Researching the Sustainability of Reform

# SYCAMORE


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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 a survey administered to all principals and a random sample of 100 teachers 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.

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

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# 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.

# SYCAMORE
## EXECUTIVE SUMMARY

## INTRODUCTION

The Sycamore School District[1] is on the threshold of sweeping change in almost every realm. Until recently, this community was the embodiment of stability. Teachers with less than 10 years of experience in the community were considered "newcomers," and administrators moved into their positions only after many years of teaching in Sycamore's schools. Now, the 30-year veterans are beginning to depart, a new superintendent from outside the city has taken the helm, and the community is building new, large schools for the first time in 30 years. As teachers and administrators leave, they take with them memories of the origins of the science program and their experiences and commitment to the science program. Now, those who remain must introduce large numbers of new teachers to the program and adapt the structure of the program and its supports to function in schools three and four times the size of the current ones. This will be a test for the science program that, until now, has enjoyed uncompromised, widespread financial and political support.

## CONTEXT

### *Community Overview*

Sycamore is a small city of about 89,000 people, located on an ocean inlet. A thriving, industrial mill town during the First World War, shifts in industry in the 1920s initiated an economic deterioration. Now, there are many working poor. The median household income of $20,000 is among the lowest in the state and 53 percent of the residents do not have a high school diploma. There is only one area of middle class homes, near the school with the smallest free lunch population, and one development of upscale condominiums. Otherwise it is a blue-collar community that is 69 percent white with small numbers of African Americans, Asians, and others.

Sycamore has 28 K–5 schools and 2 K–2 schools with a total of 6,400 students and 300 teachers. Most schools are small old brick buildings in urban surroundings, dating back 70–100 years with one classroom per grade level. The total population of Limited English Proficient students is 41 percent and the district percentage of students eligible for free and reduced lunch is 65 percent, but it ranges from 14 percent to 84 percent, depending on the school. Sixty percent of the schools have more than 70 percent of students at or below the poverty level.

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

### *Issues of Local Importance*

**New School Buildings:** The mayor, who also serves as ex-officio head of the school board, has initiated the first large-scale school construction project in more than 30 years. Soon, the city will have large schools with four classrooms per grade level. The new schools also will have science labs, so program leaders will need to address the challenge of integrating what happens in the science room with the core science curriculum.

**Increased Teacher and Administrator Turnover:** Until very recently, the turnover rate of teachers and administrators was extremely low; many have been in the district for 20 years or more. Data from the survey administered by this research project demonstrates that well over half of responding teachers have taught for more than 20 years with about a quarter reporting that they have spent those 20 years in the same grade. One principal remarked that in 17 years of being a principal, she had yet to hire a new teacher. However, with many retirements on the horizon, Sycamore, for the first time in many years, will be hiring large numbers of new teachers. Many principals also are retiring, prompting a significant number of new administrative hires.

## PROGRAM HISTORY AND DEVELOPMENT

While the current program "officially" began in 1989, it evolved from a National Science Foundation-funded, hands-on science program that was in place from 1971 to 1979. The program was run by a Catholic school science teacher who had a staff of up to 12 science specialists in K–8 who supported the use of *SAPA*[2] *(Science, a Process Approach)*, *ESS*[3] *(Elementary Science Study)*, and other kit-based science units across the district. They brought the kits to schools, did demonstration lessons, and urged the teachers to do follow-up lessons until the next visit.

At the same time that the kits were at their height of use (the mid 1970s), a Head Start Follow-Through program was in full operation. This program had a philosophy and pedagogical approach that was compatible with the science program and seemed to reinforce its growth. Because the philosophy of this program and the kit-based science pedagogy were mutually reinforcing, the Follow-Through schools were a spawning ground for

1 *SAPA* was developed under the auspices of the American Association for the Advancement of Science and first published in 1967.

2 *ESS* was developed by Educational Services Incorporated (now Education Development Center, Inc.) in Newton, Mass., and was first published in 1969.

inquiry science leadership. Then, in 1980 after passage of a state ballot measure that resulted in loss of the funds needed to support the specialist teachers, the program disappeared, and according to the former assistant superintendent, the "kits went into the closets."

From 1980 until 1989, a textbook science program was in place, but many teachers did hands-on science on their own. Teachers were philosophically committed to hands-on science from their experiences with the NSF program, but they did not have the needed resources and support. In 1988, Allison Stowe, now the K–12 science coordinator, convinced the assistant to the director of curriculum to abandon textbooks and support a new kit-based program. That same year, the state offered money for buying kits. Stowe led a team to the first National Science Resources Center (NSRC) Leadership Institute in 1989, and there the team learned about other programs and kit-based units.

In the fall of 1989, two second grade kits were introduced to all the second grade teachers. In 1990, Stowe became a full-time coordinator of the science program and, in the next three years, kits were introduced across all the grades, and the program extended to all classrooms, with four or more units at each grade. Over time, newer kits have been added to strengthen the program. Eventually, Sycamore developed a model of "peer coaches" with one in each school to provide support to all classroom teachers.

From 1993–1999, Stowe and others participated in other professional development activities and meetings including conferences sponsored by the NSRC and meetings of the ASMC (Association of Science Materials Centers). An important development in 1999 was the creation of four new K–12 curriculum director positions in science, mathematics, language arts, and social studies. These new positions were specifically added to the school budget by the school committee to bolster student learning. Stowe was made K–12 science director, and she hired a strong peer coach to be a resource teacher for the K–5 program.

# THE CURRENT PROGRAM

## Curriculum

The basic science program is spelled out in a memo that Stowe sent to elementary principals at the start of the 1999–2000 school year. It included the following guidelines:

1. Kindergarten has four required modules; grades 1, 2, 4, and 5 have five; and grade 3 has 6, of which one is math/science.
2. Teachers must teach to the state framework inquiry standards and content learning standards aligned to each kit module.

3. The time to be allotted in grades K–2 is four periods per week plus language arts integration. For grades 3–5, five periods per week are required, plus language arts integration.
4. In all grades, students must write to explain their science concept understanding in each lesson. Grades 2–5 have a Science Writing Resource Guide.
5. There is a science vocabulary list to be used for each unit, and a grade-level vocabulary.
6. Formative assessments have been developed for the grades 2–4 kits to be used to assess students' understanding.
7. Silver Burdett and Ginn textbook material and *FOSS Science Stories* are to be used in conjunction with the hands-on modules, after the activities, to consolidate children's conceptual understanding.

In addition to this brief memo, a *K–5 Curriculum Guide* for science outlines expectations, philosophy, and resources. Also included in the memo is a list of the specific units for each grade and their associated text chapters. The kits comprise a combination of *FOSS*[4], *STC*[5], and *Insights*[6] units with a minority of the units composed of locally developed, science museum units that date back to the beginning of the program. The latter are being replaced over time.

## Instruction

One of the striking aspects of Sycamore is the extent to which science is a part of almost all students' instructional experience. By all accounts, most, if not nearly all, elementary teachers are teaching the kits. Information gathered through the survey shows that nearly all of Sycamore teachers report that their students design and carry out investigations of their own questions in either some or most lessons and that nearly all students do structured hands-on activities following specific directions in either most or all lessons.

## Assessment

The state administers a science test (CTAP) at the fifth grade. All the CTAP test items are released annually. The 1999 test had 34 multiple choice questions and 4 extended response items. The alignment of the test items to an inquiry science program is questionable. The science program efforts to improve performance on CTAP are double-barreled with textbook chapters

4 *FOSS (Full Option Science System)*: Developed by Lawrence Hall of Science, published by Delta Education.

5 *STC (Science and Technology for Children)*: Developed by National Science Resources Center, published by Carolina Biological Supply Company.

6 *Insights*: Developed by Education Development Center, Inc., published by Kendall/Hunt Publishing Company.

aimed at the multiple choice questions and some assessments and writing efforts aimed at the vocabulary and writing emphasis of the extended response items.

## PROFESSIONAL DEVELOPMENT

### *Peer Coaches*

Sycamore has 26 peer coaches who comprise the foundation of Stowe's professional development work. Nineteen of the current peer coaches were trained as part of the NSF program co-led by Stowe and a chemistry professor from a local state university from 1992–1995. Since then, professional development for peer coaches has been ongoing, but has varied.

The peer coaches' role in the schools is to help teachers improve at teaching inquiry science through classroom observation, coaching, and debriefing, when requested. The coaches have no formal authority, so all of their work is negotiated. They troubleshoot, provide advice, and help new teachers get comfortable with the kits and start teaching from them. Then, once they get teachers "beyond the kit," they focus on more of the specifics of teachers' instruction.

### *Kit Training*

When the district introduces new kits, all teachers are required to participate in kit trainings led by peer coaches. These are the only common professional development experiences all teachers have. The trainings typically last about 2.5 hours during the school day and are conducted in small groups of 10 or so. Teachers also have an option of participating in later 1.5-hour "revisiting the kit" workshops. Veteran teachers, most of whom have been teaching kit-based science for 10 years or more, feel they can easily master a new kit that has a thorough teacher's guide. They rarely use the peer coaches. New teachers, on the other hand, get help from their peer coaches and grade-level colleagues.

### *Other Professional Development*

After initial training, Stowe provides opportunities for a variety of voluntary professional development activities. Each year she offers different opportunities that are designed to expand horizons for eager teachers and for her leaders. She has recently placed a priority on improving the inquiry and experimental design aspects of the science program.

# DECISION MAKING AND LEADERSHIP

### *District Leadership*

Sycamore's new superintendent started at the beginning of the 2000–2001 school year. He has been very impressed with the science program and

seems to be willing and eager to delegate and draw from the strengths of the staff already in place. In January 2001, he had not yet hired a new assistant superintendent for curriculum and instruction (the preceding one had nurtured the science program for a decade), but emphasized that he was going to depend on this person to improve instruction across all subject areas, and that his own role would be to provide administrative support and resources.

There is a new team of four K–12 curriculum directors: Stowe in science, plus three other very capable people in math, language arts, and social studies. They currently are involved in some common efforts, including visiting classrooms, helping vice principals focus more on instruction rather than discipline, and planning a summer institute for new teachers. They expect that their work will be closely coordinated so curriculum work in other subject areas is likely to complement and coordinate with the science program. And yet, their work is to some extent on hold until a new assistant superintendent is hired.

