Researching the Sustainability of Reform

HUDSON

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PROJECT OVERVIEW

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

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

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

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

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

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

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SUMMARY OF RESEARCH METHODOLOGY

Research Questions

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

Research Design & Analysis

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

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

Site Selection

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

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

1 All district and individual names are pseudonyms.

Site Visits

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

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

Interview and Observation Protocols[2]

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

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

Principal and Teacher Surveys

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

2 For a list of interviews and observations conducted at this site, see Appendix A.
3 One district, Montview, chose to abstain from participation in the survey.

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

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

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.

HUDSON
EXECUTIVE SUMMARY

INTRODUCTION

Hudson's[1] hands-on elementary science program was established in the mid-1970s and guided throughout most of its long history by a committed, politically savvy leader in a conservative and stable suburban environment. With a small dedicated staff, Linda Lawson built Hudson's elementary science program slowly and deliberately until it became districtwide. As an outgrowth of Lawson's leadership, Hudson developed a reliable, state-of-the-art central materials distribution center. As Hudson's science program has become nationally well-known and visible over the years, it has served as a model for other districts wishing to establish similar programs. The superintendent has always kept the program a district priority through local funding and political support. In 1996, the district augmented district funds by obtaining $6 million from the National Science Foundation in the form of a Local Systemic Change grant for science, math, and technology professional development.

Despite its strong history, the elementary science program faces significant challenges in the coming years. Funds from the large NSF-funded program are coming to an end just as the need for professional development is growing along with the population, and as experienced teachers are retiring. With added pressure from the state accountability system, the district will be stressed to keep up with existing professional development, let alone to deepen the nature of inquiry instruction as desired.

CONTEXT

Community Overview

Hudson is a sprawling suburb close to a major city. It was founded in the late 1800s and remained primarily an agricultural community until 1965, when it quickly began to evolve into a small suburban city, supported by a mix of commercial, agricultural, and tourist services. The economy has been expanding by double digits annually for the past 15 years and the Hudson area adds thousands of jobs each year, with growth in construction, financial services, manufacturing, and trade contributing the majority of new positions.

Within this context of newness and economic well-being, Hudson Public Schools (HPS) enjoys a good reputation. There are 50 elementary schools

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

(K–6) with a more ethnically diverse population than the community at large. It is 68 percent white, 23 percent Hispanic, 4 percent American Indian, 3 percent African American, and 2 percent Asian. The percentage of free and reduced price lunch-eligible students varies throughout the district, with an average of about 25 percent. There are about 1,600 elementary teachers in the district, with a comparatively low turnover rate, approximately 10 percent per year, including growth and attrition.

Budget

Hudson is not a wealthy school district, ranking below nearly all of the other districts in the state with more than 20,000 students. The state itself is one of the lowest in expenditures-per-pupil in the nation. Hudson has kept administrative costs low by creating large elementary schools (around 850 students) with no assistant principals at the elementary level. The most recent vote in favor of taxes to support the schools was in 1996.

Local Issues

Hudson has very stable, conservative roots, and administrators choose their language carefully in talking about their science program. The implication is that local is good; national or federal is questionable. They do not necessarily call their program "inquiry science." Rather, the learning goals for the curriculum were articulated long ago and have been acceptable to the community, so they avoid labels that might create conflict where it does not need to exist

PROGRAM HISTORY AND DEVELOPMENT[2]

Linda Lawson was an exemplary elementary school teacher with endless energy who had been using hands-on techniques to teach her students science, as well as the other fourth, fifth, and sixth grade students in her building. In 1972, with most of his time focused on reforming the math curriculum, the district's corrdinator of elementary math and science recruited Lawson to help him improve the science curriculum and to help recommend textbooks for adoption.

Lawson visited every school and her approach was soft-sell, deliberately "under-promise, over-deliver." Kit implementation was not mandatory, allowing reticent teachers to do what they had done previously, while Lawson identified the people who really wanted to do science. There was minimal training; Lawson would visit teachers who had questions or asked for her help, and she did some site-level training visits with very small groups.

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

By 1977, despite having almost no financial support, Lawson had managed to scrounge up a resource center and a mode of distribution—a dilapidated building and an old station wagon. Teachers would call with a request for a kit, and she would bring them materials as soon as they were available. Teachers received training on a kit before they taught it and were asked to evaluate and make recommendations for unit revisions. Over the next decade, most of the *ESS* and *SCIS* kits that were used in Hudson were revised to reflect local and state standards.

Textbook money provided a portion of the funding, and money also was pooled from other subjects that fell under the science department's jurisdiction. The program grew by word of mouth and, by the later 1970s, Lawson had recruited four specialists from teachers she had come to rely on during training. These resource teachers wrote teacher guides and additional units. They provided kit-specific one-on-one training and also tried to visit every teacher who was new to the district during the first week of school to explain the science program to them.

In 1978, the district built a new materials center, designed by Lawson to also provide space for the district's professional devopment. By the early 1980s, the science program was maturing, and with district support, was branching out into a more formalized structure with a liaison teacher in each school. Monitoring implementation became more of a focus, and Lawson and the resource specialists formalized the expectation that three kits per year were to be taught at each grade level, leading to the establishment of a core curriculum.

