Researching the Sustainability of Reform

BAYVIEW

Staff of the Center for Science Education (CSE)
Education Development Center, Inc. (EDC)
Newton, Mass.
Jeanne Rose Century
Abigail Jurist Levy
Felisa Tibbitts
Mary Jo Lamberti

and

Staff of the Caltech Pre-College Science Initiative (CAPSI)
Pasadena, Calif.
Jerome Pine
Pamela Aschbacher
Ellen Joy Roth
Melissa Jurist
Cynthia Ferrini
Ellen Osmundson
Brian Foley

ACKNOWLEDGMENTS

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

Center for Science Education
Education Development Center, Inc.
55 Chapel Street
Newton, MA 02458-1060
800-225-4276

This report and other project information can be found at http://www.edc.org/cse

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

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

TABLE OF CONTENTS

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.

Please direct any inquiries about this study to:
EDC Center for Science Education
55 Chapel Street
Newton, MA 02458
617-969-7100

Dr. Jeanne Rose Century	Abigail Jurist Levy
x2414	x2437
jcentury@edc.org	alevy@edc.org

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.

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

OVERVIEW OF PROJECT SITES

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

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

BAYVIEW
EXECUTIVE SUMMARY

INTRODUCTION

Bayview School District's (BSD)[1] elementary science program is a story of champions, evolution, and uncertainty. Thirty years ago, John Evers championed hands-on science teaching in Bayview by establishing one of the nation's first kit-based programs. Driven by Evers' desire to grow and improve, the program evolved, making its way through a series of improvements, testing, and revision, and now is embedded in the district. Over time, it survived the challenges that face many districts committed to hands-on science: changing demographics, economic instability, political pressures, and shifting priorities. The program's adaptation and evolution has helped to establish and strengthen the district's shared understanding of the importance of the science kits and the philosophy behind their use. Today, Bayview is grappling with accountability and assessment, the same issues that concern districts without such long-established programs. Additionally, the program's historic champions are leaving the district after decades of dedicated service. It is uncertain how the factors that have characterized and sustained Bayview's kit-based science program in the past will fair in the months and years to come.

CONTEXT

Community Overview

BSD serves students in five suburban communities located about 10 miles from the center of an urban area with a population of over one million. There are 22 elementary schools, 4 middle schools, 4 high schools, and 1 alternative high school. Since the mid-1980s, BSD has undergone a far-reaching demographic change. At that time, the district, which surrounds a regional airport, was bisected by the expansion of a second runway. As a result of this expansion, the student population dropped dramatically from 32,000 to 18,000 with a little over half of those students in the K–6 elementary schools.

The resulting smaller district has battled with the environmental and economic impact of airport growth ever since. High-income neighborhoods lie at one end of the district with the other end occupied by high-poverty households where up to 80 percent of the students in some of the neighborhood schools are eligible for free and reduced price lunch. With the fourth largest number of students eligible for free and reduced price lunch

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

in the state, the numbers continue to rise and have tripled since 1990. During the 1999–2000 academic year, 41 percent of the students in the district were eligible, compared with 31 percent statewide. Additionally, 87 percent of the students receiving English as a Second Language (ESL) services (10 percent overall) are below the poverty level. Ethnically, BSD remains a predominantly white district. In 1997, the total population was 57 percent white with 18 percent Asian, 12 percent African American, and 10 percent Hispanic. Less than 3 percent are Native Americans.

Budget

The process for funding the science program has remained stable since its inception in 1966. Every year since the program began, the science program has had a line item in the budget and the science coordinator has always had the authority to make the decisions about how to spend the program's money. Revenues for the science program come partly from district funds and partly from another, more creative source. For the past 15 years, Bayview has been renting its kits to eight neighboring districts. Currently, Bayview charges a fee of $10.00 per student per year, which covers the cost of materials for the district and one full-time clerk.

Issues of Local Importance

Regional Airport: The noise from the nearby regional airport has been a serious concern in the district for decades. In addition to this problem, much of the district's residential property is close to the airport, which has discouraged higher income homebuyers from settling in the area.

Teacher Turnover: Of the approximately 600 elementary teacher positions in the district, there has been a turnover rate of around 12 percent per year over the past five years. With about 70 elementary positions having new hires each year, the level of teacher experience has dropped. One reason for this high turnover is a salary differential of as much as $6,000 per year between Bayview and neighboring districts. Other nearby districts also have wealthier students with fewer special needs, which may make them still more appealing to teachers. These circumstances, combined with BSD's poor facilities, make teacher recruitment very difficult.

Decay of School Buildings: The condition of Bayview's physical plant has become so poor that in September 1999, the superintendent declared the buildings were in "emergency condition." In 1999, the superintendent appointed a 40-member committee to evaluate the condition of all buildings and make recommendations. The school board unanimously agreed to put a $297.5 million construction bond to the voters on September 19, 2000. The new bond would pay for 10 new elementary schools and major renovations at four schools. Unfortunately, the bond issue was voted down, and the problem of inadequate facilities continues to plague Bayview.

PROGRAM HISTORY AND DEVELOPMENT

Program Origins

In 1965, John Evers, an eight-year veteran high school chemistry, math, and physics teacher, was recruited to fill the recently vacated position of K–12 science coordinator. A serious and energetic advocate for science instruction, Evers visited elementary teachers across the district and noticed that they were teaching very little science and, even in that instruction, they were using only textbooks. Evers decided to get some firsthand experience himself and substitute taught, sometimes for prolonged periods, in elementary classrooms. He reviewed the existing curricula, reflected on the content and instruction, and had a committee of elementary principals to advise him on matters of material adoption. With these experiences under his belt, Evers looked ahead to the possibility of developing a new curriculum and convinced the principal's committee to "hold off" buying new textbooks in order to develop an expanded, inquiry-based elementary program.

The superintendent was very impressed with Evers' plan for the program. He decided to provide financial support for the program but apparently misunderstood the budget requirements. He awarded Evers the entire three-year budget for the first year of implementation, a fact that still surprises and amuses Evers. The plan had been ambitious—to begin curriculum development in the summer of 1966, pilot one kit for each grade level 1–6 in the fall, and have the program officially begin in January of 1966. The "windfall" additional funding, in Evers' opinion, allowed the tight timeline to succeed. Thus, the entire program was conceived, planned, funded, written, piloted, and implemented in three years. All 24 completed science kits underwent development, evaluation, and revision simultaneously, a pattern that continues to this day in Bayview. According to Lisa Cooper, who has succeeded John Evers as coordinator of K–12 science, a basic tenet of the program is that "the units of work are never finished."

The Middle Years

The 1970s was a period of adaptation for Bayview with external pressures that required Evers to make physical and financial adjustments in the program. By 1975, the nearby regional airport added its second runway. Although this was advantageous to surrounding industry and the growing city 10 miles to the north, the new runway divided the district neatly in half, clearing away a wide center of roads and housing. In addition to interfering with the district's infrastructure, the residential space that remained was closer to the airport with its noise and traffic. The result was the closure of 25 district schools and a nearly 50 percent drop in enrollment.

The dwindling student population, while posing many challenges to the district, brought an opportunity for the science program. With the reduction

of enrollment, science kits that had been prepared for a larger population of students went unused. Concurrently, several neighboring districts approached Evers about using Bayview's kits. So to benefit each party, Evers rented the kits, thus securing additional revenue to support the program.

As the program progressed through the 1980s, changes in staffing brought new leadership while the existing leaders moved to other parts of the district administration, assuring continued support for the program. Lisa Cooper, an elementary teacher who had been working on "Project Summer Study," was hired as a mathematics/science specialist, essentially a teacher on special assignment outside the classroom. By the end of the 1980s, Cooper had become the coordinator of K–12 science, and Evers had become the assistant superintendent of curriculum, where he would continue to advocate for science.

Recent Developments

In 1994, John Evers left Bayview to become a National Science Research Council (NSRC) consultant, and Cooper assumed sole oversight of the science program. She grew into the role of coordinator quite naturally, having worked closely and comfortably with Evers for over 10 years. As Cooper's responsibilities increased, Molly Bradford-Jones was hired in 1993, primarily to oversee the then-active $500,000 National Science Foundation (NSF) teacher enhancement grant for staff development in assessment. Funded through several sources, Bradford-Jones has continued to work closely with Cooper, working almost full time for the program. Together, Cooper and Bradford-Jones are the key central office staff for mathematics and science in Bayview. A new transition in leadership is inevitable, however, as Cooper looks toward her own retirement in the next few years.

THE CURRENT PROGRAM

Curriculum

The science curriculum in Bayview consists of three or four core kits per grade level along three strands: physical science, life science, and earth/space science. The kits include a mix of locally authored and commercially produced units that are aligned with the district, state, and national content and performance standards. All units also include an evaluation sheet that asks teachers to assess the interest and practicality of the kits. While few criticize the commercially developed units, many prefer the local kits, feeling that they are more substantial or more developmentally appropriate.

Materials Center

The science materials center, which has been a foundation of the program throughout its evolution, is responsible for collecting, refurbishing, and

delivering kits to teachers. The center is housed in a former school building and managed by the same person who has run the center since its inception. In addition to the manager, whose position is currently funded by the kit rentals, the materials center employs three full-time employees funded by the district. Each school has a scheduled weekly delivery day for pick-up and drop-off of kits, and the center uses a full-time district warehouse driver for deliveries. The work is seasonal, with all 4,000 kits returning to the center in the spring for refilling and redistribution to the schools during the fall.

Instruction

Many teachers, principals, and central office administrators share a common view of what inquiry science teaching is, describing it as "brainstorming," "asking questions about why 'it' really happened," and instruction that emphasizes children's involvement with science as opposed to merely observing it. While instruction represents a range of styles, the teachers structure their lessons in a fairly similar way. Most use the district's kits to facilitate a prescribed hands-on lesson, sometimes supplemented with their own science materials. Although the hands-on lesson is the primary activity, teachers also lecture, ask students to present their work, and in a limited number of instances, have students investigate their own questions about the phenomena under investigation.