### *Science Program Leadership*

Over the years of its growth and development, the program has had active central office support. They all supported the kit-based, hands-on pedagogy and the way that Stowe had built and maintained the program. Now, with changes in administration, Stowe faces some uncertainty about how much administrative support the science program will receive.

In general, there is a sharing of science program leadership between Stowe, the K–5 resource teacher, the peer coaches, and the senior teachers. However, Stowe is the key person who worries about the problems, strategizes, and makes decisions about how to act. Since becoming K–12 director, Stowe has had a full-time K–5 resource teacher. The resource teacher is a long-time participant in Sycamore education, beginning as a parent community liaison in Follow-Through. She and Stowe are "finding their way" in the job sharing. She has no strong formal science background, but she has learned on the job from the workshops and she has experts to consult when she needs to.

### *Communication*

The district has done a careful job of creating a set of K–12 learning standards in science and technology. The drafting committee included Stowe, three of the instructional leaders dating back to Follow-Through, and eight other K–12 teachers. The learning standards fuse the Sycamore program and the largely fact-based State Learning Standards. Teachers and principals in the district take them seriously.

Stowe has recently distributed to all teachers and principals the memo that articulates expectations about the science program. In part because Stowe is highly respected and in part due to the decision-making culture of the com-

munity, the memo appears to have the force of law. Thus, between current standards and this memo, the goals and structure of the program are directly communicated to all.

# RESOURCES AND SUPPORT

## Funding

The school committee, with city council approval, sets the budget total. Once the budget total is approved, the school committee starts to allot specific amounts to individual departments and programs. The science program makes modest demands, and according to Stowe, they are not contested. The kit refurbishing budget is firmly institutionalized in the budget process, and Stowe and the former assistant superintendent obtained numbers of small and specialized grants from the state and foundations that help support special professional development activities and some instructional materials needs. The district supports peer coaches for their time at two-hour monthly meetings.

The Sycamore science program has not received any large grants (though they have had small amounts of support through their participation in others' professional development efforts and initiatives). Even without large grants, the Sycamore science program has not suffered financially. In light of Stowe's widespread respect and credibility, science program financial resources at the level she has asked for over the past several years seem to be securely institutionalized.

## Community and Partnerships

Sycamore is in the process of developing several partnerships. A long-standing partnership with a local state university is once again emerging as a strong support for the program, and the school district also has a relationship with a small, privately endowed, nonprofit education and research center. A smaller partnership is in place with the Audubon Society, and there exists a long-standing connection to the local museum of science.

# ACCOUNTABILITY

The state assessment, CTAP, has had a strong influence on the science program in Sycamore. The test sends a message that the curriculum must be aligned with the state framework and, in fact, adjustments have been made to the Sycamore program as a result. The test is viewed as a mixed blessing. While it imposes some pressures, it has helped to keep science on the front burner.

Aside from the CTAP, few formal accountability measures exist to ensure that teachers are using the program. Accountability of teachers appears to be left to the principals, none of whom oversee science in any systematic way. Similarly, no formal process exists for ensuring that the principals are supervising their teachers' use of the science program. Yet, even without formal accountability systems, the message is clear that science is "mandatory."

## EQUAL ACCESS TO SCIENCE

Sycamore is a relatively poor community. Most of the schools are very old, with limited resources. Several principals characterized some of the students as quite "needy." In this setting and with the widespread commitment to helping the student population, the science program has received recognition for helping students who otherwise might not have had opportunities to learn science.

## SUMMARY

The Sycamore program has grown over 12 years to become a securely established part of the district and community. The program seems so firmly institutionalized and so effectively connected to the system, from top to bottom, that the idea of it disappearing seemed completely foreign to many. However, within the past year there have been many changes. The old stability has gone. A new superintendent has arrived and the community is entering a process of hiring many new teachers. Sycamore also is headed into changes that result from building new schools. No longer will they be sharing conversation in a cramped but cozy corner. Soon, the teachers will be in large schools with several grade-level colleagues; something they never had before. The ultimate impact of these changes on the science program is yet to be seen, but the leadership, strategic implementation and adaptation, and financial management of the past, combined with the supportive culture, suggest that the Sycamore program has every opportunity to continue to evolve and be sustained into the future.

# SYCAMORE

## INTRODUCTION

The Sycamore School District[1] is on the threshold of sweeping change in almost every realm. Until recently, this community was the embodiment of stability. Teachers with less than 10 years of experience in the community were considered "newcomers," and administrators moved into their positions only after many years of teaching in Sycamore's schools. Occupants of the schools and central office consider each other "family." As one principal said, "...we have had children together...we have watched them grow up and get married." Now, the 30-year veterans are beginning to depart, a new superintendent from outside the city has taken the helm, and the community is building new, large schools for the first time in 30 years.

As teachers and administrators leave, they take with them memories of the 1960's origins of the science program. Even more important, they take their training experiences and wisdom and their commitment to the science program—the result of years of investment and hard work on the part of Allison Stowe, the K–12 science coordinator. Now, Stowe and her colleagues that remain must introduce large numbers of new teachers to the program and adapt the structure of the program and its supports to function in schools three and four times the size of the current ones. This will be a challenge for the program leaders and a test for the science program that, until now, has enjoyed uncompromised, widespread financial and political support and respect from teachers, administrators, and the community.

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.

## CONTEXT

### *Community Overview*

Sycamore is a small city of about 89,000 people, located on an ocean inlet. A thriving, industrial mill town during the First World War, Sycamore's port brought in raw goods, processed them, and then shipped them out again to international markets. Many residents also earned a living from commercial fishing. When textile manufacturing began to move to more hospitable locales in the 1920s, the city began to deteriorate. Now, large, mostly-empty multi-story brick mill buildings dot the city. As the industrial work declined, unemployment soared, but it has now dropped to single digits. Still, there are many working poor. The median household income of $20,000 is among the lowest in the state and 53 percent of the residents do not have a high school diploma. There is only one area of middle class homes, near the school with

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

| | |
|---|---|
| **SIZE** | |
| Sq. miles | 25 |
| # elem. students | 6,400 |
| # elem. schools | 30 |
| # elem. classroom teachers | 300 |
| **RESOURCES** | |
| Per pupil expenditure | $6,500 |
| Teacher starting salary | $29,892 |
| NSF funds? | no |
| **DEMOGRAPHICS** | |
| % students eligible for free/reduced price lunch | 65% |
| % white | 69 |
| % African American | 12 |
| % Hispanic | 11 |
| % Asian/Pacific Islander | 8 |
| % Native American | 0 |
| % Other | 0 |
| **YEAR CURRENT PROGRAM BEGAN** | **1988** |

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

the smallest free lunch population, and one development of upscale condominiums. Otherwise it is a blue-collar community that is 69 percent white with small numbers of African Americans, Asians, and others.

Sycamore has 28 K–5 schools and 2 K–2 schools with a total of 6,400 students and 300 teachers. Most schools are small old brick buildings in urban surroundings, dating back 70–100 years with one classroom per grade level. Portuguese students are concentrated in a handful of schools, and some schools offer bilingual Portuguese instruction. The total population of Limited English Proficient students is 41 percent and the district percentage of students eligible for free and reduced lunch is 65 percent, but it ranges from 14 percent to 84 percent, depending on the school. Sixty percent of the schools have more than 70 percent of students at or below the poverty level.

The district central office is located in a converted mansion, which contributes to the family-like atmosphere generated by the informal but respectful interactions among staff. As in the schools, the central office staff has been very stable over the years, with that steadiness only now beginning to give way. In 2000, a new superintendent was hired from outside the district. Coincident with his arrival, the assistant superintendent for curriculum and instruction decided to leave after many years of providing substantive and financial support for the science program. These shifts portend change in the interactions among, and operations of, central office staff.

### *Issues of Local Importance*

**New School Buildings:** Sycamore schools are old and crowded with only one classroom at each grade and little room for administrative space. In some cases, the principals' "offices" literally are closets. Still, the close quarters and clutter contribute to a cozy ambiance in the schools, and many in the district have found benefits in staying small. One principal commented that he likes having a small school because it allows him to keep his "finger on the pulse of what is going on." Some teachers, required to team up in a single classroom to reduce the teacher-student ratio, have found that they enjoy the close collegiality.

Still, building space is widely acknowledged as a problem. The mayor, who also serves as ex-officio head of the school board, has initiated the first large-scale school construction project in more than 30 years. He accomplished this by changing a law that required any capital expenditure over one million dollars to be placed on the ballot for a referendum. The revised law changes the cap to five million so that, with the help a 90 percent state subsidy, they can more easily build schools without public ballot approval. Soon, the city will have large schools with four classrooms per grade level. The new schools also will have science labs, so program leaders will need to address the challenge of integrating what happens in the science room with the core science curriculum.

The construction of new buildings will have many ripple effects. The new schools will prompt changes in teaching, administration, and learning. As the former assistant superintendent for curriculum remarked, "I think the building of the new schools is the most significant thing that has happened in the city, because it has deep psychological and philosophical implications."

**District Improvement Efforts:** Two major improvement initiatives have been launched in Sycamore, and both will influence the future course of the science program. The district instructional program, science included, now has a "Blueprint for District Improvement," created by a committee appointed by the mayor. The program is built from outcomes of a two-day "educational summit" the mayor organized that involved about 200 community stakeholders. It is a call for high academic performance, improved facilities, improved relevance to workforce needs, community service, and increased involvement of business. It reflects the perspective of the former assistant superintendent for curriculum who noted a shift in psychology, away from "settling for less...because Sycamore was not 'good enough'" toward asking for the best for all students. The plan includes support for better facilities and maintenance, class size reduction, and higher achievement on CTAP (Comprehensive Testing and Assessment Program) scores. It also cites the need to budget for teacher professional development. The plan does not single out individual subject areas, but emphasizes CTAP subjects (including science).

Sycamore also has a more detailed, but similar, District Five-Year Strategic Plan published at the beginning of 2000. This plan embodies strategies for improving achievement (in terms of CTAP scores), improving facilities, increasing community involvement, and ongoing staff evaluation. The district requires principals to develop School Improvement Plans to address these goals. The state has improvement expectations for CTAP scores, school by school, based on scores in the first "baseline" year, and 13 of the 28 Sycamore elementary schools have met them in science. Individual subjects are embedded in the general headings of the strategic plan. Science, for example, is addressed through inclusion in the broad goals of curriculum improvement and professional development.