In 1996, the NSF "Hudson Systemic Initiative" (HSI) grant was funded with $6 million for five years. The aim of the grant was "the improvement of science and mathematics instruction through site-based learning communities and cross-district support." This funding contributed to the support for three full-time science resource specialists, one liaison teacher, and one mentor teacher in science per school, and a team of 22 "connection" teachers with professional development responsibilities.

The past five years have seen several changes in leadership and administrative organization. One of the resource specialists under Lawson served as director of the science program for a few years and then was promoted to assistant superintendnt of curriculum and instruction. The new head of the science program has experience in science teaching and administration both in and outside Hudson. In 1999, the superintendent for the past 16 years retired. A new superintendent from outside the district left after 18 months, and the previous assistant superintendent of curriculum and instruction became the district's new superintendent in January 2001.

3 *SCIS, the Science Curriculum Improvement Study*, was founded at UC Berkeley in 1963 by Dr. Robert Karplus with funding from the National Science Foundation. The study developed science curriculum for levels K–8.

4 *ESS, Elementary Science Study*, curriculum kits and materials were developed by Educational Services Incorporated (later to become Education Development Center (EDC) in Newton, MA. Development funded by NSF and begun in 1960.

THE CURRENT PROGRAM

Curriculum[3]

The current list of kits used by HPS includes *FOSS*[4], *Insights*[5], *STC*[6], and locally developed kits. The curriculum and kits are constantly being reworked to fit the state science standards. Most of the kits include a writing component in the form of notebooks or journals. Teachers are expected to teach four to five science kits or units; of these, three or four are required or "core" units, depending on the grade. Teachers are to select at least one additional unit from a list of optional ones.[7] For a complete list of core and optional units in grades 1–6, see Appendix D. In kindergarten, the district provides science-oriented resource materials, but they are not complete kits as used at the other grade levels.

Materials Center

Science kits are refurbished and distributed from the district's materials center. Teachers order the kits they need and specify a delivery date; each school has a weekly delivery date, and teachers can keep kits for a maximum of nine weeks. Eight clerks (seven full-time and one part-time) are responsible for refurbishing the kits. In addition, the resource center relies on volunteer support recruited from retirement communities to help restock and prepare kits for use. A bar code and software system is used that tracks orders and kit usage (providing the name of the requesting teacher, the packing clerk's name, and the clerk's direct phone number), and generates new orders for new materials based on this information.

Instruction[8]

The goal for science instruction is 120 minutes per week, and teachers in this study reported teaching science for 90–140 minutes, varying by grade level. Some anecdotal comments and an earlier district survey suggest implementation may actually fall somewhat short of this. The RSR survey revealed two main issues regarding science instruction: lack of time and training. Nearly three-quarters of the teachers and principals who responded reported insufficient time for teachers to prepare effective science instruction, and half of the teachers reported that they were trained on half or less of the curriculum they were expected to teach.

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

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

5 *Insights*: Developed by Education Development Center, Inc., published by Kendall/Hunt.

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

7 Fourth and fifth grades each have four core units instead of three.

8 For a vignette of a classroom lesson in Hudson, please see the site report.

Researchers visited 21 Hudson classrooms in 15 of the 50 elementary schools over a two-year period. In observed lessons, teachers spent the most time on whole classroom discussions, question-and-answer sessions, and sharing findings with the entire group. The second most time consuming activity was small-group work, usually with four to six students per group. Students typically carried out a well-prescribed task provided by the teacher. Introductions to the science lessons ranged from nonexistent to extensive, and lesson conclusions were generally very brief and focused only on the activity at hand without regard to previous or future lessons. In a majority of the classrooms, the lesson closure was rushed, and teachers cited time restraints as a specific impetus.

Assessment

Testing for elementary students in Hudson can stretch for four weeks or more. Tests include district tests in science that are unburdened by significant consequences but continued by the district for monitoring purposes. Additionally, students are given the SAT9 tests in science, math, and reading (grades 2–11) to satisfy state requirements. These requirements have only been in place since the 1999–2000 school year, and results are published on the district Web site as well as in the newspapers. Hudson has recently added new state-developed tests in math, reading, and writing. Students who do not pass are not to be promoted to the next grade and, eventually in grades 10–12, students must pass the test in order to graduate. School principals may be held accountable for their students' reaching this level, and a one percent staff incentive pay will be tied to achieving the target scores.

Professional Development

Professional development and training has always been voluntary in Hudson and is provided by resource teachers, liaison teachers, mentor teachers, or "connection" teachers, who provide four types of training, from kit-specific to science content. However, teachers new to the district or to their grade level will not receive a kit until they have participated in kit-specific training for their grade level. Elementary science mentor teachers provide kit training to new teachers and others who desire it. In addition, new kit training is available in regularly scheduled professional development sessions.

Almost all the people interviewed believe there is not enough professional development available for principals and teachers. Principals responding to the RSR survey also reported that they would like to have more time to attend meetings and talk to one another about science, so that they know what to expect for classroom practice and how to support it. Through the HSI grant, principals have been encouraged to take part in professional development and are viewed as critical to maintaining the program's philosophy and support. Release time is a serious obstacle to professional development in Hudson. There are not enough substitute teachers in the district to provide adequate coverage. In spring of 2000, a year prior to the end of the HSI grant, the superintendent met with district administrators to confirm commitments for continuing the professional development aspects of the grant into the future to maintain the high profile of science.