Assessment

The arrival of the state science standards has increased the urgency of the district leaders' efforts to encourage teachers to pay closer attention to student learning in science. In 1999–2000, a new report card format for grading students in science was implemented. Rather than a single letter grade summarizing a student's achievement, the science content standards are itemized, and teachers must define the level of mastery each child has achieved relative to each standard. As one principal commented, "The hope is, instead of just saying, 'This kid likes science, give him an A,' we now need to have evidence that the kids have completed the work."

Professional Development

Historically, professional development in Bayview has been voluntary for both new and veteran teachers. However, teachers who were certified after 1987 must, over five years, complete either 150 university- or approved professional development credits or 450 district-provided clock hours to maintain their teaching credentials. Bayview provides its teachers with pay incentives for completing either route. In addition, teachers have 12 days of professional development available to them, three supported with state funds and nine with district funds. Most recently, the district's professional development has focused on improving teachers' reading and math instruction with the aim of improving student test scores.

Professional development in science is facilitated by a network of teacher experts whom Cooper has cultivated over the past 15 years. Cooper and Bradford-Jones recruit facilitators by finding teachers who are particularly interested in science and working informally with them to expand their knowledge of kit usage, assessment, or inquiry processes. Once they've gained a sufficient amount of experience and knowledge, Cooper asks them to help design and facilitate professional development or lead kit-training sessions. As a result of this gradual learning process, the science program enjoys a reserve of well-trained facilitators who have from 2 to over 20 years of experience in the district. In return for leading professional development sessions, they receive stipends from district funds.

DECISION MAKING AND LEADERSHIP

District-Level Decisions

In the past, central office administrators have been relatively complacent about the elementary science program. However, now that Cooper and Bradford-Jones have presented the new science content standards that accompany the state academic requirements to the school board and the superintendent, they are demonstrating far greater interest than they had in the past. With the increased attention, the current superintendent, in his eighth year as of 2001–02, and the board are starting to create some pressure for the science program. He is asking questions that haven't been posed in years such as, "Does everybody teach the units?" and "What are the statistics?" This increased attention holds both positive and negative implications for the science program. Increased priority may be good, but increased scrutiny may be a challenge to contend with.

School-Level Decisions

As educational leaders of their buildings, principals play a significant role in determining the degree to which the district's educational programs are delivered. Thus, their understanding of the science program is important, as is their willingness to press their teachers to teach it. Cooper and Bradford-Jones meet with the principals monthly to maintain their familiarity with the program and professional development opportunities. Although Cooper also invites principals to attend all professional development workshops, few have done so. Principals report feeling the same pressures to improve reading and mathematics scores as teachers do, and as a result, feel they have little time to devote to science.

Science Program Leadership

When John Evers came to Bayview to serve as science coordinator, he brought a great deal of enthusiasm for inquiry science, as well as natural gifts important for a program leader. Today, several key personnel make

decisions affecting the Bayview science program. Cooper, Bradford-Jones (the mathematics and science specialist), and the assistant superintendent of curriculum and instruction, all participate with input from principals and teachers who interact with them. Several features of Cooper's tenure differ significantly from when Evers was leading the program. First, Cooper oversees science and mathematics in the district, a scope of work that is extremely challenging and, perhaps, unrealistic because mathematics is the object of much attention in the current environment of accountability and testing. Second, Cooper does not have the same degree of control over budget decisions that Evers had, due to her slightly lower placement in the hierarchy. And finally, Cooper has to contend with constraints on the budget that were not an issue during Evers' tenure. Resources he had at his disposal are now disappearing, resulting in program cuts. Without Evers' rank and command over the budget, Cooper is at a disadvantage when trying to advocate for the program. In addition, after more than 30 years in the district, Cooper is nearing retirement and the program faces another leadership transition.

RESOURCES AND SUPPORT

FUNDING

Internal Funding

Managing the variability of resources and program needs has been an important aspect of the program's sustainability. A reliable source of revenue has been the kit rental program. At a 2001–2002 rate of $10.00 per pupil, rentals generate about $150,000 per year, which has enabled Bayview's program to continue to grow and reinvest in quality materials and personnel. Another pool of resources has been the funds for curriculum development and revision. These monies originate from the budget set aside for textbook adoption and vary from year to year. When kit development is needed, and especially when aligning the kits to the standards is required, $20,000 or more can be accessed from this source.

External Funding

Bayview has grown and sustained its science program with surprisingly little outside funding. One important exception was a nearly $500,000 NSF grant entitled, "Improving Science by Improving Assessment." This four-year grant, part of NSF's Teacher Enhancement Program, was awarded to BSD in 1993. It funded Bradford-Jones's position and professional development for all elementary teachers. The professional development focused on expanding teachers' content knowledge relative to specific science units and developing assessments for those units. Cooper recollected, "The professional development was probably the best shot in the arm we could have

had. We impacted a lot." The assessment work is still visible in professional development in science writing available to all interested teachers. Smaller grants also helped the program carry out specific projects in the late 1970s and early 1980s.

COMMUNITY AND PARTNERSHIPS

The Northern Center for Science

The Northern Center for Science (NCS), a regional nonprofit science center, has long been closely allied with the Bayview School District. Founded in 1962, NCS has offered professional development workshops in Bayview since its earliest days. Back then, professional development offerings were "scattershot," according to the associate director of education at the Center. They offered 10- or 15-hour content-based workshops to Bayview and other districts. In the past decade or so, in the wake of science education reform movements, the center has provided longer, more specific workshops targeting districts' specific curriculum materials with a concentration on questioning strategies and inquiry in elementary science. Bayview also used its most recent NSF funds to hold summer institutes and follow-up sessions at the Center. The Center also has played a role with Bayview in their curriculum development efforts, helping to revise science units so they were aligned with the state science standards.

Parents

The parents in Bayview learn about the science program primarily through curriculum nights, newsletters, and district-designed pamphlets. The district's booklet, "Student Learning: A School and Home Partnership," covers curricula for each of the elementary grades and includes a section on each content area where the state standards/skills are listed, along with small-scale family activities to help meet these standards. Additionally, some teachers write and distribute their own classroom newsletters that include take-home experiments and other science information. So far, efforts seem to be successful.

ACCOUNTABILITY

The state science standards, which Bayview adopted in 1998 in concert with the coming state test in science, have had a tremendous impact on the elementary program. Cooper, Bradford-Jones, and an interested group of teachers worked to align the district science units with the state science standards as well as the state mathematics standards. The impetus for these curriculum changes is the Forester Assessment of Student Knowledge (FASK), the state's new testing program. Currently it covers math, reading, writing, and listening, and is administered in grades 4, 7, and 10. The state

piloted the science portion of the test for grade 5 in spring 2001, and began voluntary testing in 2002. Required testing in science is scheduled to begin in 2005, and pilot-testing in social studies, health and fitness, and the arts is planned for 2006. Ultimately, high school graduation will depend on passing grades on the FASK, but that is not expected until 2006.

While creating undesirable pressures for teachers and principals, the accountability system has positively affected the science program by raising its visibility. Cooper and Bradford-Jones felt that a test in science would keep it from being neglected by teachers and principals. However, according to some teachers, principals' attitudes toward science range from giving teachers permission to omit science from their instruction in favor of reading, writing, and math, to principals mandating that their teachers provide science lessons. Regardless of principals' inclinations, there is no systematic process for ensuring that science instruction will occur in their schools.

EQUAL ACCESS TO SCIENCE

Bayview's science program is described in district documents as "a world-class, student-focused, K–12 science program that provides all students with wide-ranging learning experiences…" Although there is no evidence that these goals are not being met, two features of BSD's science program have made providing science to all children an unlikely occurrence. First, teaching science has essentially been voluntary. Although it is expected that all elementary teachers will teach the curriculum, there are no mechanisms for holding them accountable for doing so. As a result, some teachers teach little or no science, thus denying their students Bayview's complete educational program. Second, the press for attention to reading and math scores has again left science instruction to those teachers who are committed and energetic enough to find ways to fit it into their schedules.

The antidote for much of this inattention may be the mandatory science test that will be included in the FASK in 2005. Teachers are increasingly aware of the state science standards and their alignment with the district's science units. Until this awareness translates into increased science instruction, however, children must rely on their teacher's personal interest and skill if they are to benefit from the elementary science program.

SUMMARY

Over time Evers and Cooper have carved out a tradition of developing and improving the program's science units and teachers' ability to use them. Nevertheless, as the program's professional development strategies and sources of revenue changed shape, some program values remained constant. The use of hands-on science units remained the only vehicle the district considered for the instruction of science, and the choice of teach-

ing science remained in the hands of the classroom teacher. It was impossible to tell how far the program spread across district classrooms and schools, but it was easy to see that those who knew the program, from central office administrators to classroom teachers, understood it deeply and were committed to its continuation.

The program is now facing another phase in its evolution. The lack of scrutiny regarding student achievement in science is coming to a close as state testing in science is on the horizon. Moreover, the beginning of science testing signals the end of the freedom that teachers have always enjoyed relative to science. As the imperative of high achievement gains in importance, the freedom of teachers to accept or decline the invitation to teach science is receding.

Such a transition raises many questions about the program's sustainability. With its 30 years of history, it is bolstered by a track record of weathering storms and the district's unwavering commitment to hands-on materials. But, the fate of many a program often rests with its ability to prove its impact. The Bayview science program has yet to be tested in this manner. How will students fare on the state's science test? If their achievement is sub-par, where will the administration and the parents look for efforts to improve? As new leaders emerge, the pillars of Bayview's program appear to be quite strong. However, the lack of accountability in the past has made understanding how far the program's support extends difficult to capture. As testing in science unfolds in Bayview, that may soon become clear.