**Increased Teacher and Administrator Turnover:** Until very recently, the turnover rate of teachers and administrators was extremely low; many have been in the district for 20 years or more. Data from the survey administered by this research project demonstrates that well over half of responding teachers have taught for more than 20 years with about a quarter reporting that they have spent those 20 years in the same grade. One principal remarked that in 17 years of being a principal, she had yet to hire a new teacher. However, with many retirements on the horizon, Sycamore, for the first time in many years, will be hiring large numbers of new teachers. Many principals also are retiring, prompting a significant number of new administrative hires.

Sycamore educators also worry that it will be difficult to find individuals with the same commitment that the retirees brought to their positions. One retiring principal commented that the new population of teachers and principals "won't have the dedication that the current generation has" and that the "new population won't stick with it as much...the kids are needy [and] this takes a toll." He explained that teachers have to be "priests, social workers, counselors...the family problems are getting more and more serious...kids are coming in undisciplined." Historically, principals have come from the teaching ranks, but the role is less appealing to teachers today because, according to the science coordinator, the "principal's role has become much more difficult over the last several years with the state accountability issues." This increase in retirement represents a significant loss of commitment to and understanding of the science program.

## PROGRAM HISTORY AND DEVELOPMENT[2]

Allison Stowe, the current K–12 science coordinator, created, and since 1989, has overseen a strong districtwide kit-based science program. Along the way, Stowe enjoyed support from the assistant to the director of curriculum, who then became the assistant superintendent for curriculum and instruction and who eventually left the district in June 2000. During those 11 years, Stowe worked with three superintendents. The first supported the inception of the program. The second experienced the early origins of the program as a principal, and then supported it as assistant superintendent and finally as superintendent from 1993 to 2000. The third superintendent took over in September 2000.

### *Program Origins*

While the current program "officially" began in 1989, it evolved from a hands-on science program that was in place from 1971 to 1979. The program, funded by the National Science Foundation (NSF), the Elementary and Secondary Education Act, and other grants, was run by a Catholic school science teacher. Under her guidance, a staff of up to 12 science specialists in K–8 supported the use of *SAPA*[3] (*Science, a Process Approach*), *ESS*[4] (*Elementary Science Study*), and other kit-based science units across the district. They brought the kits to schools, did demonstration lessons, and urged the teachers to do follow-up lessons until the next visit. The success of this model varied. While some say that the teachers did follow up, others recall that the teachers didn't do any science between visits.

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

3 *SAPA* was developed under the auspices of the American Association for the Advancement of Science and first published in 1967.

4 *ESS* was developed by Educational Services Incorporated (now Education Development Center, Inc.) in Newton, Mass., and was first published in 1969.

During this time, the program was earning the support of what would be one of its strongest advocates. A principal who saw the science program working superbly in his school would eventually become the second superintendent overseeing the development of the new science program in the 1990s. He explains that, as a principal, he was quick to support the implementation of the program because "...the earlier firsthand positive experience I had ... with a similar program." He was disappointed to see the program dissipate in 1980 after passage of a state ballot measure that resulted in loss of the funds needed to support the specialist teachers. According to the former assistant superintendent, the program disappeared and the "kits went into the closets."

At the same time that the kits were at their height of use (the mid 1970s), a Head Start Follow-Through program was in full operation in Sycamore. This program had a philosophy and pedagogical approach that was compatible with the science program and seemed to reinforce its growth. The Follow-Through schools received federal money from 1967 to 1985 to provide ongoing support for Head Start kids in four of the lowest income Sycamore schools. The Bank Street College of Education was the professional development mentor for Follow-Through, and the principal-turned-superintendent explained that as part of the program, he and others received intensive professional development in child-centered education. Because the philosophy of this program and the kit-based science pedagogy were mutually reinforcing, the Follow-Through schools were a spawning ground for inquiry science leadership. In those years, Stowe was a teacher and then professional developer in the district.

The philosophy of this program and the kit-based science pedagogy were mutually reinforcing.

The early legacy of the Catholic school teacher's program and Follow-Through programs permeates the district even now, over 20 years later. The second superintendent commented, "Having been a principal when the [science] program started, it allowed me the opportunity to come in on the ground floor...I was allowed, as others were, to really get a feeling for the program before it even started." He also remarked that the Follow-Through program had "one of the most qualified overall staffs I have ever seen...every one of those people, in some shape or form, did become an integral part of the school system in another role." He went on to say, " I happen to think the reason these people went on to become innovative leaders in other teaching positions or administrative positions in the school system was the fact that they got outstanding training and implemented an excellent program back then."

From 1980 until 1989, a textbook science program was in place, but many teachers did hands-on science on their own. Many teachers were philosophically committed to hands-on science from their experiences with the NSF program, but they did not have the needed resources and support. As

"Science was the stepchild to language arts and math."

one principal recalled, "science was the stepchild to language arts and math." After a fiscally lean time in the early 1980s, funding for education began to grow in the state, and Stowe and others were eager to begin a new hands-on program. They wanted it to be classroom-teacher-based, without specialists, because they remembered that the old program ended when specialist salaries were eliminated. As the assistant superintendent stated, "It was based on sustainability right from the start."

"It was based on sustainability right from the start."

### *The Genesis of the Current Program*

In 1988, Stowe convinced the assistant to the director of curriculum to abandon textbooks and support a new kit-based program. That same year, the state offered money for buying kits, and a committee assembled and chose two second grade kits developed at nationally recognized science museums. The following summer, in 1989, Stowe led a team to the first National Science Resources Center (NSRC) Leadership Institute. There, the team added to their knowledge through contact with leaders from other established programs across the country, and learned about other kit-based units.

In the fall of 1989, the two second grade kits were introduced to all the second grade teachers, with 2 1/2-hour trainings led by Stowe and an expert Follow-Through science teacher. Stowe also made sure that Sycamore provided centralized materials support from the beginning. The next year, in 1990, Stowe became a full-time coordinator of the science program and, in the next three years, kits were introduced across all the grades and the program extended to all classrooms, with four or more units at each grade. Over time, newer kits have been added to strengthen the program. The present kit curriculum is listed in the appendix.

As the program developed, centralized materials support continued, as did districtwide kit training, but there also was considerable additional school-based professional development. "Peer coaches," nominally one per school, helped colleagues by request while still teaching full time. Most of the peer coaches had attended about 100 hours of voluntary paid training at intensive NSF-funded summer institutes at a nearby university. This program, which ran from 1993–1996, focused on training individuals as "trainers." This was the genesis of the peer coach staff.

In 1993, Sycamore started to participate in its state's NSF-funded Statewide Systemic Initiative. This connected them to some development activities outside of Sycamore. Stowe and a team also attended additional conferences sponsored by the NSRC and meetings of the ASMC (Association of Science Materials Centers), which have given them national perspectives on science education and contributed to their thinking about the Sycamore program. Then, in 1997, they participated in a network of urban school districts organized by Education Development Center, Inc., (EDC) in Newton, Mass.

An important development in 1999 was the creation of four new K–12 curriculum director positions in science, mathematics, language arts, and social

studies. These new positions were specifically added to the school budget by the school committee to bolster student learning. Stowe was made K–12 science director, and she hired a strong peer coach to be a resource teacher for the K–5 program. Stowe will be very busy with grades 6–12, and the future growth of the K–5 program will depend significantly on the skills of her successor.

### *Looking to the Future*

In 1999, after 10 years, the program was reaping the fruits of its stability and supportive district leaders, teaching staff, and school environments. Under Stowe's creative leadership, it had grown steadily with few external funds and minimal support from outside the district. However, in the school year 2000–2001, several major changes took place that would bring shocks to this comfortable system. The very supportive superintendent left, as did the assistant superintendent, who had been closely involved from the beginning. Six new large elementary schools were being planned, which would relocate more than half of Sycamore's students. While the new, modern, and much larger schools will offer extensive new opportunities, they pose a threat to the continuation of the spirit and collegiality that thrived in the older, smaller buildings.

In 1999, after 10 years, the program was reaping the fruits of its stability and supportive district leaders, teaching staff, and school environments.

Finally, many experienced teachers—some 30+ year veterans—are retiring, and numerous new teachers will join the staff. Also, class size reduction in grades K–2 is in progress, subsidized by the state, and will double the staff at those grade levels. Principals, many of whom are veterans, are also retiring; five left at the end of the 2000–2001 year and at least seven more are expected to retire within the next two years. The superintendent expects that few Sycamore teachers will want to fill those jobs, so new principals are likely to be from outside the district and new to the science program. The teaching staff will become much younger and have more highly varied backgrounds. As a result, the necessary professional development for both teachers and principals will escalate. The appendix includes a timeline of the history of the program.

## THE CURRENT PROGRAM

Teachers and administrators in Sycamore talk about the science program with a shared sense of understanding and commitment. Their descriptions of the goals and purposes of the program vary somewhat, but they are united in their view that the program is focused on meeting the needs of the children of Sycamore and instilling in them an enduring interest in science learning throughout their lives. The second superintendent initially described the goals for the program as, "trying to teach science concepts." But, he went on to explain, "more importantly is...get students and staff to use all of the senses in a way that allows them to (a) understand what science

They are united in their view that the program is focused on meeting the needs of the children of Sycamore and instilling in them an enduring interest in science learning throughout their lives.

is all about, and (b) find science as a useful tool throughout life." He continued, "[the program] teaches the ABC's and the 123's of science on the one hand, while developing other critical skills that kids are going to need to survive, at least economically in life." He believes that the program has reached its goals at the elementary level as far as implementation goes but is careful to say "you are never fully there." He notes that it is important to "continually evolve it into a program that continues to meet the needs of the kids."

Sycamore's principals echo the former superintendents' views. One principal described the goals of the program as helping students understand that science is a way of relating to their world. Another suggested that they are focused on "helping students become more aware of what's around them...ask better questions, [and] explain. They are challenging each other...that give-and-take makes it better...that's what the district would hope." And still another suggested that among the goals of the science program was an interest in developing an appreciation of science.

In Sycamore, teachers and administrators are driven to consider the goals of the science program from the perspective of supporting their student population to be productive, engaged citizens in the community and beyond.

Sycamore educators are deeply committed to their students, who in the past, have been the victims of low expectations and limited opportunity. The former assistant superintendent, for example, explained her interest in having children develop their own sense of inquiry and that she would like to see them "owning the question." Similarly, a principal portrayed the program as having a lot of integration with language arts and social studies all moving toward the goal of making kids aware that "this is their world." She explained that the program placed emphasis "not on teaching them, but letting them investigate." Another commented that her hope was to "teach the kids to ask questions and find out the answers to those questions." These comments reflect the notion that, in Sycamore, teachers and administrators are driven to consider the goals of the science program from the perspective of supporting their student population to be productive, engaged citizens in the community and beyond.