DECISION MAKING AND LEADERSHIP

District-Level Leadership

Lawson developed strong relationships with her superintendents (and auditors), but she also had an advantage working in a community where superintendents have had long, successful terms; the district had had only four superintendents in over 60 years. This stability and the close relationships that existed among many administrators over the years provided the science program with a secure base. The superintendent for over half the life of the science program was a key source of support for the science program, and the Hudson School Board has always been supportive of the science program. In particular, Superintendent Michael Johnson (superintendent for over half the life of the science program) and Linda Lawson were especially helpful to the board, frequently giving presentations and demonstrations on science.

Science Program Leadership

Lawson was undoubtedly the critical force in the creation of the Hudson elementary science program, and she guided it very successfully until her retirement after 23 years. Her strengths included her knowledge of science, tremendous knowledge of effective teaching and learning, dynamic commitment to her work, creative problem solving, hiring excellent staff, and her strategies for dealing with people.

Lawson also shared science program leadership responsibilities with five different categories of teachers with positions that were supported by the HSI grant, Eisenhower funds, and general district funds. Teachers in these positions tended to have a can-do attitude, and several of these teachers stayed in the district through retirement, later serving in positions where they continued to support the science program, such as director of the NSF grant.

With the shift from central office to site-level accountability in the past few years, teacher leadership is now a key issue for sustainability in Hudson. Since Lawson's retirement, there has been less administrative stability overall and more room for slippage in daily operations, although people generally feel the program still works well.

RESOURCES AND SUPPORT

Funding

The elementary science program budget has been part of the department budget since the program was established in the 1970s. Each year the director of science and social sciences submits a budget request for science/social science textbook money, which also covers health, social studies, traffic safety, and world languages. This budget is fluid; available money can be shifted between programs throughout the year. The director of science has final say over day-to-day spending once the annual budget is approved, giving him some flexibility. If he needs to make changes to the budget, he will approach the superintendent, who might bring the desired changes to the board of education.

District administrators tend to view external funds, like the NSF HSI grant and Eisenhower monies, as having a minimal or insignificant impact on the science program in Hudson. People expressed no fear that the science program would suffer when the external funding ends, but the director of the HSI said he was planning to write a teacher enhancement grant proposal.

Community and Partnerships

There has been an ongoing connection between the local state university and the district, though not a formal partnership, for most of the history of the program. More recently, there is a somewhat more formal relationship with an astronomer and university professor who is co-principal investigator on the HSI. An additional informal partnership, the Carson Delta Project, is a consortium of business people who volunteer to assist the schools in a number of ways, such as talking with students about applicaitons of science and math in various jobs.

Accountability

A recent evaluation report on the HSI suggests that many teachers and principals share the belief that math is a primary curriculum focus at the expense of science. As a result, many teachers feel unable to include science regularly, if at all, because they feel the need to emphasize math and reading. And, as evidenced in the 1999 survey, in some cases, teachers return kits to the materials center unused.

While the district collects data on teachers' use of curriculum kit materials, these data are used at the discretion of the principals, and there is little evidence that it plays a major role in shaping classroom practice or the science program. As an accountability measure, an aggregate report on kit usage at the school goes to each elementary principal at the end of the academic year to use at their discretion. Some principals pass the data on to their liaison teachers for coaching purposes, while some use the information to discuss kit usage with teachers across grade levels.

EQUAL ACCESS TO SCIENCE

Equity does not appear to be a topic in the foreground of discussion in Hudson Public Schools, although the district is concerned about the issue. The number of English-language learners and minority children is increasing in Hudson, and an article by Hudson's science program coordinator in a leading practitioner journal describes steps taken by the district to expressly attract and keep minority teachers.

Although all kits are shipped to all schools on a consistent and equitable basis, there is no guarantee that all teachers are implementing the kits as expected, or implementing them at all. In the classrooms observed, implementation of the kits varied greatly. Further, even those teachers who desired to teach the kits struggled with the lack of time to do so.

SUMMARY

As is true with most school programs, no single circumstance wholly shapes success or failure. In Hudson, one of the longest lived programs in this study, success has come over time and has been the result of stability, dedicated leadership, and a commitment to shared ideals. Hudson's science program has long been institutionalized as a valued part of the core curriculum in the district, and its existence does not seem threatened by any pending crisis. Nonetheless, it is not clear that implementation in Hudson is any more widespread than in other districts of the study. There exists in Hudson, as elsewhere, state test-driven pressure on teachers and principals to worry first about literacy and math, often stealing time, attention, and priorities away from science. Thus, the breadth and quality of science classroom practices in the future might well be affected by recent changes in leadership, impending retirements of long-term staff, literacy and math challenges to science for attention and resources, and ongoing professional development needs at a time when external funding is ending.

HUDSON

INTRODUCTION

Hudson[1] has had a hands-on elementary science program since the mid-1970s. Throughout its long history, the program has benefited from monetary and political support at the district level, a clear focus on improving the educational experience for local children, and stable leadership. As Hudson's science program has become nationally well-known and visible over the years, it has served as a model for other districts wishing to establish similar programs. Now, funds from their large NSF-funded program have dwindled, and they face an obstacle to success and growth in the future as the district continues to grow and employ more teachers.

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.