BAYVIEW

INTRODUCTION

Bayview School District's (BSD)[1] elementary science program is a story of champions, evolution, and uncertainty. Thirty years ago, John Evers championed hands-on science teaching in Bayview by establishing one of the nation's first kit-based programs. He began simply by inviting teachers to consider this new approach to teaching science. Driven by Evers' desire to grow and improve, the program evolved, making its way through a series of improvements, testing, and revision, and now is embedded in the district. Over time, it survived the challenges that face many districts committed to hands-on science: changing demographics, economic instability, political pressures, and shifting priorities. The program's adaptation and evolution has helped to establish and strengthen the district's shared understanding of the importance of the science kits and the philosophy behind their use. As the assistant superintendent explained:

> I believe, as do a lot of people now, that the way to teach science is to have kids engage in it, not just see their teacher do some half-witted experiment once in a while. By getting involved, they learn the process and the content of science. That's what the kits are all about.

Today, Bayview is grappling with accountability and assessment, the same issues that concern districts without such long-established programs. As the pressure to document student achievement through standardized tests bears down, some of the program's hallmarks are changing. Program leaders no longer are extending "invitations" to engage in hands-on teaching. Now, teachers are required to provide their students with exposure to the science they will need to succeed on the impending state science tests. The program's historic champions are leaving the district after decades of dedicated service. In addition, the characterization of the science program's quality no longer rests only with its leaders, but is defined by the external measure of the state's science standards. It is uncertain how the factors that have characterized and sustained Bayview's kit-based science program in the past will fair in the months and years to come.

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.

I BELIEVE THAT THE WAY TO TEACH SCIENCE IS TO HAVE KIDS ENGAGE IN IT, NOT JUST SEE THEIR TEACHER DO SOME HALF-WITTED EXPERIMENT ONCE IN A WHILE.

CONTEXT

Community Overview

BSD serves students in five suburban communities located about 10 miles from the center of an urban area with a population of over one million.

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

SIZE	
Sq. miles	55
# elem. students	5,849
# elem. schools	23
# elem. classroom teachers	600
RESOURCES	
Per pupil expenditure	$5,973
Teacher starting salary	$27,467
NSF funds?	no
DEMOGRAPHICS	
% students eligible for free/reduced price lunch	40%
% white	57
% African American	12
% Hispanic	10
% Asian/Pacific Islander	18
% Native American	3
% Other	0
YEAR CURRENT PROGRAM BEGAN	**1966**

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

There are 22 elementary schools, 4 middle schools 4 high schools, and 1 alternative high school. Since the mid-1980s, BSD has undergone a far-reaching demographic change. At that time, the district, which surrounds a regional airport, was bisected by the expansion of a second runway. As a result of this expansion, the student population dropped dramatically from 32,000 to 18,000 with a little over half of those students in the K–6 elementary schools.

The resulting smaller district has battled with the environmental and economic impact of airport growth ever since. Most of the wealthy residents have long since left for quieter neighboring towns, leaving a student population that represents a wide range of socio-economic status with an obvious difference in wealth. High-income neighborhoods lie at one end of the district with the other end occupied by high-poverty households where up to 80 percent of the students in some of the neighborhood schools are eligible for free and reduced price lunch. With the fourth largest number of students eligible for free and reduced price lunch in the state, the numbers continue to rise and have tripled since 1990. During the 1999–2000 academic year, 41 percent of the students in the district were eligible, compared with 31 percent statewide. Additionally, 87 percent of the students receiving English as a Second Language (ESL) services (10 percent overall) are below the poverty level. Ethnically, BSD remains a predominantly white district. In 1997, the total population was 57 percent white with 18 percent Asian, 12 percent African American, and 10 percent Hispanic. Less than 3 percent are Native Americans.

Budget

Schools in the state are funded by a combination of federal, state, and local monies. State law provides for a specified level of funding for "basic education" needs, which in the past five years has composed about 81 percent of BSD's budget. The additional 19 percent must be raised locally through levies attached to property taxes, which take place every one to four years. In Bayview, where many families are poor and fewer than 25 percent of voters are homeowners with school-aged children, levies are a delicate issue, which directly impact the overall quality of education. As one district official remarked:

> If we didn't have these levies, basic education would be pretty dismal. You'd have an elementary school with just teachers and a principal, maybe a part-time custodian, maybe one person in the office. Every time we vote on a levy it's a big deal. Everyone is on pins and needles because if it fails, it's a major cut.

The budget is overseen by a five-member elected school board, which has ultimate authority over school finance and curriculum. However, daily operations and decisions are handled by administrative, department, program, and building-level personnel. Budgets are determined through a collaborative process, starting with the principals, who develop their own budgets

with discretionary funds allocated to their buildings. Principals also articulate suggestions (their own and their teachers') at monthly district-level meetings where district officials ultimately decide departmental budgets. Finally, the superintendent presents the budget to the board for approval, which is usually a smooth process.

The process for funding the science program has remained stable since its inception in 1966. Every year since the program began, the science program has had a line item in the budget and the science coordinator has always had the authority to make the decisions about how to spend the program's money. Over the past 10 years, the line item has seen little variation. For example, a per-student budget has always been set by the coordinator for kit maintenance and refurbishment. In 1998–99, this amount was $2.55 or about $46,000.

The process for funding the science program has remained stable since its inception in 1966.

Revenues for the program come partly from district funds and partly from another, more creative source. For the past 15 years, Bayview has been renting its kits to eight neighboring districts. This rental program has garnered between $50,000 to $160,000 per year, with the most recent year grossing $162,000. Currently, Bayview charges a fee of $10.00 per student per year, which covers the cost of materials for the district and one full-time clerk. The fee is expected to increase to $11.00 per student within the next few years.

Issues of Local Importance

Regional Airport: The noise from the nearby regional airport has been a serious concern in the district for decades. As a school board member remarked in 1997:

> Students and teachers in the Bayview School District suffer from hardships no other school district in the state endures—daily interruptions from aircraft noise. Our kids deserve to be in classrooms that foster healthy, quiet opportunities to learn.

In addition to the noise problem, much of the district's residential property is close to the airport, which has discouraged higher income homebuyers from settling in the area. Culturally and linguistically diverse residents tend to occupy the affordable housing near the airport. As a result, about 40 languages are spoken in BSD schools, and the population of ESL students is, according to a district official, "skyrocketing."

Teacher Turnover: Bayview also faces a challenge in the area of teacher turnover. Of the approximately 600 elementary teacher positions in the district, there has been a turnover rate of around 12 percent per year over the past five years. With about 70 elementary positions having new hires each year, the level of teacher experience has dropped. One reason for this high turnover is a salary differential of as much as $6,000 per year between Bayview and neighboring districts. Other nearby districts also have wealthier students with fewer special needs, which may make them still more

Nearby districts have wealthier students with fewer special needs, which may make them more appealing to teachers.

appealing to teachers. These circumstances, combined with BSD's poor facilities (described below) make teacher recruitment very difficult.

Decay of School Buildings: Another issue of increasing concern has been the condition of the district's school buildings. In fact, the condition of Bayview's physical plant has become so poor that in September 1999, the superintendent declared the buildings were in "emergency condition." One district official explained:

> Most of the facilities were built in the '50s when we had the baby boomers coming into the system. They were built as fast as we could throw up four walls and a roof. They weren't built to last. There's no energy conservation; they are filled with asbestos, and the flat roofs leak. We had to close two years ago for toxic mold—that cost us $2 million of our fund balance.

In 1999, the superintendent appointed a 40-member committee to evaluate the condition of all buildings and make recommendations. After several months of meetings and building inspections, the committee reviewed cost estimates and submitted their recommendations to the board. The school board unanimously agreed to put a $297.5 million construction bond to the voters in the fall of 2000. The new bond would pay for 10 new elementary schools and major renovations at four schools. Unfortunately, the bond issue was voted down, and the problem of inadequate facilities continues to plague Bayview.

PROGRAM HISTORY AND DEVELOPMENT

Program Origins

Bayview teachers and administrators considered their textbooks inadequate and outdated.

The genesis of Bayview's science program can be traced to a pivotal mid-century event: the successful launch of the Sputnik I satellite by the Soviet Union in 1957. This event was a catalyst for many U.S. schools to reconsider their approach to science education as the "space race" heated up. Bayview teachers and administrators considered their textbooks inadequate and outdated, and they felt that they needed new, more appropriate science programs.

In 1965, John Evers, an eight-year veteran high school chemistry, math, and physics teacher, was recruited to fill the recently vacated position of K–12 science coordinator. A serious and energetic advocate for science instruction, Evers was introduced to inquiry science as a college student when he studied with a popular physics professor who used inquiry instruction in his own classroom. This professor subsequently became a personal friend and shaped Evers' convictions that "kids responded best" to inquiry-based science.

In his new position, Evers thought that a focus on elementary science was appropriate, as he put it, "from a political point of view" given the climate

of the times. Thus, he was determined to gain experience and what he termed "credibility" in elementary classrooms. He visited elementary teachers across the district and noticed that they were teaching very little science and, even in that instruction, they were using only textbooks. In general, instruction in science was "spotty" at best. Evers decided to get some first-hand experience himself and substitute taught, sometimes for prolonged periods, in elementary classrooms. He reviewed the existing curricula, reflected on the content and instruction, and had a committee of elementary principals to advise him on matters of material adoption. With these experiences under his belt, Evers looked ahead to the possibility of developing a new curriculum and convinced the principal's committee to "hold off" buying new textbooks in order to develop an expanded, inquiry-based elementary program.

Evers was determined to gain experience and "credibility" in elementary classrooms.