## Curriculum[5]

### *The Science Program*

The basic science program is spelled out in a memo that Stowe sent to elementary principals at the start of the 1999–2000 school year. It included the following guidelines:

1. Kindergarten has four required modules; grades 1, 2, 4, and 5 have five; and grade 3 has 6, of which one is math/science.
2. Teachers must teach to the state framework inquiry standards and content learning standards aligned to each kit module.

5 For an overview of the curriculum units used at this site, see Appendix D.

3. The time to be allotted in grades K–2 is four periods per week plus language arts integration. For grades 3–5, five periods per week are required, plus language arts integration.
4. In all grades, students must write to explain their science concept understanding in each lesson. Grades 2–5 have a *Science Writing Resource Guide.*
5. There is a science vocabulary list to be used for each unit, and a grade-level vocabulary.
6. Formative assessments have been developed for the grades 2–4 kits, to be used to assess students' understanding.
7. Silver Burdett and Ginn textbook material and *FOSS Science Stories* are to be used in conjunction with the hands-on modules, after the activities, to consolidate children's conceptual understanding.

In addition to this brief memo, a *K–5 Curriculum Guide* for science outlines expectations, philosophy, and resources. Also included in the memo is a list of the specific units for each grade and their associated text chapters. The kits comprise a combination of *FOSS*[6], *STC*[7], and *Insights*[8] units with a minority of the units composed of locally developed, science museum units that date back to the beginning of the program. The latter are being replaced over time. The kits as of 2000–2001 are listed in the appendix.

Stowe's communication about the science program is clear.

Stowe's communication about the science program is clear. When asked how she knew what to teach, a new teacher interviewed explained that "the kits are required" and that she hears about them in frequent communications from the science department. Information from the survey conducted by the research staff of this project provides further evidence that both principals and teachers have heard Stowe's message about the science program. Teachers and principals both report that teachers teach close to (if not exceed) the number of expected kits. Furthermore, when asked how often they use science kits, nearly all teachers responding said that they use kits "very often." Similarly, nearly all of the principals responding stated that the use of kits provided by the district or school was "very important."

In general, teachers love having the materials provided for them in the kits. They see the students enjoying them and, in turn, they enjoy them as well. The use of the materials varies, from those who teach the kits as they are written, to others who adapt and add to the materials. One teacher, for example, does some supplemental activities and tries to tie the kits to "thematic units...to tie everything to the science unit."

6 *FOSS (Full Option Science System)*: Developed by Lawrence Hall of Science, published by Delta Education.

7 *STC (Science and Technology for Children)*: Developed by National Science Resources Center, published by Carolina Biological Supply Company.

8 *Insights*: Developed by Education Development Center, Inc., published by Kendall/Hunt Publishing Company.

The science staff circulates kits each quarter so that each is used four times per year after being refurbished at the materials center. The center is staffed by one full-time employee who is an education student and who also serves in the important role of part-time substitute for peer coaches when they visit others' classrooms. The annual budget for the materials support system and the manager is secure.

In addition to the school curriculum, students have access to additional resources and supplements, including a field trip or traveling lab visit (supported by various local science institutions) for each grade level once a year. Each grade level also has an opportunity to visit a nature trail and study center that the peer coaches created at one of the schools. The peer coaches have also designed "Families Do Science" nights, with take-home bags of materials for parents and children. Other science related activities include a new program initiative with NASA. Aided by a NASA liaison, the team is working to develop curriculum materials primarily aimed at middle school but still intending to include K–5. Still other activities include a Family Math and Science Center housed at a middle school and funded by the state to be staffed one day per week.

### *Extending to Other Subjects and Grade Levels*

Stowe has been working to update the science program and better coordinate it with the state framework as well as other subject areas.

Stowe has been working to update the science program and better coordinate it with the state framework as well as other subject areas. For example, in 2000–2001, Stowe replaced three old units with new *FOSS* kits. These were selected for their quality, but also with an eye toward improving the match to the state framework. She bought *FOSS Readers* to go with them, and has kit-related supplementary reading throughout the curriculum.

Stowe also is reaching out to include technology. The district technology coordinator is integrating the two or three computers per classroom into the science program and, working with Stowe and a technology coach, has developed one "computer connection" with the science curriculum at each grade level. Following Stowe's model, she has enlisted 22 "computer peer coaches," trained them, and established them as school consultants on software and minor hardware problems. She is coordinating the use of word processing, graphing, and spreadsheets with the kit-based curriculum. She also is developing computer-based extensions for one unit per year in collaboration with Stowe and the coaches.

By all accounts, most, if not nearly all, elementary teachers are teaching the kits.

The district has given some specific attention to literacy, and while one principal commented that science incorporates literacy with "no competition," there is no question that it is a present and emerging priority. Some of the principals spoke of a "literacy initiative" in their schools and, in one case, the school had a literacy coordinator and a 2.5-hour literacy block in the schedule. An administrator was quick to comment that "all of the literature has been in support of the science program," meaning that the topics of the literature is aligned with the science topics. This comment is corroborated

by the survey information that demonstrated that about 75 percent of responding teachers used science related nonfiction literature either often or very often in their classrooms. Similarly, about 75 percent of the principals responding reported that the use of science related nonfiction literature was either moderately important or very important.

The elementary program also has strong ties to the middle schools and the high schools. A middle school resource teacher and the head of the high school science department until 2000–2001 were both specialists in the Sister's early kit-based K–5 program, and the resource teacher moved to working out of the Office of Instruction before going to the middle school. They are supportive of the K–5 program, and seem ready to improve and better articulate the secondary program under Stowe's leadership. She faces a challenge at the middle level that grows out of the aging and inflexible staff and poor facilities. And at the high school level, Stowe believes that the dearth of good secondary materials will favor a slow improvement.

## INSTRUCTION

One of the striking aspects of Sycamore is the extent to which science is a part of almost all students' instructional experience. By all accounts, most, if not nearly all, elementary teachers are teaching the kits. Information gathered through the survey shows that nearly all of Sycamore teachers report that their students design and carry out investigations of their own questions in either some or most lessons and that nearly all students do structured hands-on activities following specific directions in either most or all lessons. The new superintendent, who had made it a point to visit all of the schools in his first three months, commented that he was surprised to see so much science. He remarked, "...I have been a superintendent or assistant superintendent for 25 years, so it was unusual; I was struck by how unusual it was for me to see this."

Researchers asked to visit classrooms with science instruction at a level that represented a realistic goal for what could be accomplished across the district. All observations were of complete lessons; in only one case where the lesson was part of an ongoing process the engagement and wrap-up were not observed.

Researchers observed 15 classrooms in 11 schools of various sizes and ages. The sample included two teachers who were peer coaches, seven who had more than 20 years experience (about average for Sycamore), and five who were new to teaching or new to the district. The new teachers were all in first and second grade classrooms, but their practice was not significantly different from that of the more experienced teachers. Typically, the classes had 15–20 students. The majority had classrooms with student work in science and materials and/or posters about science displayed. The lessons were 50–90 minutes long. All the teachers taught with confidence, and the

***Water and Words***

The teams of first graders are mesmerized by their new equipment. Each child, with an eyedropper and a sponge, meticulously practices the skill of producing individual droplets for today's study of water and evaporation. When they have mastered the task, teacher Mary Marcusen sets the stage for their investigation by reviewing student observations from the last science lesson. "Today, I'm going to give each one of you a piece of wax paper, and you are going to be scientists and look at the water closely with the hand lens. What might we look for?" One student eagerly speculates that she might look to see if the water goes through the paper. Another wants to see if it rolls off the paper, and still another wants to see if it will spread out or stay in a drop. They get started.

As they work, Ms. Marcusen encourages them to try different approaches. She asks, "What if you put two drops on the paper?...If you

have more than one drop, is there a way to make it only one?...Can anyone get all of the water off their paper?" After the children have had time to explore and observe, Ms. Marcusen gathers them together to discuss their observations. She reviews the predictions they made at the beginning of the session and then records their "discoveries." When one student describes seeing the drops "stick together," Ms. Marcusen introduces the word "cohesion." She explains, "it's a big word...let's clap out the three syllables together." She writes the word on a card and adds it to their science vocabulary chart. They finish the lesson by adding the class's discoveries to their class science log.

great majority of the students were engaged. From this evidence, it seemed clear that the science program was well established for both the students and teachers.

Many classes illustrated the importance of aligning science instruction with other district priorities, in this case, literacy. Most teachers expressed a serious interest in teaching vocabulary. The district approach to vocabulary is that it is best developed in connection with concrete hands-on experiences. The district also is interested in incorporating student writing into the science curriculum, and in about half of the classes, there was some writing beyond merely filling in a worksheet. And yet, based on comments from a focus group, some teachers felt there should have been more. Overall, the observations showed all teachers using the kit-based materials with more than half using the materials as written and the remaining teachers employing strategic pedagogical strategies and adapting and/or supplementing to promote increased understanding of conceptual content. All of the teachers seemed to feel confident in teaching the kits, and were adept at leading students in discussions that covered the material of the units.

Teacher interviews most often took place immediately after classroom observations. In those conversations, teachers reported that their primary goals were stimulating kids curiosity, increasing their enjoyment of science, and building their inquiry skills. They made some comments about content, but it was clear this was not a dominant driver of their instruction. Some teachers reported using textbooks, but only as an adjunct, to be read after the hands-on lessons. Information from the survey demonstrated that more than half of the teachers "very rarely" or only "sometimes" used textbooks with another quarter simply responding that the question was not applicable. The principals' responses to questions about the use of textbooks differed somewhat. Over a third responded that textbooks were "moderately important," illustrating a gap between teacher and principal perspectives on the role of textbooks in the Sycamore science program.

When asked to speculate as to why the program had lasted as long as it had, one teacher commented "because it is required," suggesting that the message of support from the central office had reached her quite clearly. She also commented that many teachers' discomfort with the subject of science "makes them want the kit." Still, one teacher commented that some teachers complain that the program "takes their creativity away." So, while support is widespread, it is not universal.

They were aware of how the time pressures on the teachers made it hard for them to do it all, but felt that science did help instruction across the curriculum.

