. In the absence of evidence of student learning, the school board based their judgment of quality on the alignment of the program with science standards. The debate then became "which standards?"

The science coordinator and those attentive to SHOW expect that the amount and quality of science that is being offered in Lakeville classrooms will continue to erode. Although teachers may hold a core commitment to the use of hands-on science, their implementation of the materials is highly variable. Many do not move beyond rote use to more sophisticated adaptation for their own classrooms. While science program leaders understand that this is a predictable result of the reduced supports for teachers and the challenge of adjusting to large numbers of new teachers, they also see a sad irony. If the district implements a standardized assessment for science, these assessments might capture student performance at its lowest since the inception of the program. The response to the "quality question," therefore, may come too late and might not help bolster support for the program.

SUMMARY

The Lakeville program has endured a 15-year roller coaster ride of support from the initiation of the partnership with GU in 1985 to the 2000 challenge from the school board. At the beginning and into its maturation, the program enjoyed commitment from sources internal to and external from the district, and a steady stream of large and small external grants complemented by modest district commitments. Later, it felt the impact of the loss of support through the reduction of funding for science program staff but, more importantly, through the departure of the assistant superintendent who had been a strong advocate and source of stability. And through it all, the GU leaders, Diaz and LaBel with their colleague and friend Wolters, worked to promote and grow the program while responding to the expected and unexpected challenges that inevitably arose.

Now the program rests in uncertainty. In the wake of the school board challenge, the district adopted supplemental texts that some view as contrary to the program's intent, leaving key leaders frustrated and disillusioned. They had successfully navigated the program through the turbulence of changing funding, leadership, and curricular priorities, but found that a single factor—accountability—could pose a serious threat to the program's future.

They also found that data on the impact of the program was necessary, not only for their own decision making, but also to help them effectively represent it to others.

Lakeville's story raises questions about what sustainability actually means. Does the addition of textbooks, for example, eclipse the importance of hands-on materials, one of the program's fundamental values? Our definition of sustainability emerged from our research and from questions like this one.

> **Sustainability**: The ability of a program to maintain its core beliefs and values and use them to guide program adaptations to changes and pressures over time.

Faced with changes in the curriculum, turnover of leadership and teachers, and shifting priorities, will the program, in fact, be able to maintain those "core beliefs and values"? At what point should one say that the program no longer is sustained? That point has not yet come to Lakeville, but it is a possibility. Looking back, program leaders could not have predicted many of the challenges that the program endured or the supports that emerged to strengthen it. There may, yet again, be unexpected supports that will reinforce the program's foundation and enable it to weather the next 15 years of district change. Sometimes a program's sustainability is only evident with hindsight.