Acting from personal conviction and "not knowing any better, and not having a research base," Evers wrote a prospectus of his envisioned science program based on his work in the elementary classrooms. While struggling "to make it sound scientific," he modeled his curriculum plan on materials from the American Association for the Advancement of Science (AAAS), and brought it to community members for feedback. Encouraged by the reaction of local parents and teachers, he presented his prospectus, along with a three-year budget proposal, to the superintendent of curriculum and instruction.

The superintendent was very impressed. He decided to provide financial support for the program but apparently misunderstood the budget requirements. He awarded Evers the entire three-year budget for the first year of implementation, a fact that still surprises and amuses Evers. The plan had been ambitious—to begin curriculum development in the summer of 1966, pilot one kit for each grade level 1–6 in the fall, and have the program officially begin in January of 1966. The "windfall" additional funding, in Evers' opinion, allowed the tight timeline to succeed.

Evers began writing curricula that summer with a group of interested elementary teachers who shared his vision for hands-on science instruction. At first he thought that units should be taught in three-week segments because "I had it in my head that teachers get tired of any subject that they are teaching, unless there is a change." But teachers did not like the short, intense format, so Evers expanded the time for each unit to four to six weeks. Evers and his colleagues continued writing curricula by "instinct," using cast-off science "junk" that principals sent him for developing kits. He told the principals that they could clean out their science equipment and materials and "use those closets for another purpose," because he "guaranteed" they would not have to buy, gather, or store any more science equipment—he would support the program from a central location, yet to be built.

By January of 1967, the first units (one each for grades 1–6) were ready. Interested teachers participated in four hours of grade-level training and

then could request the kits that would be delivered to them at a time that would fit their schedules. Evers sought their suggestions and feedback, and the units underwent revision during the spring and summer. At the same time, in the summer of 1967, Evers and his group wrote 10 more units. Again, teachers had in-service training, used them, and shared comments with the curriculum development committee as before. Also in 1967, Evers established a materials center that focused on kit maintenance and replenishment—it remains a key component of the program today. The last group of eight units was written in fall of 1967 and ready for teachers to use in winter 1968. The entire program was conceived, planned, funded, written, piloted, and implemented in three years. All 24 underwent development, evaluation, and revision simultaneously, a pattern that continues to this day in Bayview. According to Lisa Cooper, who has succeeded John Evers as coordinator of K–12 science, a basic tenet of the program is that "the units of work are never finished."

A basic tenet of the program is that "the units of work are never finished."

There is little formal documentation of the events of the early program years and recordkeeping was sketchy. There are no details of precise program costs or job descriptions nor are there records of the numbers of teachers who participated in or led kit trainings. Participation in training was never a formal prerequisite for requesting a kit, so the total numbers of teachers who participated in these early workshops is unknown. Still, the general consensus from long-time district personnel is that the trainings were popular, and all who wanted or needed training were accommodated.

The Middle Years

The 1970s was a period of adaptation for Bayview.

The 1970s was a period of adaptation for Bayview with external pressures that required Evers to make physical and financial adjustments in the program. By 1975, the nearby regional airport added its second runway. Although this was advantageous to surrounding industry and the growing city 10 miles to the north, the new runway divided the district neatly in half, clearing away a wide center of roads and housing. In addition to interfering with the district's infrastructure, the residential space that remained was closer to the airport with its noise and traffic. The result was the closure of 25 district schools and, as mentioned earlier, a drop in enrollment from 32,000 to 18,000.

The program made an important adaptation to its shrinking size, which secured additional revenue.

The dwindling student population, while posing many challenges to the district, brought an opportunity for the science program. With the reduction in enrollment, science kits that had been prepared for a larger number of students went unused. At the same time, several neighboring school districts who admired Bayview's program but did not have the resources to develop or distribute their own units, approached Evers about using Bayview's kits. Evers calculated the per student cost of distributing and refurbishing the kits and then began renting them to the neighboring districts. Thus, the program made an important adaptation to its shrinking size, which secured additional revenue.

The 1970s also saw the failure of several levies in Bayview while the state was making significant changes in its funding for education. In 1975, a neighboring urban school district was experiencing its own financial woes and sued the state for failing to fund their district's basic education costs. The suit was successful and, as a result, legislation now exists that requires the state to provide a base of funding for all districts. Specifically, state funds must pay for districts' basic education, special education, transportation for special education students, bilingual services and remediation, and transportation for children living far from their assigned school. Where local levies had constituted 30 percent or more of a district's revenue, under the new legislation, local levies could account for only about 14 percent.

Two grants also helped the science program weather the lean years in the mid-1970s to early 1980s, and had even longer lasting impacts on the program than the original funds provided. Evers and several teachers developed a proposal for and received a $300,000 grant to write kit curricula for "Project Ecology." The grant enabled the program to produce kits that centered on environmental issues especially pertinent to the surrounding area. Remnants of "Project Ecology" curricula are still present in the current fourth grade kit, "Discovering Our Local Ecology." Evers and his colleagues also obtained a $10,000 grant for "Project Summer Study" that focused on integrating mathematics and science in the primary grades.

As the program progressed through the 1980s, changes in staffing brought new leadership while the existing leaders moved to other parts of the district administration, assuring continued support for the program. Lisa Cooper, an elementary teacher who had been working on "Project Summer Study," was hired as a mathematics/science specialist, essentially a teacher on special assignment outside the classroom. By the end of the 1980s, Cooper had become the "Coordinator of K–12 Science," and Evers had become the assistant superintendent of curriculum, where he would continue to advocate for science.

Existing leaders moved to other parts of the district administration, assuring continued support for the program.

Recent Developments

In 1994, John Evers left Bayview to become a National Science Research Council (NSRC) consultant, and Cooper assumed sole oversight of the science program. She grew into the role of coordinator quite naturally, having worked closely and comfortably with Evers for over 10 years. Inspired by the fact that Evers was "always there when the decisions were made," Cooper consciously chose to maintain this style of management and makes every effort to attend district meetings, particularly those in which financial decisions are made. In this way, she is able to influence funding for science as much as possible, and help "keep science on the front burner."

As Cooper's responsibilities increased, Molly Bradford-Jones was hired in 1993, primarily to oversee the then-active $500,000 National Science Foundation (NSF) teacher-enhancement grant for staff development in

assessment (see description in Professional Development below). Funded through several sources, Bradford-Jones has continued to work closely with Cooper, working almost full-time for the program. Together, Cooper and Bradford-Jones are the key central office staff for mathematics and science in Bayview. A new transition in leadership is inevitable, however, as Cooper looks toward her own retirement in the next few years.

THE CURRENT PROGRAM

Goals

According to administrators and district documents, the goal and vision for the Bayview elementary science program have always been to provide "a quality science education program for all students." During the past several years, however, especially in the current climate of standards and outcome-driven education, the district has been striving to clarify the vision and translate it into measurable standards and achievement.

In 1998, following the adoption of the state's academic standards, Bayview published a document entitled, "A Vision for Science Education." This newly articulated vision, initiated by principals and created with teachers and parents, reads as follows:

The district has been striving to clarify the vision and translate it into measurable standards and achievement.

> BSD offers a world-class, student-focused, K–12 science program that provides:
>
> - All students with the wide-ranging learning experiences that engage the students in using their scientific knowledge to explain everyday phenomena, to solve practical problems, to inform decisions, and to learn more about taking responsible actions in their lives.
> - A K–12 articulated and cohesive curriculum that reflects state and national standards and is supported by research.
> - A school environment that supports science literacy goals, with regularly scheduled time throughout the week and year for science and opportunities to extend learning beyond the classroom.
> - Support for teachers to offer high quality science instruction that reflects "best practices."
> - Instructional materials and equipment needed to teach a hands-on, minds-on, inquiry-based program.

While these goals were not new for the science program, they represent a change in that they explicitly stated the program leaders' intentions that, until then, had been communicated less formally and directly.

Curriculum[2]

The science curriculum in Bayview consists of three or four core kits per grade level along three strands: physical science, life science, and earth/space science (see the appendix for a list of specific kits by grade). The kits include a mix of locally authored and commercially produced units that are aligned with the district, state, and national content and performance standards. All units also include an evaluation sheet that asks teachers to assess the interest and practicality of the kit.

Beginning in the 1999–2000 school year, the district made a significant change in the program's practice of leaving kit selection and scheduling to the discretion of teachers. Since the national science standards and the state academic standards were finalized, Cooper has used them to guide the alignment and revision of the kits, as well as the selection of commercially produced kits. More significant for teachers, however, is the shift from a self-selected program of kits to a required, prescribed schedule for kit instruction. Although teachers may make special requests for kits from the materials center, the message is clear; the units and the schedule for teaching were aligned with the state science standards with the hope of increasing the likelihood that students would succeed on the fast approaching state science test (see section on Accountability below for further details).

The process of designing and revising kits has been a hallmark of Bayview's program. As Cooper said, "The traditional cycle in this district is to develop materials; pilot them; train teachers to use them; and then evaluate, revise, and begin the cycle again. The trend is to always re-examine our curriculum and improve it." The cost of developing a single kit, although a fraction of the development costs of commercial kits, still represents a significant investment of time and money for Bayview. The district has developed many kits over the years and teachers have a comfortable familiarity with them. This raises questions about their willingness to work with new materials as the districts brings in commercially developed kits as part of an effort to better align with state standards. While few criticize the commercially developed units, many prefer the local kits, feeling that they are more substantial or more developmentally appropriate than the commercial kits.

The process of designing and revising kits has been a hallmark of Bayview's program.

Materials Center

The science materials center, which has been a foundation of the program throughout its evolution, is responsible for collecting, refurbishing, and delivering kits to teachers. The center is housed in a former school building and managed by the same person who has run the center since its inception. As the materials center manager proudly states:

> I was hired October 10, 1967 by John Evers to help carry out his vision. All of our units were homegrown back then. I was

2 For an overview of the curriculum units used at this site, see Appendix C.

> brought back to a room with some empty shelves and boxes of supplies. Then he gave me the curriculum and I just started building the kits and scheduling. I started out half-time, but by January 1, 1967, I was full-time.