Principals also were widely supportive of the program and under the impression that the great majority of their teachers were teaching it. Their impressions seemed based on information that was not very detailed, and none volunteered a specific anecdote that indicated classroom observation of science teaching beyond a quick look. They were aware of how the time pressures on the teachers made it hard for them to do it all, but felt that science did help instruction across the curriculum, which contributed to it being taught.

## Assessment

The state administers a science test (CTAP) at the fifth grade. The CTAP was developed by the state to enforce their standards with a high stakes graduation requirement and to generate pressure on schools by publication of school and district scores in the newspaper and on the Web. All the CTAP test items are released annually. The 1999 test, given in May, had 34 multiple choice questions and 4 extended response items. The alignment of the test items to an inquiry science program is questionable, so it is possible that raising scores on this test will require some concentration on facts and test taking. The science program efforts to improve performance on CTAP are double-barreled with textbook chapters aimed at the multiple choice questions and some assessments and writing efforts aimed at the vocabulary and writing emphasis of the extended response items.

CTAP has been able to maintain the status of science as a core curriculum subject.

While the presence of the test provides some newfound support for science teaching, science still doesn't rank with mathematics and language arts since those scores are the only ones considered when determining high stakes consequences. And yet, the CTAP has been able to maintain the status of science as a core curriculum subject. Sycamore's CTAP scores are lower than the state average, but still significantly higher than the english/language arts and mathematics scores, which protects Stowe from pressure to change the program but may give her less priority for resources. Referring to the CTAP, one teacher's comment seemed to evoke continued support for the science program saying, "We didn't have to do as much running around for science as other programs...It [the science program] worked...". With the increased attention to science the test brings, in 2000–2001 Stowe was able to use $30,000 of district money to improve the kits. At the same time, the test has had negative consequences, such as an emphasis on vocabulary and the need to use text material to cover areas not addressed by the kits.

There was little evidence of parental interest in CTAP scores, but Stowe still wants to improve them, and the district Blueprint asks her to. The state has funded afterschool tutors to help students with low CTAP scores (curiously, students are selected for this tutoring based on their scores on the Iowa Test of Basic Skills), but the emphasis has been on math and literacy. At eight schools, the tutors are using a program in science that Stowe has created, mainly based on exemplary tasks developed in Vermont and the *Insights Mystery Powders* unit. Literacy and mathematics tutoring are supported in all schools.

Also stimulated by CTAP needs, Stowe and the peer coaches, with an outside consultant, have created unit-based assessments at each grade level that are based on free response and performance items. They are designed to match the open-ended CTAP questions and have grading rubrics that define the four CTAP levels of Advanced, Proficient, Needs Improvement, and Failing. In parallel, writing has been supported by the district language arts coordinator through the introduction of a program called First Steps, from

Australia, which emphasizes expository writing. This is a natural match to the science program. A recent development, which also to some extent reflects the CTAP framework, was to add an inquiry experience at each grade level in which students will design an investigation.

CTAP was discussed often, always as a positive, if sometimes intimidating, influence. It was given credit for more teacher adherence to the program and for better teaching, and also as a source of stability for the program due to the perception that the program is aligned with it. A fourth grade teacher invents mini-CTAP quizzes and feels they are a good teaching tool. He said, "When CTAP first came in it was overwhelming, but I like it now." Still, the superintendent notes that should some evidence emerge that their program is not sufficiently aligned with the test, there is no doubt that changes would have to be made:

> We can't afford to continue to develop a program we feel strongly about, we think makes sense, that we support, if the state says no, we are not going to measure you that way...If that is going to happen, then as much as we believe in this, we are going to have to change and adapt because the state will not accept the fact that we have a rationale as to why, in the measurement they have used, we might not have done as well in.

## Professional Development

Stowe brings a powerful background to leading professional development activities. She taught for 12 years in grades 2, 3, 4, and 5, and then was a staff developer in the Follow-Through program. During that time, she and a colleague created science curricula and kits for Follow-Through teachers, and provided support for their use. The end of Follow-Through brought her to the whole district as a staff developer and then founder of the present program.

### *Peer Coaches*

Sycamore has 26 peer coaches who comprise the foundation of Stowe's professional development work. Nineteen of the current peer coaches were trained as part of the NSF program co-led by Stowe and a chemistry professor from a local state university. Through this program, two cohorts of teachers received 100 hours of training from 1992–1995. Since then, professional development for peer coaches has been ongoing, but has varied. Even so, seven schools do not now have peer coaches (some have more than one). As teachers retire, there are an increasing number of new peer coaches who did not get the 100 hours of training from this early program. In the past, new peer coaches have learned from workshops, from Stowe, and informally from their colleagues. However, in 2001 (perhaps due to the increased attrition and number of new peer coaches, some of whom are new to the district), the district offered a 16-hour peer coach training course with weekly meetings.

The peer coaches' role in the schools is to help teachers improve at teaching inquiry science through classroom observation, coaching, and debriefing, when requested. The coaches have no formal authority, so all of their work is negotiated. In one school, for example, where the coach is relatively new to the school (in Sycamore, "relatively new" is 12 years), her colleagues don't necessarily respond to her the way they would to a "veteran." So, peer coaches work with teachers by invitation only, and typically focus on only a small number of teachers at any given time. They troubleshoot, provide advice, and help new teachers get comfortable with the kits and start teaching from them. Then, once they get teachers "beyond the kit," they focus on more of the specifics of teachers' instruction.

The coaches have no formal authority, so all of their work is negotiated.

After peer coaches identify who they want to work with, they let Stowe know and she tries to arrange for coverage, sometimes using the materials support manager as a substitute. Their time budget is two to four half days when their classes are covered during each quarter. In this time, they do a range of formal and informal visits focusing on a variety of needs. They begin by working with identified teachers for a designated amount of time and then move on to others in the building. It is not clear how much formal "peer coaching" they do. Some explain that their role is like being an assistant in the classroom and, recently, with many new teachers coming on board, they are just trying to get these teachers acquainted with the kits.

The 20 peer coaches meet with Stowe once a month. The coaches are exemplary, capable teachers who form a strong, close-knit support group. In addition to their school-based coaching, they provide Stowe with support by assisting with many district-based professional development activities, including kit trainings. Recently, for example, peer coaches led schoolwide workshops to discuss the connections the science curricula carry from grade to grade. They also provide a vital communication link with principals and a feedback path from schools and teachers to Stowe.

### *Kit Training*

When the district introduces new kits, all teachers are required to participate in kit trainings led by peer coaches. These are the only common professional development experiences all teachers have. The trainings typically last about 2-1/2 hours during the school day and are conducted in small groups of 10 or so . Teachers also have an option of participating in later, 1-½ hour "revisiting the kit" workshops. Veteran teachers, most of whom have been teaching kit-based science for 10 years or more, feel they can easily master a new kit that has a thorough teacher's guide. They rarely use the peer coaches. New teachers, on the other hand, get help from their peer coaches and grade-level colleagues.

While this amount of training is somewhat less than what other districts provide, teachers have a positive view of it and of the backup provided by the peer coaches. Teachers uniformly applauded the training and felt that it

was of appropriate design and length and very beneficial. The survey demonstrated that more than a third of responding teachers felt "moderately prepared" to teach science and over half felt "very well prepared." No teachers responded that they were "not at all prepared." Principals' responses to a similar question demonstrated that they didn't have the same level of confidence in teacher preparation. About a third responded that they "strongly agree" that teachers are well prepared, but over half responded that they either "somewhat disagree" or only "somewhat agree" that teachers are well prepared.

Although kit trainings are offered and required when a new kit is introduced, new teachers don't always have access to trainings on old kits. Due to the historically low teacher turnover, this has not been a significant issue until recently. Many of the new teachers interviewed were teaching kits for which they were not trained, though those that had had workshops valued them. Videos that accompanied the *FOSS* kits also were praised as an important aid. Few of them mentioned using a peer coach, but they valued the possibility of support from the program when needed.

### *Other Professional Development*

After initial training, Stowe provides opportunities for a variety of voluntary professional development activities. Each year she offers different opportunities that are designed to expand horizons for eager teachers and for her leaders. She has recently placed a priority on improving the inquiry and experimental design aspects of the science program.

Each year she offers different opportunities that are designed to expand horizons for eager teachers and for her leaders.

For example, Stowe has created some sessions to build the teachers' expertise for working in their own classrooms. In 1999, the peer coaches worked with Stowe to create and lead a week-long summer inquiry institute. This institute was designed for school-based teams and required the principal attend for at least one day. They designed a similar but shorter institute in 2000. The institutes were designed to replicate inquiry institutes at the Exploratorium in San Francisco. These sessions mirror the philosophy of inquiry by having participants work with materials and, in some cases, echo the kinds of experiences they expect their children to have.

The 2000 inquiry institute was offered to about 35 teachers for two days, with a planned follow-up during the school year of four "callback" sessions. One observed callback session had a very good organization, with ample opportunities for teacher participation. Participants discussed children's questions about science, teachers' questions about pedagogy, and assessment issues in a very full one-and-one-half hour session. Teacher engagement seemed spotty, perhaps because it was the first such callback session. Stowe reported that the second session was organized to include more small-group work, and was much better received. It seems clear that Stowe will continue inquiry institutes and the form will evolve as she learns how to make them most effective.

In addition to the work focusing on inquiry, teams of teachers have been formed to develop a program where teacher teams (led by peer coaches) study student work to hone their skills in analyzing it, so as to gauge the needs and effectiveness of instruction. Stowe also is working with a local state university to create new credit courses that will support good science teaching for both in-service and pre-service students, with a hope that the courses will be required for new teachers in the district. Stowe and the peer coaches also have developed guides and kit materials for "Families Doing Science," including take-home bags given out with them. Stowe also has organized sessions focused on content that are led by high school and college science faculty. Finally, there is a hope among the four curriculum directors (including Stowe) that there can be a coordinated institute for all new teachers in the summer.

On a limited basis, professional development is available for principals as well, first, as part of the summer institute teams described above, and then occasionally as part of the principals' regular meetings. In addition, five principals—all veterans from the early days of science specialist teachers and Follow-Through—went recently to an Exploratorium Inquiry Institute. Stowe's intention is that they will spearhead a new staff development effort to help all principals better understand and support the program. They seem to understand the program, in general, quite well and appear to be strong supporters while relying on the peer coaches to help make it work in their schools. Still, the turnover issue applies to principals as well as teachers, and Stowe is very aware that she will need to educate new principals about the science program as they arrive.