The Hudson program was established and guided throughout most of its long history by a committed, politically savvy leader in a conservative and stable suburban environment. With a small, dedicated staff, Linda Lawson built Hudson's elementary science program slowly and deliberately until it became districtwide. As an outgrowth of Lawson's leadership, Hudson developed a reliable, state-of-the-art central materials distribution center ,which is emulated throughout the country. In addition, the superintendent has always kept the program a district priority through local funding and political support. The program has been a budget line item since it began, avoiding the need for external funding until the past few years.

In 1996, the district obtained $6 million from the National Science Foundation in the form of a Local Systemic Change grant (called the Hudson Systemic Initiative or HSI grant) to augment district funds for science, math, and technology professional development. That grant ended in June 2001, and no additional outside funding has taken its place.

Although the program has informal connections to local universities, there have been no formal, long-term partnerships for most of the program's history. A professor at the local state university, however, has collaborated with the district extensively and was co-principal investigator on the HSI grant.

There have been a number of recent changes in district and program leadership, but there is no evidence that the changes have threatened the stability of the program. Lawson retired in 1997 and was replaced by her preferred colleague—one of her long-term resource specialists. However, that resource specialist was recently promoted to assistant superintendent for curriculum, and a new director of the science program was selected from outside the district. There have been two new superintendents in the past three years (although only two before that throughout the life of the

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

SIZE	
Sq. miles	200
# elem. students	43,151
# elem. schools	50
# elem. classroom teachers	1,630
RESOURCES	
Per pupil expenditure	$5,122
Teacher starting salary	$27,686
NSF funds?	yes
DEMOGRAPHICS	
% students eligible for free/reduced price lunch	41%
% white	68
% African American	3
% Hispanic	23
% Asian/Pacific Islander	2
% Native American	4
% Other	0
YEAR CURRENT PROGRAM BEGAN	**1974**

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

program), and some restructuring has taken place in the central office. The school board, famous for its long-term stability and unity, is beginning to see more contentious candidates, often committed to one issue, for the first time in its history. And yet, science at Hudson, having been in place for years, seems secure. Nonetheless, some pressure is coming from a strong state emphasis on test-based accountability in literacy and math, which may finally erode some of the base of support for inquiry-based science.

Recent demographic changes are having additional impact on the district and the science program. As the population grows in the Hudson area, as it has during the past 10 or 12 years, many new teachers are entering the system as older ones retire. Possibly as a function of this demographic change, the district has found that the science program may be weakening, particularly in how teachers approach inquiry in the classroom. One focus of the HSI grant was to develop site-based learning communities as a strategy to strengthen instructional practices in science, math, and technology to be more representative of true inquiry. The need to implement an inquiry approach beyond what was described as “mechanical usage” or “recipe” instruction, the loss of extra money for professional development, and increased accountability measures may represent the first true pedagogical and economic challenge for the program.

CONTEXT

Community Overview

Hudson is a sprawling suburb close to a major city. It was founded in the late 1800s and remained primarily an agricultural community until 1965, when it quickly began to evolve into a small suburban city, supported by a mix of commercial, agricultural, and tourist services. The peak of its growth came during the 1980s, as its population nearly doubled to about 400,000 in 1998. This population boom was fueled by two groups of newcomers; retirees seeking a warm weather climate, and families leaving older, denser urban centers seeking jobs in the young, expanding economy. The quality of life is perceived as high in the Hudson area, and the economy has been expanding by double digits annually for the past 15 years. Even in the recent stale economic climate, the Hudson area adds thousands of jobs each year, with growth in construction, financial services, manufacturing, and trade contributing the majority of new positions.

Within this context of newness and economic well-being, Hudson Public Schools (HPS) enjoys a good reputation. It is the largest school district in the state with 73,000 students overall. There are approximately 43,000 elementary school students (1998–99) in 50 elementary schools (K–6). The district also includes 13 junior high schools (grades 7–9), 6 high schools (grades 10–12), 10 alternative schools, and one vocational-technical school. The district serves over 200 square miles, including an urban core and a small agricultural area in addition to the middle class suburbs that predominate. During the 1980s when the district experienced dramatic growth, as did its neighboring city and suburbs, it was increasing by approximately 2,000 students and two to three new schools a year. But growth has tapered off, and it now averages a few more than 200 new elementary students a year.

Hudson's general population is 90 percent white. The surrounding area, including the inner city, is primarily Hispanic. The elementary school students are more diverse than the community population at large, composed of 68 percent white, 23 percent Hispanic, 4 percent American Indian, 3 percent African American, and 2 percent Asian. The percentage of free and reduced price lunch-eligible students varies throughout the district, with an average of about 25 percent.

There are about 1,600 elementary teachers in the district, with a student-to-teacher ratio of about 24:1 in the primary grades (K–3) and 27:1 in the upper elementary grades (4–6) in 1999–2000. There is no teacher's union in Hudson, however, 40 percent of Hudson's teachers belong to the state professional educators association, a professional group with no collective bargaining rights. The teacher turnover rate is quite low when compared with other districts in this study, approximately 10 percent per year, including growth and attrition.

Hudson students tend to have very good standardized test scores, and most students there aspire to higher education. On the SAT9 achievement test, which is administered yearly to all students in the 2nd through the 11th grades, scores in reading and math are consistently above the national average, ranging from the 52nd to 56th percentiles and 54th to 61st respectively. Hudson's college entrance exam scores also exceed state and national averages. The 1997–98 SAT average verbal score was 536 and SAT math score was 555, compared with national averages of 505 and 512, respectively. Nearly 80 percent of HPS graduates go on to college or technical schools.