In addition to the manager, whose position is currently funded by the kit rentals to neighboring districts, the materials center employs three full-time employees funded by the district. Each school has a scheduled weekly delivery day for pick-up and drop-off of kits, and the center uses a full-time district warehouse driver for deliveries. The work is seasonal, with all 4,000 kits returning to the center in the spring for refilling and redistribution to the schools during the fall. An additional source of much needed labor for refurbishing kits during busy periods is "light-duty" employees—classified district employees who, due to injuries, need to be transferred to lighter work until their injuries heal. The center uses several of these employees on a casual, but regular, basis.

An ongoing problem at the materials center is space. At any given time, 4,000 kits are either in use or at the center for refurbishment. The kits are stacked about four or five high in all available space: halls, shelves, and entire rooms. The materials for refurbishing also require large amounts of storage space, making the materials center resemble a small warehouse. The constant need for space has led to five center relocations during the life of the program. Lisa Cooper observed wryly that one of the keys to maintaining space in a district is to "take a space and outgrow it" so that larger spaces become necessary.

Instruction

Many teachers, principals, and central office administrators share a common view of what inquiry science teaching is. One teacher articulated very clearly that children should:

> ...demonstrate the ability to observe accurately, to pose a question that may not even be answerable, to compare and contrast what they thought in the beginning and cite evidence of a change in thinking.

"If you are observing carefully and documenting what you see, then you are doing science."

Others describe inquiry as including "brainstorming," "asking questions about why 'it' really happened," and instruction that emphasizes children's involvement with science as opposed to merely observing it. One teacher explained, "If you are observing carefully and documenting what you see, then you are doing science. I don't think there is any other subject area where if you look and think carefully, you can come up with the right answer."

Teachers also had a great deal to say about the importance of teaching science through the use of kits in general, and about the kit program in Bayview in particular. Their enthusiasm for the program grew out of their personal enjoyment of science, their appreciation for the kits themselves,

and the increase in their students' engagement and science skills. Suggestions for improving the kits generally focused on adding materials, such as reading lists and other enrichment activities, and improving the assessment tools for teachers to use with their students.

The primary source of frustration grew out of the issue of not having enough time to teach science. Although the district requires that 90 minutes per day be spent on reading and 60 minutes per day on math, there are no such requirements yet for science. As a result, the amount of science instruction that children in Bayview receive varies across classrooms and schools. Still, Bayview teachers responding to the survey reported teaching an average of 85 minutes of science a week, while about a quarter of the respondents indicated that they teach kits from the "beginning until they ran out of time." Nearly three-quarters of respondents reported that they use the kits "very often," with more than half describing their usage as piecemeal—picking and choosing the activities for their students. Less experienced teachers also expressed their concerns about the classroom management skills needed to teach the kits and how to handle "failed" experiments.

"Instead of just saying, 'This kid likes science, give him an A,' we now need to have evidence that the kids have completed the work."

Researchers observed 20 classrooms, K–6, in various schools, selected by the district science coordinator. Researchers asked to see teachers who practiced the kind of science teaching that Cooper thought most likely to be achievable across the district. The teachers represented a range of training and experience, as well as understanding and enthusiasm for science. That variability, however, was accompanied by a common understanding of the goals of the science program on the part of teachers, and a general familiarity with science materials, processes, and concepts on the part of students.

The physical classrooms differed greatly in the amount of space and materials dedicated to science. In one building, science class was held in an enclosed library amphitheater; other classrooms had sinks and marble lab tables; while still others were "science rich" with tools, artifacts, prominently displayed student science work, science/nonfiction texts, and live animals and plants.

While instruction represented a range of styles, the teachers structured their lessons in a fairly similar way.

While instruction represented a range of styles, the teachers structured their lessons in a fairly similar way. Most used the district's kits to facilitate a prescribed hands-on lesson, sometimes supplemented with their own science materials. Although the hands-on lesson was the primary activity, teachers also lectured, asked students to present their work, and in a limited number of instances, had students investigate their own questions about the phenomena under investigation. Lesson conclusions ranged from class discussions that summarized the day's work to others that focused on student-generated questions to be explored in the next lesson. Most often, however, teachers were pressed for time and wrapped up rather abruptly.

Most often, students worked in small groups of 3–5, but occasionally students worked in pairs, alone, or in a whole class discussion. In general, children appeared to be experienced and comfortable with scientific inquiry

Investigating Rocks

In a third grade class, students are deeply involved in the examination of various rocks and minerals, observing their characteristics and classifying them. Each group receives an egg carton full of rocks, each labeled with a number. The students are excited about the investigation and immediately begin examining the rocks. Some dump out the entire contents of the egg cartons and begin sniffing the rocks, running their fingers over them and examining them with their hand lenses. The teacher reminds the students to focus on the properties of each rock, saying, "You should write something in your rock journals about six rocks." Students have time to examine the rocks and describe them. One writes, "This rock is hard, shiny, and light," while another writes, "pebbly, layers, rows of other kinds of rock." The teacher brings the lesson to

and the use of scientific equipment. Most classes were able to measure, record, make predictions, and analyze their data. Often students used science journals for their work, and in classes where teachers used more scientific language and procedures, children's work and discussions reflected the impact of this emphasis.

Assessment

The arrival of the state science standards has increased the urgency of the district leaders' efforts to encourage teachers to pay closer attention to student learning in science. In 1999–2000, a new report card format for grading students in science was implemented. Rather than a single letter grade summarizing a student's achievement, the science content standards are itemized, and teachers must define the level of mastery each child has achieved relative to each standard. As one principal commented, "The hope is, instead of just saying, 'This kid likes science, give him an A,' we now need to have evidence that the kids have completed the work."

Development of effective tools to assess student learning in science has been a consistent priority for program leaders and the subject of a wide range of regular professional development. Still, there remain many differences among teachers in their efforts to assess their students' knowledge using these tools. The revised report card system may contribute, over time, to a greater reliance on these tools, ultimately ensuring a deeper understanding of how children are progressing in their mastery of the curriculum.

Professional Development

Overview

Historically, professional development in Bayview has been voluntary for both new and veteran teachers. However, teachers who were certified after 1987 must, over five years, complete either 150 university or approved professional development credits or 450 district provided clock hours to maintain their teaching credentials. Bayview provides its teachers with pay incentives for completing either route. In addition, teachers have 12 days of professional development available to them, three supported with state funds and nine with district funds. Most recently, the district's professional development has focused on improving teachers' reading and math instruction with the aim of improving student test scores.

The district provides additional support for novice teachers through a four-day orientation and access to a highly-valued peer-mentoring program. Peer mentors assist K–8 teachers with their adjustment to the district with a particular emphasis on teaching mathematics, reading, and language arts. Support in science can be requested and is expected to be added to the mentoring program in the future. Mentors have a great deal of latitude, and can

work with individuals, study groups, and principals. The program also affords inexperienced teachers the opportunity to receive valuable support and develop their leadership abilities.

This peer-mentoring program has grown and received broad support within Bayview. It was originally funded with local grant money, but Bayview has now absorbed all of the costs and expanded access to it by increasing the number of mentors from four to six. Bradford-Jones described the mentoring program as an asset for science instruction because mentors are able to share what works for teachers in science districtwide and, thus, help support science teaching throughout Bayview. According to Bayview's director of human resources, interviewers use the peer-mentoring program as a selling point when recruiting candidates.

Professional Development in Science

Cooper and Bradford-Jones together decide on the content of science professional development. Guided by current research, state content standards, performance standards, and teacher interests, they design one- to three-session workshops and courses that are scheduled on a comprehensive districtwide calendar. A district-level staff person who oversees staff development for all grades and subjects arranges the logistics.

Professional development workshops are facilitated by a network of teacher experts whom Cooper has cultivated over the past 15 years. Cooper and Bradford-Jones recruit facilitators by finding teachers who are particularly interested in science and working informally with them to expand their knowledge of kit usage, assessment, or inquiry processes. Once they've gained a sufficient amount of experience and knowledge, Cooper asks them to help design and facilitate professional development or lead kit-training sessions. As a result of this gradual learning process, the science program enjoys a reserve of well-trained facilitators who have from 2 to over 20 years of experience in the district. In return for leading professional development sessions, they receive stipends from district funds.

The schedule for professional development has always been the same—some opportunities during the year, some in the summer, and when outside funding is available, summer institutes. Saturday sessions have been offered in the past but have suffered from low attendance. In fact, poor attendance at the science workshops has been a challenge for Cooper and Bradford-Jones. They work hard to encourage teachers to attend, sending personal invitations to new teachers and scheduling sessions during the school year and the summer so they are as accessible as possible. The low attendance is a particular concern in light of high teacher turnover. Cooper estimates that there may be several hundred teachers without formal kit training and, in fact, close to half of the teachers who responded to the informal survey reported having had no training on the kits they teach, while almost a fifth had received training on only one kit. Still, some teachers commented, with no requirement to

a close by saying, "Now I want you to present your findings, that is, I want you to state the properties of the rocks that you examined." The students readily volunteer their information and are eager to share their findings with the class.

Digging Dinosaurs

Dinosaurs greet visitors to this Bayview kindergarten class. There are dinosaur mobiles hanging from the ceiling, dinosaur models, dinosaur puzzles, books, stencils, and dinosaur poems. In the back of the classroom there is a paleontological "dig," complete with dinosaur bones and assorted prehistoric artifacts. The group is gathered at the "dig" and while they search through the sand using excavation tools, other students work quietly on puzzles or reading books. A small voice is heard from the back of the room, "I found a jaw bone! Let's add it to the chart."

attend and with all of the pressures related to teaching reading and math, their energy for science professional development is diminishing.