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A gap existing in the professional development is support of teachers for science content education. When asked what she would do differently if she had it to do over, Stowe replied that she would have put more emphasis on content from the start, instead of just concentrating on having kits used in the classrooms. The newly emerging connection with the local state university may provide this resource (see section on partnerships below), and the peer coaches and teachers can get significant science content from the high school teachers, who have provided some workshops. Further content activities, as well as the strengthening of inquiry science skills, are on the agenda for future staff development.

As for Stowe herself, she has participated in several national programs that have provided her with a broader perspective and connections to others doing similar work. For example, she has been part of EDC's network of elementary school districts that has helped her connect with 20 other science education leaders engaged in implementing hands-on elementary science districtwide. She also has attended meetings of ASMC and Next Steps conferences sponsored by NSRC, both of which helped illuminate new ideas and strengthen her ability to be creative and strategic in her leadership.

# DECISION MAKING AND LEADERSHIP

### *District Leadership*

Sycamore's new superintendent started at the beginning of the 2000–2001 school year. A former high school social studies teacher, he has been a superintendent in six other districts, including a blue-collar steel mill community similar to Sycamore. He enthusiastically described the rewards he has felt building excellent education programs in communities like Sycamore. Since he arrived he has visited almost all of the schools and principals, as well as a great number of classrooms. He conveyed enthusiasm and confidence that the district will move forward despite financial challenges. He spoke well of the school committee and of the mayor who he said is "smart, well educated... and believes in education."

The superintendent has been very impressed with the science program. He commented, "I have never seen anything like this, at this extensive level" and remarked further on the commitment of the teachers. He visited a "festival" Stowe put on for the peer coaches and "had never seen such hands-on science and articulated curriculum done by peer coaches."

The superintendent seems to be willing and eager to delegate and draw from the strengths of the staff already in place. In January 2001, he had not yet hired a new assistant superintendent for curriculum and instruction (the preceding one had nurtured the science program for a decade), but emphasized that he was going to depend on this person to improve instruction across all subject areas, and that his own role would be to provide administrative support and resources.

There is a new team of four K–12 curriculum directors: Stowe in science, plus three other very capable people in math, language arts, and social studies. They currently are involved in some common efforts, including visiting classrooms, helping vice principals focus more on instruction rather than discipline, and planning a summer institute for new teachers. They expect that their work will be closely coordinated so curriculum work in other subject areas is likely to complement and coordinate with the science program. And yet, their work is to some extent on hold until a new assistant superintendent is hired.

Over the years, the former assistant superintendent for curriculum had requested supervision positions for the curriculum areas, but it had always been viewed as "impossible within the budget." So, when school committee approval finally came (she speculates that it was a result of the CTAP stimulation of interest in having more direct supervision of the subject areas), she was ready and staffed the positions with a very impressive team before she left. Together, the four of them have a common vision of student-centered learning across the curricula and are closely coordinating their efforts. As for the new assistant superintendent, the superintendent explained he

would tell the new person, "You have four very talented curriculum coordinators who know what they are doing and listen and learn and go with the flow..." and "they have great ideas." He wants someone who "believes in and agrees with what they are doing."

While the team of directors is strong, they must act in the face of an uncertain budget. The departing assistant superintendent allotted them $15,000 each to keep them going after she left, with more hoped for from her successor. There is a definite feeling of equality among them, although at present, Stowe is the only one with a "staff," in the form of her K–5 resource teacher. Stowe used to get all the Eisenhower funds, but has now agreed to share them 50/50 with the math director; her share was $35,000 in 2001. Though all the directors, like Stowe, have K–12 responsibility, they speak of a strong commitment to maintaining and strengthening the K–5 efforts. The directors meet together weekly, and they meet individually and as a group with principals and assistant principals.

While the team of directors is strong, they must act in the face of an uncertain budget.

### *Science Program Leadership*

Over the years of its growth and development, the program has had active central office support from the superintendent, the assistant superintendent for curriculum, the business manager, the directors of special education and technology, and from the new K–12 language arts director, who has worked with Stowe for some time. They all supported the kit-based, hands-on pedagogy and the way that Stowe had built and maintained the program. This support has been valuable in that it has nurtured the perceived importance of the programs in the minds of principals. One principal commented, for example, "Foremost is the commitment of the district to the program...from the top on down...it has to come from the top...."

Now that the assistant superintendent for curriculum has left, Stowe faces some uncertainty about how much administrative support the science program will receive. That assistant superintendent provided Stowe with representation to the superintendent and the board, supported her belief in inquiry science from the very beginning of the program, and funded Stowe willingly. She was a co-leader as well as a smart, perceptive, thoughtful supporter. In talking about sustainability, one teacher said that if either Stowe or the assistant superintendent left, the program would be OK, but not if they both left. Of course, the assistant superintendent has indeed left, and the new one will have a big impact on the future of the science program.

Since becoming K–12 director, Stowe has had a full-time K–5 resource teacher. The resource teacher is a long-time participant in Sycamore education, beginning as a parent community liaison in Follow-Through. She was a teacher for 13 years in K–2 special education, and has been a science peer coach since attending the second summer institute. She was a literacy and math expert before that. She is clearly a very strong person, well prepared for her role as the new mainstay of the K–5 program. She and Stowe are

"finding their way" in the job sharing. She enjoys professional development and has led a 16-hour workshop for peer coaches. She also is taking responsibility for the logistics of kit distribution, and for materials procurement. Additionally, she has worked with pilot teachers on the big ideas of the kits and on integration. She has no strong formal science background, but she has learned on the job from the workshops and she has experts to consult when she needs to. She has been to two Exploratorium institutes on inquiry and one on assessment. The 16-hour course for peer coaches described above was her idea. It seems clear that by selecting her, Stowe has ensured that the K–5 program will be well tended to in spite of grades 6–12 pressure.

In general, there is a sharing of science program leadership between Stowe, the K–5 resource teacher, the peer coaches, and the senior teachers. However, Stowe is the key person who worries about the problems, strategizes, and makes decisions about how to act. From teachers to the superintendent, many characterized her role as fundamental to the program and cited her commitment and leadership as instrumental in supporting it. As the former superintendent commented, Stowe and the former assistant superintendent's "...enthusiasm and willingness to go above and beyond" was key, along with their "ability to then work with elementary school principals and staffs, and convince them that this was the direction to go."

Many characterized Stowe's role as fundamental to the program and cited her commitment and leadership as instrumental in supporting it.

One teacher even characterized her as "a gift from God." Stowe seems to lead more by providing the right opportunities and the right context than by charisma and exhortation. Looking back at the steady progress of the program over 10 years, she has been thoughtful, strategic, and patient, key leadership traits for the long haul.

### *Communicating Decisions*

The district has done a careful job of creating a set of K–12 learning standards in science and technology. The drafting committee included Stowe, three of the instructional leaders dating back to Follow-Through, and eight other K–12 teachers. The learning standards fuse the Sycamore program and the largely fact-based State Learning Standards. Teachers and principals in the district take them seriously.

Stowe has recently distributed to all teachers and principals the memo summarized by the seven points on page 8. In part because Stowe is highly respected and in part due to the decision-making culture of the community, the memo appears to have the force of law. Thus, between the standards and this memo, the goals and structure of the program are directly communicated to all. Central office administrators were all well aware of the basic philosophy of the program, which they supported. The recent emphasis on student inquiry and on summer inquiry institutes is now sending a message about the importance of that element of the curriculum.

Due to the decision-making culture of the community, the memo appears to have the force of law.

Communication with principals beyond the written memos is mainly based on their interaction with peer coaches. The small schools give principals

many opportunities to visit classes and interact with teachers and peer coaches informally. Principals also have appreciated the Families Do Science nights as a means for connecting with parents and have called them a big success.

# RESOURCES AND SUPPORT

## Funding

The school committee, with city council approval, sets the budget total. It is funded by state money, and local tax money is required to match or exceed a statewide minimum. During the past several years, under the state Education Reform Law of 1993, this minimum level has steadily been increased, to a current $6,500 per pupil. The state money is very important to Sycamore. It is poor, and ranks near the bottom of the state in net worth of value. As a result, it receives 80 percent of its education budget from the state. However, the floor is set by the legislature, which is unpredictable, but during the past few years money has been increasingly available. The City Council has the power to disapprove the budget, but generally does not oppose the school committee's submissions.

Once the budget total is approved, the school committee starts to allot specific amounts to individual departments and programs. The science program makes modest demands, and according to Stowe, they are not contested. The kit refurbishing budget is firmly institutionalized in the budget process, and Stowe and the former assistant superintendent obtained numbers of small and specialized grants from the state and foundations that help support special professional development activities and some instructional materials needs. The district supports peer coaches for their time at two-hour monthly meetings.

The Sycamore science program has not received any large grants (though they have had small amounts of support through their participation in others' professional development efforts and initiatives). The assistant superintendent for finance noted that grants are "not all profit," meaning that writing proposals and administrating grants takes a good deal of staff time and energy. In the future, he plans to provide more centralized grant management support. He explained:

The Sycamore science program has not received any large grants.

> The hard part with every grant is when you get a program going, then the grant itself simply goes away and that becomes a problem, especially if you are funding people. If you are just funding supplies...that is a fixed cost; it just kind of keeps going with you. People costs keep going up. People costs are traditionally far more expensive than the materials costs. So normally speaking, it is fairly easy to maintain a program's

> materials. Once it is there and once the educators decide that that is what they want to do, then you just build it into the budget and fund it. There is no magic to it. We don't go out and try to find the money in some obscure corner of the city or of the budget; It is there.

Even without large grants, the Sycamore science program has not suffered financially. The assistant superintendent for finance suggests that if Stowe needed money, she would simply go to the assistant superintendent, and if it was for a good idea, she would get the funds. He is clearly a fan of Stowe and the program and, thus, a strong ally in supporting it. He explained that the central office tries to help people with initiative. In light of Stowe's widespread respect and credibility, science program financial resources at the level she has asked for over the past several years seem to be securely institutionalized.

Principals get some discretionary money distributed on a per pupil basis. Then, if a principal wants more money for science, he/she approaches Stowe, and then she takes the request to the assistant superintendent. The assistant superintendent then decides what strategy to use to find the money either from her own budget or she will go to the business manager and see if he could find the money. As he explains, "It becomes very subjective, you can't fund them all, but...we try to help somebody out who has some initiative to go do something...If somebody has the initiative to look at something and say that might work and try to figure out how to fund it, then I usually like to try to figure out how to fund it." He summed up the nature of funding as having "no hard line between the program, the funding, where the funds come from...There is either a program, or there isn't. If there is a program, if the instructional people want the program, within some reason, there is generally some way...to fund it." The decision really rests with the assistant superintendent.