Budget

Hudson is not a wealthy school district, ranking below nearly all of the other districts in the state, with more than 20,000 students. The state itself is one of the lowest in expenditures-per-pupil in the nation. During the 1998–99 school year, Hudson's budget per pupil was $5,122 per year, with a total budget for the district of approximately $360 million. The district's budget priority is students and curriculum. Hudson has kept administrative costs low by maintaining one of the most efficient administrator-to-student ratios in the country. It has purposefully created larger elementary schools than many districts (around 850 students) with no assistant principals at that level. Money is allocated to principals on the basis of the number of teachers and students in each school, and they have the authority to decide how to use it. "We believe in trust and treating people professionally," said an administrator who deals with the budget. The schools and district offices are in very good repair and look much newer than their years. Researchers often heard from interviewees, "When Hudson does something, they do it well." The most recent vote in favor of taxes to support the schools was in 1996.

Local Issues

The district has received national attention over the years for several of its programs, including its inquiry-based science program. The science program has been recognized as one of the best in the nation by numerous media. In addition, a national magazine ranked Hudson among the top 100 of the nation's public school districts, based on academic excellence and affordable housing. And, a recent superintendent, who had served the district for over 30 years, about half of those as superintendent, was recognized by the state for his success and was named one of the top 100 school-management experts in North America by a professional magazine.

Hudson has very stable, conservative roots, and despite its recent growth and ethnic diversity, it continues to be a conservative community. Administrators there mentioned that they choose their language carefully in talking with the public about their program. For example, one mentioned that although the program was designed to reflect the national science standards, "We don't talk about them much, in that context, because we have to be careful that this is a community effort, and we speak in the context of Hudson standards or state standards." The implication is that here, local is good; national or federal is questionable. Others mentioned that they do not necessarily call their program "inquiry science." Rather, they said, the learning goals for the curriculum were articulated long ago and have been acceptable to the community, so they try to avoid labels that might create conflict where it does not need to exist

PROGRAM HISTORY AND DEVELOPMENT[2]

Early Years

The elementary inquiry science program in Hudson began informally, with roots in other, complementary disciplines. In the late 1960s, concerned with lagging reading scores, the school board hired a reading consultant whose mandate was to increase reading scores (which were reported as grade level scores) to an acceptable level. Within three years, the scores across the district increased by two grade levels, which the district deemed acceptable. (When asked how he accomplished such a feat, the consultant attributed his success to an emphasis on phonics and a change in the state test.) Encouraged by this success, the board was inspired to use a similar approach to improve math performance districtwide.

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

Jeff Winters, an educational consultant with experience in the area, was hired full-time as the coordinator of the elementary math program. Within a few years, the math scores were climbing. Winters also happened to have a very good science background, including college science courses, and one day in 1970, when the superintendent was guiding a contingent of Canadian educators on a tour of the district, he introduced Winters as the director of math and science. Later that day, Winters called the superintendent to ask what he had meant about directing science. The superintendent then formally asked him to be responsible for science, telling Winters that he had all the qualifications to direct science, too, and that very little would be expected of him—that "…you know how sometimes secondary teachers will take a trip to a conference or something and there is no curriculum level person to sign off on that."

Winters agreed. He would have liked to accomplish a lot in science, but his 70-hour a week commitment to math reforms precluded him spending as much time on science as it deserved. Still, Winters convened several conferences with district teachers to ascertain their needs and ideas about science in the district. During one of the conferences, he met and was impressed by the thoughtfulness and experience of Linda Lawson, a teacher from a nearby elementary school. He asked Ms. Lawson to become involved with the science program, knowing that he would need to hire someone formally to expand and monitor whatever science program developed. In that way, Linda Lawson became the founder of record of Hudson's inquiry science program.

During this time—the early 1970s—Linda Lawson was an exemplary elementary school teacher with six years' experience in Hudson, at a low-income school with many English-language learner students. She was a well-liked and creative woman possessed of endless energy who had been using hands-on techniques to teach her students science. One of her famous policies, which reflected her commitment to science, was this: If any student had not demonstrated mastery of the week's work in science, she would hold class on Saturday, with mandatory attendance for those students. It was a measure of parents' support for her that whenever Saturday sessions were held, the students who needed the extra work were always there. (Lawson said that after the first session was held each year and her students realized she was serious, the need dropped off radically.) She described the rationale for her approach to learning and to discipline as follows:

> I didn't work with any of the NSF stuff at all. I was just pretty ignorant in that I was separated from the science community [at large], but I knew from my undergraduate work in science that you had to do something in science in order to be able to think about it….[and] there was no question that everybody had to learn each week, because we couldn't really start the next week until everybody had learned what they needed to learn this week. If we hadn't learned it on Friday, then we would be here on Saturday.

Before coming to Hudson, Linda Lawson had led an adventurous life, having taught secondary-level math and science for two and a half years while in the Peace Corps. She brought some of that energy and determination to her years as an elementary teacher in Hudson, where she had a unique assignment. She taught her own classroom of students half the day, and then taught fourth, fifth, and sixth graders science the rest of the day. The schedule was organized so that she taught the same lesson three times a day for two weeks, then repeated the same lessons with a new group of students. In her six years as the science specialist, she taught each of the lessons 24 times, accruing a huge background of science experience when one considers that a general classroom teacher teaches each lesson once a year.