In response to an increasing pressure to give priority to reading instruction, Cooper, Bradford-Jones, and the assistant superintendent for curriculum and instruction offered three sessions on the integration of science and language arts. The workshops also aimed to help less experienced or less science-oriented teachers who saw the need to integrate subjects but felt unable to do so. A multitude of topics were covered, including the use of science notebooks, inquiry pedagogy, integration with literature, and assessing student work. Following this series of workshops, at least four teachers commented that they would change the way they taught to include science writing, and that they were more confident in their ability to consistently integrate science into the curriculum.

Professional development workshops are facilitated by a network of teacher experts whom Cooper has cultivated over the past 15 years.

Low attendance notwithstanding, many Bayview teachers report that they have found their professional development experiences in science beneficial in many ways. They particularly value the opportunity to "talk shop" and gain "hands-on management tips" from their peers. Several teachers spoke specifically about the usefulness of having science experts to help deepen their content knowledge, while others valued learning more about the inquiry method of teaching.

DECISION MAKING AND LEADERSHIP

District-Level Decisions

Historically, decision making and central office support have always been closely connected and essential to the science program. Throughout Evers' 30-year tenure (1965–1994), he cultivated strong relationships with the superintendents and with teachers and administrators across the district. Even more beneficial for the science program was the fact that for his last seven years in the district, Evers was an assistant superintendent—in his words, a "friend at court." From the beginning of his career, Evers made a practice of understanding the science program and the district budgets, thus making him a well-armed advocate for science program resources.

From the beginning Evers made a practice of understanding the science program and the district budgets, thus making him a well-armed advocate for science program resources.

In the past, central office administrators have been relatively complacent about the science program. According to one superintendent, "Because science kits are so much a part of our culture, it has not been a discussion topic since I have been here" Instead, discussions of science focus on the middle and secondary grades and an occasional response to rare calls from parents regarding evolution in the curriculum. Further, the curricular issues that dominate school board meetings have concerned standards, as well as reading and math achievement scores.

However, now that Cooper and Bradford-Jones have presented the new science content standards that accompany the state academic requirements to

the school board and the superintendent, they are demonstrating far greater interest than they had in the past. With the increased attention, the current superintendent, in his eighth year as of 2001–2002, and the board are starting to create some pressure for the science program. He is asking questions that haven't been posed in years such as, "Does everybody teach the units?" and "What are the statistics?" This increased attention holds both positive and negative implications for the science program. Increased priority may be good, the but increased scrutiny may be a challenge to contend with.

Increased priority may be good, the but increased scrutiny may be a challenge to contend with.

School-Level Decisions

As educational leaders of their buildings, principals play a significant role in determining the degree to which the district's educational programs are delivered. Thus, their understanding of the science program is important, as is their willingness to press their teachers to teach it. Cooper and Bradford-Jones meet with the principals monthly to maintain their familiarity with the program and professional development opportunities. Although Cooper also invites principals to attend all professional development workshops, few have done so.

Principals report feeling the same pressures to improve reading and mathematics scores as teachers do, and as a result, feel they have little time to devote to science. Nearly all of the teachers responding to the survey reported that their science instruction had not been observed during the current year. Likewise, almost three-quarters of the principal respondents reported discussing science in their building only two to four times a year at schoolwide meetings. Several teachers commented on the impact of pressures to raise student reading and math scores on their principals' attention to science. One remarked, "There is getting to be less support and leadership within the building [for science]. It's getting to be that way in most buildings." Given their time constraints, principals who want to foster science teaching in their schools appreciate the support the alignment with state science standards has given them. As one principal remarked, "Now we are able to say, 'It says right here that you are going to teach this.'"

Principals who want to foster science teaching in their schools appreciate the support the alignment with state science standards has given them.

In addition to communicating with principals, schools stay informed about the science program through their "science representative." These teachers, either volunteers or selected by their principals, meet monthly at the district level. Ideally, science representatives arrange time for schoolwide meetings to inform their colleagues of recent program developments, model the science curriculum for their colleagues, and bring professional development lessons back to their schools. However, they vary in their commitment to the program and often serve simply as messengers for program logistics.

More authentic science leadership at the building level mostly occurs as a result of Cooper's recruitment efforts. A teacher who was "discovered" this way commented on her growing commitment to a program that she felt "listened to the teachers." Similarly, a teacher involved in the districtwide

science notebook assessment movement saw herself as an "integral" part of the BSD science program. Clearly, this form of cultivating teacher leaders builds an additional source of support for the program, one that is knowledgeable and credible.

Science Program Leadership

When John Evers came to Bayview to serve as science coordinator, he brought a great deal of enthusiasm for inquiry science, as well as natural gifts important for a program leader. Lisa Cooper explained that Evers was bright, articulate, and had command of budget issues. Thus, he advocated for educational programs effectively and answered questions in ways that made sense to people. "He was so well-respected and he didn't waste his capital. He would invest it where it was important and so, by style, he was the last person to talk." Most central office personnel who knew him agree that his gregarious, likable, articulate, and well-informed style, coupled with his zeal for science, proved a great asset to the program, resulting in beneficial budgetary and staffing decisions.

As Evers moved higher in the administration, Cooper moved into his former position and a gradual change in leadership occurred. Cooper, who came to Bayview in 1966 as an elementary teacher, is articulate, outgoing, and energetic. She is also well known in the science education community and tirelessly attends science budget and curriculum meetings. She is very adept at working within the constraints and culture of Bayview. As Cooper said, "You take advantage of opportunities that come your way and make them work for you and the people around you."

"You take advantage of opportunities that come your way and make them work for you and the people around you."

Today, several key personnel make decisions affecting the Bayview science program. Cooper, Bradford-Jones (the mathematics and science specialist), and the assistant superintendent of curriculum and instruction all participate with input from principals and teachers who interact with them. Several features of Cooper's tenure differ significantly from when Evers was leading the program. First, unlike Evers, Cooper not only oversees science, but she also is responsible for mathematics in the district, a scope of work that is extremely challenging and, perhaps, unrealistic because mathematics is the object of much attention in the current environment of accountability and testing. Second, Cooper does not have the same degree of control over budget decisions that Evers had, due to her slightly lower placement in the hierarchy. And finally, Cooper has to contend with constraints on the budget that were not an issue during Evers' tenure. Resources he had at his disposal are now disappearing, resulting in program cuts. Without Evers' rank and command over the budget, Cooper is at a disadvantage when trying to advocate for the program.

Now, after more than 30 years in the district, Cooper is nearing retirement and the program faces another leadership transition. One assistant superintendent said it would take at least two people to replace Cooper, one in

mathematics and one in science. The necessity of two people to carry on Cooper's work illustrates how her responsibilities have expanded over the years. Bradford-Jones is experienced and capable, but the pool of available science specialists with deep history in Bayview is small. To maintain the visibility and respect that Evers and Cooper garnered, new science advocates will need to develop the budgetary savvy and personal contacts of their predecessors. Anticipating the next phase of program leadership, Cooper commented, "The common ingredient is going to be a person or a couple of people who are at the right place at the right time, and who have the personality for the right place at the right time."

RESOURCES AND SUPPORT

Funding

Internal Funding

The financial capacity for sustaining the Bayview program has been in place for more than 30 years. Although the funding has never been in question, levels of funding fluctuate from year to year, depending on fiscal strength and educational priorities. Managing the variability of resources and program needs has been an important aspect of the program's sustainability.

A reliable source of revenue has been the kit rental program. At a 2001–2002 rate of $10.00 per pupil, rentals generate about $150,000 per year, which has enabled Bayview's program to continue to grow and reinvest in quality materials and personnel. Another pool of resources has been the funds for curriculum development and revision. These monies originate from the budget set aside for textbook adoption and vary from year to year. When kit development is needed, and especially when aligning the kits to the standards is required, $20,000 or more can be accessed from this source.

Some have questioned whether a textbook program is less expensive than a kit program. However, an assistant superintendent in Bayview pointed out that even with kit development and alignment, the costs are no greater than a text-based curriculum. She said, "If you take the cost of kit development and amortize it over 10 years, it's no more money than a textbook that will be outdated a year after you buy it." Bayview must manipulate the available funds to continually update the science kits. As the assistant superintendent explained, "We've said, 'Okay, we'll take a little draw from the textbook budget. This year we'll draw $20,000 and next year we won't. That's just to give us that developmental cost.' That's part of how we fiscally sustain it here."

"If you take the cost of kit development and amortize it over 10 years, it's no more money than a textbook that will be outdated a year after you buy it."

External Funding

Bayview has grown and sustained its science program with surprisingly little outside funding. One important exception was a nearly $500,000 NSF grant entitled, "Improving Science by Improving Assessment." This four-

External grants provided important but not essential support for the science program.

year grant, part of NSF's Teacher Enhancement Program, was awarded to BSD in 1993. It funded Bradford-Jones's position and professional development for all elementary teachers. The professional development focused on expanding teachers' content knowledge relative to specific science units and developing assessments for those units. Cooper recollected, "The professional development was probably the best shot in the arm we could have had. It had a lot of impact." The assessment work is still visible in professional development in science writing available to all interested teachers. Smaller grants also helped the program carry out specific projects in the late 1970s and early 1980s.

These external grants provided important but not essential support for the science program. It is not surprising, then, that there is no designated individual in the district to help find and write grant proposals. Nevertheless, excellent grant writers are available, and Cooper has relied on their help whenever she has made the decision to seek outside funding.

Community and Partnerships

The Northern Center for Science

The Northern Center for Science (NCS), a regional nonprofit science center, has long been closely allied with the Bayview School District. Founded in 1962, NCS is funded by the state (usually providing about 50 percent of the yearly operating costs) and by private and corporate foundations. School districts also pay a fee to make NCS professional development available for their teachers.