"If somebody has the initiative to look at something and say that might work and try to figure out how to fund it, then I usually like to try to figure out how to fund it."

## Community and Partnerships

Sycamore is in the process of developing several partnerships. A longstanding partnership with a local state university is once again emerging as a strong support for the program. The main contact person, the chemist who collaborated with Stowe on the peer coaching program, left there some time ago, and the connection languished. Now, the former assistant superintendent in Sycamore, as director of outreach to schools and teachers at the university, is working with Stowe to create new in-service and pre-service courses. She explains that their most significant outreach will be to "train or to educate the new crop of teachers who are going to be taking over these classrooms, because there is going to be a tremendous drain." Should this come to fruition, it could be an important support for the program and a significant step toward linking the established program with pre-service education.

The school district also has a relationship with a small, privately endowed, nonprofit education and research center. It has a staff of seven with three in education and others focused on research on endangered species. The center offers professional development through two-week summer institutes that focus on the local environment. The center's head of education works with Stowe to provide field experiences in marine biology for second and fifth graders. She has also developed a field-based program for sixth and seventh grade students on forest ecology.

A smaller partnerships is in place with the Audubon Society and there exists a long-standing connection to the local museum of science. For example, the museum gave the district a two-year grant for professional development and school visits for three schools, and, in the future, they expect to offer one-week "sabbaticals" for Sycamore teachers.

The schools' relationships with parents are strengthened in various ways. For some, it is through the Families Do Science nights. Another school invites parents and their preschool-aged children on field trips. The principal of the poorest school in the district said that parents would never come to an ordinary meeting, but they have turned out with enthusiasm to do science with their kids. These events involve a large number of parents and are seen as very effective ways to build their understanding and support of science.

## ACCOUNTABILITY

The state assessment, CTAP, has had a strong influence on the science program in Sycamore. The test sends a message that the curriculum must be aligned with the state framework and, in fact, adjustments have been made to the Sycamore program as a result. The State Standards and the state standardized test have put new pressures on the Sycamore science program, while at the same time have greatly strengthening its "political" clout by putting the priority of science closer to language arts and mathematics. Stowe has welcomed the "free response" science items that support including more inquiry and experimental design in the program. At the same time, the high visibility of language arts scores and the test's emphasis on writing have influenced the program to make closer connections to literacy and expository writing.

The test is viewed as a mixed blessing. While it imposes some pressures, it has helped to keep science on the front burner. When science was removed as a requirement for the exit exam, the program lost some of its influence and high profile. Parents, teachers, and community members who support the science program see the test scores as a way to maintain science as a priority in the minds of a range of stakeholders.

The test is viewed as a mixed blessing.

The former assistant superintendent suggested that when CTAP scores come in, the new superintendent will press Stowe to describe more clearly

what she is doing and why. But the superintendent's interest in CTAP scores did not seem to overshadow his faith in his subject area coordinators. Still, he was quite explicit about the heavy sword that the state test wielded over the science program, saying:

> We can't afford to continue to develop a program we feel strongly about…if the state says, "No, we are not going to measure you that way. We are going to measure you another way." If that is going to happen, then as much as we believe in this, we are going to have to change and adapt…the state will not accept [our] rationale as to why, in the measurement they have used, we might not have done as well.

Aside from the CTAP, few formal accountability measures exist to ensure that teachers are using the program.

Aside from the CTAP, few formal accountability measures exist to ensure that teachers are using the program. Accountability of teachers appears to be left to the principals, none of whom oversee science in any systematic way. Similarly, no formal process exists for ensuring that the principals are supervising their teachers' use of the science program. Principals did describe informal approaches to ensuring that science is taught. One principal, for example, commented that she "watches for and makes sure that there is a visible sign the kits are being taught" and another commented that she had plans to formally observe some science classes. The lack of formal accountability may explain the disparity between teachers' and principals' responses when asked, "Does the administration actively support science teaching?" In the survey administered by the research project, just over half of the responding teachers stated that they "strongly agree" while over three quarters of the principals responded that they are active supporters.

Even without formal accountability systems, the message is clear that science is "mandatory." Almost no one who responded to the survey or who was interviewed disagreed with the assertion that the district administration supported science teaching. One principal explained that teachers "have" to teach science five days a week. But based on the feedback she gets, she thinks that science is integrated throughout the program even though there is supposed to be a set time for science.

The kit inventories are the only source of concrete data about what is and isn't getting taught. An informal look can give one a sense of how much, and in what ways, the kits are being used. However, no one in Sycamore has assembled this data and analyzed it in a meaningful way.

## EQUAL ACCESS TO SCIENCE

Sycamore is a relatively poor community. Most of the schools are very old, with limited resources. Several principals characterized some of the students as quite "needy." One explained, "The kids come to school so developmentally unprepared...they need to learn to read." Sometimes teachers are

so occupied with meeting the range of student needs that "teaching doesn't happen every day...it just doesn't happen." While no one commented explicitly on equity issues, some remarked on their awareness of a wide range of students and economic resources in different schools. Some noted the newer "rich suburban" school as an example.

In this setting and with the widespread commitment to helping the student population, the science program has received recognition for helping students who otherwise might not have had opportunities to learn science. For example, the director of special education emphasized the value of the program in providing special needs students with "real, authentic" science, not the "watered down" science that special education students in other districts typically get. She explains, "Our kids don't have to have a remedial curriculum; they don't have to have a compensatory curriculum; they can actually have a very rich challenging curriculum..." For her, the science program represents an opportunity for success for the special education students. She elaborates, "It is not acceptable that some kids are not learning...it is not okay that overall test scores are low...no one has ever thought it was okay, but they have thought maybe that it is inevitable because of this type of population."

The science program has received recognition for helping students who otherwise might not have had opportunities to learn science.

One teacher's comments about the five special education students in her classroom underscore the director of special education's remarks. She stated, "If you were just using a text, they'd fall apart..," suggesting that the hands-on, student-directed nature of the classroom experience engages students who might otherwise be left behind. She went on to give several examples of her special education students' notable accomplishments with the science program, and then elaborated "when something like that happens, you say 'wow...this is worth it'." This same teacher also noted the value of the districtwide program in ensuring that when students move from school to school (as is common with some of the students), one can be sure that they have been exposed to the science.

The implications of equity for sustainability also are evident in the initiative to finally build new schools. The shift to constructing new buildings will cause changes in practice, perceptions of equity, and the ability to meet the needs of all children in the community. Prior to this, there was a passive acceptance of the fact that some students were in schools with little space, having no music rooms or libraries. The former assistant superintendent for curriculum remarked, "Our children don't have to be educated in buildings like this. They actually should be being educated in new, good schools with all of the resources available to them....It is not acceptable that they don't have that. I think that is very critical."

# ANALYSIS

The story of elementary science in Sycamore 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 Sycamore are discussed below. For an in-depth discussion of all of the factors, see the cross-site report of this study[9].

## Factors that Pertain to Surrounding Conditions

### *Culture: Respect and Collaboration*

The long lasting stability in the central office leadership and school staff created an exceptional context for the establishment and growth of the Sycamore program. The longevity of teacher and administrator tenure, very unusual in urban districts, benefited the Sycamore program in many ways:

**Organizational Memory:** The superintendent and assistant superintendent who supported the initiation of the present program were veterans of the Sycamore Schools who had seen the success of kit-based science in the past, and were eager to restore it when it was financially possible. There was a cadre of veteran teachers and principals, many of whom had previously experienced kit-based science instruction firsthand. Allison Stowe, who became the program leader, had been an expert teacher, specialist, and professional developer during the preceding decades, and was an ardent practitioner of hands-on science instruction.

**Consistency:** In planning kit training and other, later professional development, Stowe was not faced with the challenge of large teacher turnover, which is such a difficult issue in other communities. Most of the teachers who received training on a kit would continue teaching that kit for several

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

years to come, and there was no immediate need to organize continuous introductory kit training sessions on existing kits. Now, with the currently increasing retirements and new hires, Stowe is in a position to take advantage of the "embeddedness" of the program and not be faced with trying to train new teachers and establish the program simultaneously.

**Relationships:** Sycamore educators have known one another for many years, are closely knit, and treat each other with warmth and respect. As one principal commented, "We've gone through births, weddings, and deaths together over the years." The family-like environment of the school comes not only from many years spent together, but also from the fact that they have been working in small, cozy, albeit crowded, schools.

Sycamore educators have known one another for many years, are closely knit, and treat each other with warmth and respect.

The collegial closeness extends to the central office as well. Until the current superintendent arrived, all of the senior administrators who related to the science program had spent many years working together. As a result, they understand one another's styles; they know how to communicate and collaborate with one another with forthrightness and patience. Sycamore is not a place that one would describe as highly bureaucratic; it is friendly, collegial, and direct. Thus, Stowe and her colleagues interact with each other with respect and a shared sense of commitment to the students of the community. This environment has gone a long way to help the Sycamore program thrive.

### *Decision Making: Influence Comes with Familiarity*

The decision-making process that affects the science program is highly reflective of the nature of all interactions in Sycamore. Communications and their resulting decisions are continuous, friendly, and informal. Administrators and teachers share a commitment to the children in this community, and there is a pervasive level of trust that they each are acting in the students' best interests. This issue of trust is very significant for the science program as the time and effort that Stowe has given to the district already affords her a great deal of respect and support from others in the community. According to the assistant superintendent for finance, "There is a credibility factor with her that just says, 'If Stowe says it, the odds are damn good that it is true.'"

Familiarity with one another and shared trust and respect have helped this program go so far.

Familiarity with one another and shared trust and respect have helped this program go far. While Stowe has oversight over substantive decisions about some components of the program (e.g., curriculum and professional development), she also is vulnerable to decisions made outside of her control. In Sycamore, because Stowe is in such close communication with the highest level administrators, unexpected or unfavorable decisions come primarily from the state. Whether relating to finances or state testing, there is little Stowe can do except to use the decisions that are within her control to respond to those external pressures in a way that will keep the science program in good stead.