She came to believe that using a science specialist to teach elementary science would not support the type of science education reform she believed in.

Lawson was quick to acknowledge the effect of such intense experience. The combination of reflection time between lesson repetitions and the opportunity to teach the same lessons to students simultaneously across three grade levels provided her with hands-on experience in understanding how students learn, how activities should be sequenced, and what kinds of activities worked well with students. She also came to believe, however, that using a science specialist to teach elementary science would not support the type of science education reform she believed in—science that could support her students' efforts to assimilate science in a meaningful way:

> It [using a specialist] doesn't make the way of thinking about things in a scientific way part of all students' day, all day long. So that is why, even though it was a great fun way to teach, I don't necessarily advocate it, because it put science in a special room, rather than science as a way of thinking.

While Linda Lawson was teaching science at her elementary school in May of 1972, Jeff Winters discovered that it was an adoption year and that he had one week in which to review all available science texts and decide which book to recommend and purchase for next year's instruction. Unfortunately, he had been unaware of the looming deadline. So much for "not having to do much" as science coordinator.

Winters happened to be at a meeting with Lawson's principal the day he discovered his added responsibility. During that meeting, the principal shared with Winters his own worry about another problem—the district was about to lose Linda Lawson. While this turn of events saddened them both, Lawson was anxious to continue her own education—she was planning to resign her teaching position to do a year's residency at the regional state university. The residency was a requirement for her to complete a doctorate in science education, after which she planned to return overseas to continue her teaching begun while in the Peace Corps. Jeff Winters and the principal devised a creative solution to address the situation. On the last day of the school year, they approached Lawson with a plan to hire her half time to help Winters with the science program, a plan she happily accepted.

Until this time, each school in the district developed its own program for science. They used various textbooks, and science instruction was voluntary. When taught at all, teachers were responsible for gathering any materials required in addition to the textbook, usually without help from the school's general fund. Out of the 24 elementary schools in the district at the time, Lawson's school had a specialist, seven schools used *SCIS*[3] kits and materials, and three used *ESS*[4] kits and materials. Materials for each school's curriculum were funded by its principal with general funds.

When Lawson and Winters asked themselves what they would like to do with the elementary science program, both agreed they would like to use the *SCIS* materials, if only they had enough money. Their attachment to inquiry, in general, and to *SCIS,* in particular, grew out of fondness for a shared mentor who was a professor at the nearby regional university. The professor was very enthusiastic about the *SCIS* and *ESS* kits, and Lawson was his first doctoral student. Lawson had borrowed a couple of the kits from him and experimented with them, but had never had formal training in using kit-based curricula. She had also seen an article about a school district in Fairfax, Virginia, which was distributing science kits to teachers on a rotating basis, a new idea to Lawson. Hudson already had distribution centers where teachers could come and pick up materials to teach math and art, and it was a short conceptual leap, according to Lawson, to establishing a science center, which would actually provide teachers with the necessary science materials. Lawson said:

> My vision was that if teachers had what they needed to teach science, they would teach it. I was pretty naïve. I said if we could get the stuff to teachers, then that would be all it would take, because science is pretty easy to teach.

Lawson and Winters thought again about textbook adoption, and realized that *SCIS* and *ESS* kits were on the state-approved adoption list along with textbooks. If they used all of the available textbook money, and could pry an additional $7,000 from the board, they could purchase enough kits to provide each teacher with the necessary materials on a rotating basis, but not enough for each teacher to have her own kits. They asked the board for $9,000 beyond the regular textbook money to buy the kits, but the board could offer them only $5,000. Although the money was not enough to cover what Lawson and Winters thought was a "minimal" kit program, the alternative was to purchase textbooks and have Lawson "run around and do

3 *SCIS, the Science Curriculum Improvement Study*, was founded at UC Berkeley in 1963 by Dr. Robert Karplus with funding from the National Science Foundation. The study developed science curriculum for levels K–8.

4 *ESS, Elementary Science Study*, curriculum kits and materials were developed by Educational Services Incorporated (later to become Education Development Center (EDC) in Newton, MA. Development funded by NSF and begun in 1960.

little workshops" with teachers in order to inculcate a consistent science program. This alternative was unacceptable to either of them. Lawson recalled what they did next:

> So we sat in his office and talked and talked and we both realized that it could not be done for $5,000. We kept saying, "We know you can't do it for five. Yeah, we know. You can't do it—Yeah well, let's do it anyway!" But that turned out to be really good because we knew we couldn't do it in one year…so it was very freeing to take on a task that was absolutely impossible, because what that meant was, whatever you did was fine, but you could do what you could…So we bought a bunch of kits and some books, and we chopped the covers off the books and stuck chapters into the kits so when the teachers got their edition they had the books for outside reading…because at that point there weren't a lot of good trade books…

Program Establishment

In the first year, Lawson visited every school faculty, delivering a brief talk about what she and Winters were trying to do with the science curriculum. Her approach was soft-sell, deliberately "under-promise, over-deliver":

> We have some kits you can use instead of your textbooks. They are not really ready but we'll let you use them if you're interested, and we will train you if like; if you're not interested, just keep doing what you have in the past.