Involved with the Center from its beginning, Evers served as a member of the board of advisors for at least 20 years, and was replaced by Cooper when he retired in 1996. The current associate director of education at NCS recalled the early days when Evers was developing Bayview's science program and working formally and informally with other science and education leaders in the region. As their careers progressed, they formed a network of partners across the country from which Bayview has drawn support. NCS's relationship with Bayview continues today. The Center's director of education commented, "If we need to talk to a school district and see what's happening, we start with Lisa."

NCS has offered professional development workshops in Bayview since its earliest days. Back then, professional development offerings were "scattershot," according to the associate director of education at the Center. They offered 10- or 15-hour workshops offered to Bayview and other districts that were content-based, such as "weather" or "environment." In the past decade or so, in the wake of science education reform movements, the center has provided longer, more specific workshops targeting districts' specific curriculum materials with a concentration on questioning strategies and inquiry in elementary science. Bayview also used its most recent NSF funds to hold

summer institutes and follow-up sessions at the Center. The Center also has played a role with Bayview in their curriculum development efforts, helping to revise science units so they were aligned with the state science standards.

Unfortunately, one of the NCS's partnership components most visible to and most used by teachers, a district membership to the Center, fell victim to a recent "across-the-board" budget cut. The $10,000 membership provided each teacher with a membership card and reduced entrance fees for his or her students. As Cooper put it, "It's honestly sad. But I guess if we have to choose between a book or a microscope or a Center membership, we go with the book or the microscope." Still, Bayview is working toward grant-funding a membership because, as Cooper said, "We are sending a message about what is important—science opportunities are shrinking and it is more about reading and math."

Straton University

Similar to the NCS, Bayview has collaborated with individuals at the neighboring Straton University. Although the partnership is informal, with faculty providing assistance on an as-needed basis, it is a sound and positive relationship. One faculty member in particular has provided professional development, contributed to assessment design, participated in discussions about curriculum and the state standards, and helped lower the cost of kit supplies. In general, the faculty's admiration for Cooper and Bradford-Jones is obvious, and they have extended their availability directly to Bayview teachers, responding to their questions and requests for additional help. Unfortunately, because attendance is voluntary and hands-on workshops favor smaller numbers, teachers' exposure to this partnership and resource has been limited. Bayview has only offered a handful of professional development workshops, each attended by 20–25 teachers.

Parents

Informing parents about the science program is an important step in fostering their continued awareness and support. Cooper explains, "We have to build on the strengths of the parent advocate groups. I make sure that I go to every PTA meeting…I am on the state PTA board, and I present there about Family Science every year." The parents in Bayview learn about the science program primarily through curriculum nights, newsletters, and district-designed pamphlets. The district's booklet, "Student Learning: A School and Home Partnership," covers curricula for each of the elementary grades and includes a section on each content area where the state standards/skills are listed, along with small-scale family activities to help meet these standards. Additionally, some teachers write and distribute their own classroom newsletters that include take-home experiments and other science information. So far, efforts seem to be successful. As the assistant superintendent stated, "Reading, math, and science are fighting words from parents. They understand that the good jobs in the future are in science and math, and they see the value of learning by kits, learning by doing."

"We have to build on the strengths of the parent advocate groups. I make sure that I go to every PTA meeting...."

Camp Fields

In 1946, the district acquired a parcel of land located on a river in a nearby rural area. The land was part of the Civilian Conservation Corps during the depression and still has some of its original buildings. Now the large tract of land, situated on a river, is used as a science camp throughout the academic year. It has become part of the district's culture and science curriculum, and students, parents, and grandparents can recall their own experiences there. Fifth and sixth graders and their teachers spend five days at Fields; part of their day is in the classroom and part of the day is spent outdoors learning about water, plants, forestry, and the environment. Teachers and principals consider it an extension of the curriculum. "It's a beautiful support to the program," said one principal. "It is hands-on, exciting to the children, and corresponds with some of the kits they are using in these grades."

ACCOUNTABILITY

State-Level Standards and Accountability

The state science standards, which Bayview adopted in 1998 in concert with the coming state test in science, have had a tremendous impact on the elementary program. Cooper, Bradford-Jones, and an interested group of teachers worked to align the district science units with the state science standards as well as the state mathematics standards. According to an assistant superintendent, this alignment is necessary to cover all the required daily instruction. As she says:

The state science standards have had a tremendous impact on the elementary program.

> The science kits teach science content standards and other content area standards. They teach communication skills as you work in groups with others. You problem solve, learn to define and defend your position with data, and so forth. Depending on the kit, they can teach written skills. They teach reading and math skills—what an economical use of time.

The kit alignment, completed in 1999–2000, was the beginning of the program's incorporation of the standards. The outcome was a set of grade-level specific documents that tie the standards direction to each unit, so teachers know exactly where each standard is taught. Pamphlets that outline how the standards are addressed also are distributed to parents through district and school communications.

The impetus for these curriculum changes is the Forester Assessment of Student Knowledge (FASK), the state's new testing program. Currently it covers math, reading, writing, and listening, and is administered in grades 4, 7, and 10. The state piloted the science portion of the test for grade 5 in spring 2001, and began voluntary testing in 2002. Required testing in science is scheduled to begin in 2005, and pilot-testing in social studies, health and

fitness, and the arts is planned for 2006. Ultimately, high school graduation will depend on passing grades on the FASK, but that is not expected until 2006. An early version of the first science portion of the FASK was piloted in the fall of 1999, and as an assistant superintendent observed, "People went ballistic; it was so hard."

Teachers are now required to follow a prescribed rotation of units, designed to match the standards and prepare students for the FASK in science. Replacing teachers' choice of kits with a kit schedule was a significant departure from past practice and teachers felt the difference, particularly as pressures in reading and math were also rising. Enthusiastic teachers who taught science out of their own passion regretted the lost opportunity to use their creativity, and teachers who formerly didn't open the kits at all balked at the additional material they would be responsible for covering. An experienced teacher who loves teaching science observed, "The strength of the structure is also its weakness. We need the structure; it is very helpful. Other times it is just so structured we can't do anything."

Replacing teachers' choice of kits with a kit schedule was a significant departure from past practice.

Although many teachers found the adjustment difficult, many understood the reason for the policy change. Most were apprehensive about the approaching state test in science and were trying to ensure that their students will be successful. To facilitate teachers' use of new and/or unfamiliar units, Cooper created a matrix that showed all the standards that were covered in each unit. Depending on the unit, these might include reading, math, listening, writing, as well as science content. This organizing feature helped reluctant teachers understand the vast utility of the science units.

But they understood the reason for the policy change.

Cooper and Bradford-Jones have taken steps to support teachers' efforts to combine the curriculum with standards. A district document entitled "Enhancing Science Content and Comprehension with Literature" provides strategies for reinforcing the comprehension strategies covered in the FASK in the context of science. They also have made lists of grade-appropriate literary works with science themes available. In these documents, however, teachers are advised to be aware of superficial linkages. Stories may have themes or vocabulary that are parallel to a science concept, but not intended to substitute for the possibly more time-consuming or untidy units themselves.

District-Level Accountability

An imperative of the state's accountability system is that local districts will improve student achievement by a prescribed percentage over a three-year period. Like other school districts in the state, Bayview calculated its three-year performance goal using a baseline measure of student achievement and targeted a 13.5 percent increase in the number of students meeting state standards. Over two years the district made significant progress. In the third year, however, Bayview had to show a 2.6 percent increase in fourth graders' achievement or face state sanctions, which had yet to be determined.

While creating undesirable pressures for teachers and principals, the accountability system has positively affected the science program by raising its visibility. Cooper and Bradford-Jones felt that a test in science would keep it from being neglected by teachers and principals. In fact, they have already seen evidence that science is more frequently discussed at the secondary level, although not at the elementary level. Still teachers are struggling with finding the time for science instruction. One kindergarten teacher observed that the amount of teaching time left after other requirements is so small that she is not able to teach science more than one hour per week, despite her interest. A third grade teacher commented that she is only able to teach topics that are "two-fers," explaining, "I have no time for anything that covers fewer than two content areas at a time."

Still teachers are struggling with finding the time for science instruction.

Holding teachers accountable for teaching science in their classrooms is ultimately left to the principal. Although principals have some tools to assist them, including the science standards and kit-use data, given the current climate, they are more likely to focus on math and reading. The materials center gives kit use data to principals at the end of each year, and principals are free to use this information any way they choose. One principal found the data especially useful:

> I would compare the data from year to year to see what teachers were using. Then I would ask the teachers who weren't using them why. Were they not familiar with the kits? Haven't they had the training? Couldn't they squeeze it in? I heard all of those reasons.

According to some teachers, principals' attitudes toward science range from giving teachers permission to omit science from their instruction in favor of reading, writing, and math, to principals mandating that their teachers provide science lessons. Regardless of principals' inclinations, there is no systematic process for ensuring that science instruction will occur in their schools.

EQUAL ACCESS TO SCIENCE

Bayview's science program is described in district documents as "a world-class, student-focused, K–12 science program that provides all students with wide-ranging learning experiences…." Although there is no evidence that these goals are not being met, two features of BSD's science program have made providing science to all children an unlikely occurrence. First, teaching science has essentially been voluntary. Although it is expected that all elementary teachers will teach the curriculum, there are no mechanisms for holding them accountable for doing so. As a result, some teachers teach little or no science, thus denying their students Bayview's complete educational program. Second, the press for attention to reading and math scores has again left science instruction to those teachers who are committed and energetic enough to find ways to fit it into their schedules.

The attention to reading and math scores has left science instruction to those teachers who are committed and energetic enough to find ways to fit it into their schedules.

The antidote for much of this inattention may be the mandatory science test that will be included in the FASK in 2005. Teachers are increasingly aware of the state science standards and their alignment with the district's science units. Until this awareness translates into increased science instruction, however, children must rely on their teacher's personal interest and skill if they are to benefit from the elementary science program.