## Factors that Pertain to Science Program Components

### *Implementation: Slow and Steady*

From the start, the Sycamore program held to a strategy of slow, natural evolution. Stowe built the program on expertise from the past as well as on what she had learned from other successful programs. The program grew over a few years to include all the grades, with a full curriculum, without any large outside funding from NSF or others. She and the assistant superintendent used small sources of funds, from outside and inside the district, to build by evolution. They seem to have consciously created an inherently sustainable program, unthreatened by the loss of large external funding, as had happened with the previous specialist teacher project. The model that Sycamore presents is ongoing steady improvement over time of all aspects of the program, including change to meet new demands.

Now, they are continuously strengthening the curricula with new units and changes in old ones. And, according to one experienced teacher, "There has been an evolution from hands-on to inquiry." Stowe's present emphasis on inquiry professional development, plus the curriculum changes, is evidence that she has set goals beyond mere use of the kits as written.

### *Money: Slow and Steady*

The financial story of Sycamore is one of how smaller financial inputs contributed to a slower, more natural evolution—an evolution that was appropriate to its community culture.

The Sycamore program has had no large external grants to support the establishment, growth, or development of the science program. As the former assistant superintendent for curriculum described, when they set out to establish this program, they did so with the intention of not having it rely on funds from sources outside the district. They had learned a lesson from the loss of the Catholic school teacher's early science kit program that came with budget cuts in the early 1980s. The Sycamore program would be taught by classroom teachers and be supported with a district materials center.

Still, Sycamore did benefit from smaller amounts of outside funds. A state grant spurred the reestablishment of the program, and initial planning was supported by work with the NSRC. Furthermore, the foundation of Sycamore's professional development—peer coaches—was established as a result of an NSF grant given to a local university.

These smaller opportunities, by their nature of being small, allowed Sycamore a chance to put the resources of these projects to thoughtful use over time. Sycamore leadership drew from these resources and human

connections to guide their program through a natural progression embedded within the context of their community. Districts that receive large grants, while enjoying the benefits of having financial resources, often don't have such an opportunity to design and adapt the program thoughtfully. Rather, their work is targeted to funders' interests, guidelines, and timelines. Additionally, Sycamore district leaders were true to their words that ensured there would be internal financial support for the program as well. Funds for refurbishing kits have been embedded in the district budget, as have funds for Stowe, the materials center and staff person, and now her K–5 resource teacher.

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Still, a possible threat to the program does exist from the state. As a poor district, Sycamore depends greatly on state money. This dependence was evidenced in teacher layoffs from the early 1980s that included the loss of the science specialist teacher. Should there be another state budget crisis, money that the district commits for the science program could simply disappear. However, the present political atmosphere places education in such a high priority that this kind of threat seems improbable at this time. Yet the ongoing dependency is real.

### *Leadership: Leaders Well Matched to the Culture*

**Central Office Leaders:** During the years of establishment, growth, and development, the Sycamore program enjoyed a stability in program and district leaders that is rare. Not only did the superintendent, the assistant superintendent for instruction, and other leaders in the central office contribute their verbal support, but they also concretely demonstrated their commitment through financial support and direct engagement in program planning. Part of this support was due to a commitment to child-centered learning that was seeded through a Follow-Through program that was concurrent with the science program's early origins. Their support that has been unwavering, even in the vulnerable years when the current program was first put in place, has set a foundation of expectation for teachers and principals that remains today.

**Science Program Leaders:** One source of the commitment has been the continued, consistent respect they have for Stowe, her work, and her commitment to the program. As colleagues who value her efforts they have a "can-do" attitude about finding financial resources and are quick to offer other supports for improving the science program. Stowe's personal modesty and commitment to the students certainly contributed to others' interest in helping her. And since she has been in Sycamore for many years, she is able to negotiate the Sycamore system with a style well matched to their informal no-nonsense culture. But also important is the fact that her strategies were modest as well: manageable, reasonable, and doable. The new organization with Stowe as K–12 science director and a new K–5 coor-

dinator will certainly create a change, but it could end up being one that benefits the program by creating space for a new leader who can bring new insights and direction to the program.

Her strategies were modest as well: manageable, reasonable, and doable.

Nearly universally, Stowe is widely admired as a creative and effective leader. There is clearly some recognition that if she left, it could be a major threat to the program. But no one expects her to leave since, until recently, people in Sycamore rarely have. Stowe has been a strong leader who has been able to strategically support the program by taking advantage of opportunities while positioning the program against potential threats. Her commitment to the goals of the program balanced with her openness to input from others has provided the program with a fluidity that has enabled it to expand with the good times and weather the bad.

The peer coaches, who are the primary leaders for the science program at the school level, are valuable supports for classroom teachers and the professional development needs of the program. And yet, logistical and cultural constraints leave them an untapped resources in many ways. They have no formal authority to oversee their teacher colleagues, nor do they necessarily want such authority. Still, they do want the attention of their colleagues and their colleagues' willingness to participate in and improve science instruction. While the need is probably greater, the peer coaches go only where they are invited and work one-on-one with teachers as needed. Despite many of the coaches in-depth training, they often spend time providing basic support for teachers getting started with new kits or new teachers who are using the kits for the first time.

The peer coaches are valued by the teachers and principals alike and seen as the source of all information about the science program. Now, Sycamore is facing a loss of experienced peer coaches in some schools and looking at the new challenge of identifying and, more importantly, training the new peer coaches. Once again, the historical stability of staff that has helped the Sycamore program become more and more firmly established is waning.

## Factors that Pertain to the Whole Science Program

### *Critical Mass: Establishing Commitment*

Sycamore has had the rare experience of reaching critical mass, a milestone in any kind of educational change. As used here, "critical mass" refers to a number of teachers engaged in a practice so that it becomes the standard of use—the convention—of the district. They have enjoyed low teacher turnover and the steady support of resources devoted to introducing teachers to the instructional materials and developing their expertise. Program leaders in Sycamore have had the luxury of moving sequentially from establishing the program to expanding its growth and development without having to give attention to high numbers of new teachers or new superintendents.

That situation is about to change. The schools will become larger and more impersonal, and the surge in new staff hires will require that program leaders devote new energy and resources to introductory professional development for both teachers and principals. Program leadership will need to carefully balance the allotment of resources between introductory kit training and more in-depth focused professional development.

However, "critical mass" can refer to more than sheer numbers of teachers. In Sycamore, there also was a critical mass of belief and commitment. There was widespread articulation of what the program is, what its benefits are, and what they are hoping to accomplish with it. When beliefs are widely shared, the program can withstand pressures and upheaval that could not be weathered with only a critical mass of numbers—commitments to the underlying beliefs are essential. (See discussion of philosophy below and the cross-site report for further discussion of philosophy and belief.)

In Sycamore, there also was a critical mass of belief and commitment.

### *Adaptation: Being Proactive and Reactive*

Stowe's actions over the years offer evidence of two kinds of approaches to adaptation: She has been both proactive when opportunities have presented themselves, and she has been reactive in the face of threats. For example, with the arrival of the CTAP, Stowe stepped up efforts to generate kit-related assessments that reflected the kinds of questions asked on the state test. This was a reaction to an external pressure that led to adaptations in how program resources were focused. Ultimately, this decision seemed to have contributed to the ability of the program to endure because students are better prepared and the science program as a whole seems better aligned with the test.

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At the same time, over the years Stowe has acted proactively to take steps to further the interests of the science program. For example, in the early years, Stowe drew from the experience at NSRC to learn from others and develop a strong, informed strategy for establishing the science program. In later years, Stowe again focused on learning from the expertise of others in national professional conferences. Both kinds of actions, implemented with thoughtfulness and care, contributed to the growth and development of the Sycamore science program.

### *Philosophy: Shared Belief in the Fundamentals*

The belief in the science program and its value for students is widespread in Sycamore. This commitment, at least among the many veterans in Sycamore, is due in part to strong support for a previous program (Follow Through) which emphasized the importance of student-centered learning. With Stowe, the former superintendent, and many teachers and peer coaches as Follow-Through veterans, the groundwork was laid for initiation and establishment of their hands-on science program.

There is no question that when science is taught in Sycamore, it is taught primarily (and almost exclusively) using hand-on approaches. Similarly, there is a pervasive view that teaching science is indeed an important, expected part of the Sycamore curriculum. Data from the survey confirms that nearly all teachers believed that science was "very important" (over three quarters) or "moderately important" (almost one quarter). Similarly, all of the principals responding reported that science was either "very important" (over two thirds) or "moderately important" (one third).

It is interesting to note that even in light of this consistency, teachers and principals often don't accurately perceive each other's level of support. For example, while over two thirds of principals reported on the survey that science was "very important," just over half of teachers reported that their principals felt science was "very important." More striking is the fact that almost two-thirds of teachers reported that science was "very important" while their principals reported that only about a third of their teachers felt it was very important. So, while there is indeed a widespread shared belief in teaching hands-on science, it is not necessarily perceived as such by teachers and principals.

## SUMMARY

The Sycamore program has grown over 12 years to become a securely established part of the district and community. The program seems so firmly institutionalized and so effectively connected to the system, from top to bottom, that the idea of it disappearing seemed completely foreign to many. A typical comment was, "Why would you want to get rid of a program that works so well?" The former assistant superintendent described the science program as being "embedded" and wondered out loud if that's why she had a hard time thinking about influences on its sustainability. In her mind, it already was embedded in the larger districtwide program. In addition to its integration into the educational structure, the program has exhibited continual growth and improvement over the years and, in doing so, has established a basis for strong support at all levels. As the business manager commented, "It is the curriculum...how could you not support the curriculum?"

However, within the past year there have been many changes. The old stability has gone. A new superintendent has arrived, and a new assistant superintendent, who will have the most direct impact on the science program, is yet to be hired. The community also is entering a process of hiring many new teachers. The aftershocks of this new influx of educators has yet to be strongly felt by the science program, but it is sure to call for significant attention from Stowe and other district leaders.

At the same time, several sources of future stress on the Sycamore program are on the horizon. First, Sycamore is headed into changes that result from building new schools. No longer will they be sharing conversation in a cramped but cozy corner. Soon, the teachers will be in large schools with

several grade-level colleagues; something they never had before. The fact that the new schools will have labs could undermine the program by suggesting that science need not be taught by the classroom teacher. And finally, the collaboration of the curriculum directors could end with competition. The ultimate impact of these changes on the science program is yet to be seen, but the leadership, strategic implementation and adaptation, and financial management of the past, combined with the supportive culture, suggest that the Sycamore program has every opportunity to continue to evolve and be sustained into the future.