Teachers were intrigued. As Lawson tells it, "they sat up and listened." Her approach was not threatening because kit implementation was not mandatory. This gentle approach allowed those teachers who were unsure of their science expertise to stay in the background, doing what they had done previously, while Lawson identified the people who really wanted to do science. Those teachers and principals who were ready and interested in the new kit curriculum became the eventual support structure of the program. The slow first year's implementation also encouraged the interested teachers to take time to reflect on the kits and their use. Many of them made suggestions for adaptation and improvement to the kits, which encouraged ownership and membership in an important new curriculum development group.

Those teachers and principals who were ready and interested in the new kit curriculum became the eventual support structure of the program.

Lawson's approach was also in direct contrast to that used in other disciplines at the time, where teachers were expected to "turn in your old books and change. At the first of September you are going to have a new adoption." Such abrupt change and subsequent monitoring of implementation practice had been the norm in the district up to this point, and, Lawson believed, fostered resentment among teachers. As one former resource teacher put it, "She didn't cram anything down teachers' throats." Although Lawson's approach reflects her beliefs, she said it was also necessary because they simply did not have the materials or staff to support rapid districtwide change.

The program's first year was spent making suggestions and trying to get teachers to just use the kits. There was minimal training, and none of it occurred in formal workshops. Lawson would visit teachers who had questions or asked for her help, and she did a few site-level training visits with very small groups. There was no monitoring. Winters was too busy with the math program to do as much with science as he would have liked, but he supported Lawson's efforts in any way he could. He served as Lawson's mentor in her first two years on the job in the science program and taught her about administrative processes such as budgeting. After two years of their working together, however, he left Hudson to take a position in another state, and Lawson was made acting director of science (along with social sciences) for a year, and finally its director.

Over the first three years of introducing the program, in Lawson's one-on-one training sessions at the schools, she was able to steer teachers to units that were close to their current teaching skills, or required them to stretch a little in pedagogy and implementation skills. She reasoned that though using kits would push teachers a little pedagogically and with their content knowledge, interested teachers would learn to do it fairly quickly. Since Lawson was implementing the program virtually single-handedly, coaching teachers in the classroom or doing more in-depth training was just not a priority. But seeing the teachers' practice turn toward inquiry and students learn science was exhilarating for her. She was particularly excited to see science as a way to "help teachers learn how to create really good environments for kids to be in." By then, Lawson had fallen in love with her job and decided to stay. "It was fun for me to try to solve the problems, and the worse the problems were, the more I would love to solve them."

With plenty of hard work focused on training and involving more teachers, the program grew. By 1977, Lawson had devised a "resource center" and a mode of distribution—more accurately, an old building and an old station wagon. Teachers who were interested in teaching science could call the resource center and she would bring them materials as soon as they were available. In that way, the kits would circulate from the central location to each school. Thus, lack of materials would no longer be an excuse to avoid science instruction. Workshops by grade level followed. Teachers received training on a kit before they taught it and were asked to evaluate and make recommendations for unit revisions. Over the next decade, most of the *ESS* and *SCIS* kits that were used in Hudson were revised to reflect local and state standards.

The budget was extremely tight. The textbook money provided a portion of the funding, and money also was pooled from other subjects that fell under the science department's jurisdiction (including social studies, driver's education and world languages) to make up the difference. To avoid the administrative channels and outside influence that might interfere with her vision of inquiry and hands-on science, it became Linda's policy to avoid external funding. In addition to personal belief, she was just too overextended keeping up with teachers' needs to be able to pursue outside money with the energy required. The program grew primarily by word of mouth. As teachers observed their colleagues teaching science, they became interested, and the number of teachers wanting to be involved grew.

A happy accident that occurred in the spring of 1977 provided a significant boost to Hudson's science program. One of the junior high schools inadvertently listed science as "optional" (it was actually required) on the menu of classes from which sixth graders were to select their next year's program. There were two feeder elementary schools for this junior high, one of which used a traditional textbook approach to science instruction while the other school used the *SCIS* kits. Nearly all (96 percent) of the students from the *SCIS* elementary school elected to take science as an "optional" course, whereas almost none (4 percent) of the students from the textbook school signed up for science. This evidence helped the district see the importance of an elementary science program, and it increased their faith that the new kits would have a positive effect on students.

During this time, the later 1970s, Linda asked four exceptional teachers to become specialists—positions funded by the science budget. She recruited the four specialists from teachers she had met and come to rely on during training, all of whom possessed qualities Lawson sought for the growing program including an ability to collaborate and provide leadership at their individual sites, but more importantly, an interest in inquiry and kit-based curricula. The science specialist positions involved teacher training and kit revision. The science staff realized that the more teacher-friendly the manuals were, the more teachers would use them, the less training was required, and the more the students would experience science. So the resource teachers started writing guides for the teachers. They also wrote additional curriculum units that were not commercially available at the time. They visited teachers at the schools, four resource teachers for 40 schools, providing kit-specific one-on-one training. Resource teachers also tried to visit every teacher who was new to the district during the first week of school to explain the science program to them. One of the resource specialists during that time described the response of these teachers:

> [One of the new teachers] came from Texas because her husband was transferred here, and she was very disappointed to leave the district there. She said, "I had such a good relationship with my principal." I explained the program to her and she said, "I can't believe this." She said, "I was so fortunate in Texas that the principal allowed me to buy things at the store so I could do activities with my students." She said, "Here you are telling me I am going to get a kit and it has everything in it. I don't have to go to the store!" She couldn't believe it and felt she had just died and gone to heaven.