ANALYSIS

The story of elementary science in Bayview 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 Bayview are discussed below. For an in-depth discussion of all of the factors, see the cross-site report of this study[3].

Factors that Pertain to Surrounding Conditions

Decision Making and Power: A Friend at Court

In Bayview, decision making traditionally has rested almost exclusively with the administration. Early on, Evers cultivated relationships with his superintendents and a "seat at the decision-making table." Part of this entailed developing a command of the budgeting process and the education programs that each budget supported. This information equipped him to advocate for science in a way that advanced the program without detracting from other subjects and vice versa. He used his skills to place him among the power brokers, where he could anticipate and influence decisions that would have an impact on his program. As a result, Evers' was appointed

3 The Executive Summary of the Cross-Site Report can be found in Appendix D.

assistant superintendent and spent his last seven years in Bayview's central office, where he looked out for the program's interests as he carried on his curriculum work.

Several features of Bayview contributed to Evers' success at carving out a place for himself within the central administration. First, Bayview has held on to its superintendents for relatively long periods of time; there have only been four since the program began in 1967. As a result, Evers' relationships with them had time to become established, grow, and bear fruit. Second, although there have been periods when the district has faced budget cuts, in general Bayview has not suffered the kind of serious crises that have characterized the histories of many other programs. Such economic stability allows opportunities for programs to grow and develop under the hands of skillful leadership.

Factors that Pertain to Science Program Components

Leadership: Approaching a New Era

At the time of this writing, Bayview's science program is anticipating a change in leadership as Cooper considers retirement. Thus, after 30 years the program will have its third leader. John Evers and Lisa Cooper's abilities proved critical to the program's establishment and sustainability. Both were educators at heart, and while Evers had formal training in science, he lacked elementary experience. Cooper, on the other hand, understood the elementary environment, but did not have formal training in the sciences. What they shared was a dedication to the program and an understanding of the context within which it resided. Each leader discerned opportunities to grow and strengthen the program, whether in developing the kit rental program, aligning the units with the state science standards, or forming a more cohesive curriculum. Each leader respected the primary providers of science instruction—the teachers—and sought their input. When Evers first arrived in Bayview, he spent a great deal of time in elementary classrooms, learning about the program, the teachers, and the elementary environment. Cooper recruited teachers throughout her tenure to assist with the ongoing kit assessment and revision process, as well as with the more recent alignment. Although Cooper did not replicate Evers' access to the central administration by advancing to assistant superintendent, they both cultivated relationships with decision makers in the district, and established reputations that extended far beyond Bayview.

What they shared was a dedication to the program and an understanding of the context within which it resided.

As always, a change in leadership is a critical moment in the life of a program, and Cooper's retirement will come at a point when there are already considerable pressure and some uncertainty about student achievement in Bayview. However, much has been done to prepare the program for the future. The job of coordinating the district's science program will be separated from math,

allowing the new leader a more manageable task. This, in combination with the sound work that has been done to align the kits with the state standards, leaves Cooper's successor with a strong kit-based program that continues to be viewed as the district's best tool for teaching science.

Instructional Materials: Works in Progress

Evers' innate sense of the importance of a hands-on approach to science instruction drove his development of the units that formed the nucleus of the elementary science program. He also established Bayview's cycle of designing kits, testing, evaluating, adapting, and re-testing. This approach puts an additional burden on the program leaders because, as Cooper said, as soon as one piece is changed, additional professional development for teachers is required. However, this approach also launched an environment of collegiality within the district; program leaders sought out teachers, listened to their opinions, and valued their experience.

The materials center that Evers also established, with seemingly little effort, has managed the circulation and refurbishment of the kits as they've evolved. Because the program was built on teacher requests with no predetermined rotation schedule, the materials center had the challenging task of responding to teachers' unpredictable needs and interests. Now, with the movement to a prescribed selection of kits, this challenge will be alleviated. It is easy to take the reliability and organization of a materials center for granted, but without this component, the program would have been established on precarious ground.

It is easy to take the reliability and organization of a materials center for granted, but without this component, the program would have been established on precarious ground.

Funding for curriculum development and the materials center illustrates two important features of the program that account for some of its sustainability. Evers and Cooper refrained from seeking large NSF grants that have characterized the history of many hands-on science programs, choosing to rely instead on district support. The district answered their call, and has consistently supported materials development through the use of its textbook adoption allowance, clear evidence of the importance it places on the kits. In addition, Evers' establishment of a kit rental program to supply resources for the materials center illustrates his ability to make adaptations to the program according to prevailing needs and opportunities.

The state and national emphasis on standards and testing is having a ripple effect on the instructional materials in Bayview, and significant changes are taking place. First, the tradition of evaluating the materials continues, but they are now assessed against the state standards. Second, as adjustments to the kits are being made to better align them with the standards, many of the district's homegrown units are being set aside for commercially produced kits. In addition, as the state test in science draws near, teachers' voluntary selection and use of kits has been replaced by mandatory rotation. As Cooper suggested, these changes heighten the need for professional devel-

opment to assist teachers in adapting to new structures and practices. As the story of Bayview suggests, if science is to be available to all children, science materials need to be not only used, but used well across all classrooms.

Accountability: Increased Priority Coupled with Increased Scrutiny

One of the hallmarks of Bayview's science program has been the degree of choice it has given teachers. Teachers chose whether they would teach science at all, selecting the kits they would use and setting their own schedules. They decided whether to attend professional development workshops on the kits, and each teacher set his or her own standards for assessing students in science. There was no formal structure for holding teachers accountable for the outcomes of any of these decisions.

Without any mechanisms to determine whether teachers were providing science instruction or how well students were progressing, program leaders relied on anecdotal evidence they collected from the teachers with whom they worked. In turn, this was the only information they provided to the central administration. Although Evers and Cooper may have wanted a more complete understanding of the program's status and impact, they did not have the authority to go further. It was a partial picture at best, but for many years it was all that was available.

Statewide testing and accountability is now changing the way information about student learning is gathered and used in Bayview.

Although it is impossible to know if this partial picture of the program was a hindrance or a facilitator to its sustainability, statewide testing and accountability is now changing the way information about student learning is gathered and used in Bayview. As the state holds districts accountable for student achievement in reading and math, instruction time for science has decreased. However, Cooper and others have been preparing for the impending state science test. Thus far, this has resulted in greater attention to the curriculum and its materials, with additional focus on professional development in the integration of reading and science. As the test draws closer it will surely have additional impact, and as test results become available, more impact on the science program will follow. At present, Cooper and Bradford-Jones see the test in science as an opportunity to finally bring science to the foreground.

Factors that Pertain to the Whole Science Program

Philosophy: Maintaining Core Beliefs and Values

Bayview' science program s has gone through many adjustments over its 30-plus years. Much already has been said about its tradition of adapting its science units. Additionally, the program has weathered fluctuations in funding by bolstering its resources through the kit rental program. Further, program leaders have accommodated shifts in politics and policy by making adjust-

ments in professional development, assessing teacher needs, using resources, integrating science with reading, and pursuing (or not) outside funding.

Guiding program leaders through these decisions has been the deceptively simple belief in the importance of using materials to teach and learn science. Although the program has evolved over the 30 years it has been in place, this value, easily said but not easily achieved, has served as the leaders' magnetic north. This belief, widely shared by teachers and administrators, has brought the program always closer to its original goals.

The stories about the early days of the program, its abundant funding from the district, its speedy development and establishment, and its reputation as a trailblazer have done much to foster a feeling of pride and ownership toward the science program. These characteristics have not lead to complacency on the part of the program's leaders; however, it is difficult to ascertain if the same can be said within the district at large. As the emphasis on science achievement advances, the program's long and proud history alone will not enable it to meet its goals. However, Bayview's history as a hands-on science program and its continued use of kits to ensure student success has never been questioned. Time will tell if the district is able to capitalize on its tradition.

This value, easily said but not easily achieved, has served as the leaders' magnetic north.

SUMMARY

This report began by describing the story of Bayview School District's elementary science program as one of champions, evolution, and uncertainty. Evers and Cooper were true champions of the hands-on approach to science, pioneering the use of materials at a time when this relatively new idea caught the imagination of the country. Their diligence and skill as leaders capitalized on this early enthusiasm and established a program that contained all of the elements that have since come to be considered essential for a kit-based science program: science units and a materials center to support them, professional development to support teachers, and district administrators' backing. These elements were nurtured as the program was launched and received continuous attention as it gained increased sustainability.

Over time Evers and Cooper carved out a tradition of developing and improving the program's science units and teachers' ability to use them. But still, the program values remained constant even in the face of shifts in professional development strategies and sources of revenue. The use of hands-on science units remained the only vehicle the district considered for the instruction of science, and the choice of teaching science remained in the hands of the classroom teacher. It was impossible to tell how far the program spread across district classrooms and schools, but it was easy to see that those who knew the program, from central office administrators to classroom teachers, understood it deeply and were committed to its continuation.

The program is now facing another phase in its evolution. The lack of scrutiny regarding student achievement in science is coming to a close as state testing in science is on the horizon. Moreover, the beginning of science testing signals the end of the freedom that teachers have always enjoyed relative to science. As the imperative of high achievement gains in importance, the freedom of teachers to accept or decline the invitation to teach science is receding.

Such a transition raises many questions about the program's sustainability. With its 30 years of history, it is bolstered by a track record of weathering storms and the district's unwavering commitment to hands-on materials. But, the fate of many a program often rests with its ability to prove its impact. The Bayview science program has yet to be tested in this manner. How will students fare on the state's science test? If their achievement is sub-par, where will the administration and the parents look for efforts to improve? As new leaders emerge, the pillars of Bayview's program appear to be quite strong. However, the lack of accountability in the past has made understanding how far the program's support extends difficult to capture. As testing in science unfolds in Bayview, that may soon become clear.