As the program grew, Linda Lawson realized that her station wagon and old building could no longer suffice. In 1978, her problem was either complicated or solved for her, depending upon one's interpretation. That year, the superintendent, who knew about the building's problems and Linda's desire for an updated distribution center, met with city and federal officials regarding long-term real estate needs. The outcome had immediate consequences for the science program. The district exchanged the science center building for rights to buy two new school sites at nominal cost. The new distribution center would now have to be developed. The story of the science center's design epitomizes Lawson's integrity and creative problem-solving approach to building Hudson's elementary science program. As Lawson recounts the story:

> There was no point in getting ahead by doing something in a way, where, if someone finds out about it later, it will get you into more trouble. On the other hand, you always have to be honest and you always have to follow the rules, but you can read the rules very carefully, so that when you have done something, people will look at them and say, "Yeah, I guess that was within the rules."
>
> The superintendent went to a big meeting with [a bunch of government people] and they bargained about what they wanted in their long-term plans. When the superintendent came out, he was saying, "Oh it's wonderful, we have a new senior high site over there and all these other things."
>
> And after a while somebody asked him, "Well, yeah, but what did you have to give away?"
>
> He said, "Oh just Linda's old place." They wanted the old building [resource center] for a historical museum, which is about all that it would be worth. It was really dreadful. We had four major electrical fires in it during the time we were there… But we loved it because it was better than where we had been before… So then he had two years to get us out of there….

The superintendent then allowed Linda to have free rein in designing the science center she wanted, within very loosely defined parameters, with a surprising outcome:

> I had already worked with architects…designing a lot of the science and social science areas of the new high school, so I knew the architects and the contractors. The superintendent came to me and said, "Here is the curriculum building [plan]…and at the end of it there is this footprint. You can meet with the architect and design whatever you want…, but it has to fit in that footprint."
>
> I said, "Okay, let's make sure I understand this. I can design whatever I want as long as it fits in this space and it is attached at that end of that building?" He said, "Yes."
>
> …When we turned [our plan] in to the superintendent, he looked at it and he said, "Linda, what is this?"

> I said, "It's the design of the new resource center."
>
> He said, "It's two-story."
>
> I said "Yes. As I understood the ruling, it had to fit in that footprint and that is it." But when you do something like that,…you have to make it so that the way you have changed things is better for the people who aren't sure that they wanted it. So I didn't design a two-story building that was all resource center. I designed a two-story building which also had this room where he could run a training program for 70 people in, which he hadn't had previously, and which had two additional in-service rooms, which he desperately needed.. So he went with it. He didn't give us as much of the downstairs that I wanted originally… but over the course of a few years we got it back, but you have to have some give and take. We knew it was at least there…and I was much more concerned about potential.

Beginning in the early 1980s, the science program was maturing, and with district support, branching out into a more formalized structure. Each school was asked to select one classroom teacher, called a liaison teacher, to come to monthly meetings to exchange information with Lawson and her staff about what was going on in the schools and learn more about the district science program. This was viewed as a leadership role for the teachers—not simply a messenger service—and the principals were asked to choose teachers with leadership capabilities or potential who were also interested in science.

As the program developed, monitoring implementation became more of a focus. Linda and the resource specialists could tell by the condition of the kits upon return whether a teacher had really used the kit materials. They decided to formalize the expectation that three kits per year were to be taught at each grade level but allowed teachers to choose the kits they taught. Eventually, however, her staff and many of the teachers themselves convinced her that it would be better to establish a core curriculum. Teachers were willing to give up some personal control to gain a universal expectation of what students would learn in each grade. As the program's reputation grew, more teachers wanted to participate in it and, by 1986, 7,500 kits were being circulated. The state Department of Education adopted new curriculum standards and the kits were reworked to align with the new science standards.

Faith in the program staff, anecdotal evidence of the program's value, and national recognition were sufficient to maintain district support.

Over the years, faith in the program staff, anecdotal evidence of the program's value, and national recognition were sufficient to maintain district support. At one point, the district administered a science test to sixth graders to see what skills they had attained, but they did not do very well on the test. However, the program was already getting a lot of recognition around the country, so rather than doubting the program because of the test scores, the district felt the test did not measure their desired outcomes very well. One administrator from that time said:

> We knew there was a mismatch there. We felt quite confident in the direction with the kids. The kids were learning more science this way than they were the other way. We sort of rode with that. Sometimes you just have those gut level feelings.

The Stanford story is another frequently told anecdote revealing district pride in the apparent success of its science program. Evidently several years ago, Stanford University sent a letter to the superintendent saying that there were more acceptances for the new freshman class from Hudson Public Schools than from any other school district in the country.

Recent Developments

By 1996, the NSF "Hudson Systemic Initiative" (HSI) grant was funded with $6 million for five years. The aim of the grant was "the improvement of science and mathematics instruction through site-based learning communities and cross-district support." Another of the earlier science specialists headed the HSI, which ended in June 2001. He noted that in a district with 73,000 students and 75 schools, they "are all at a different place and serve different communities and have different needs. I think we have learned over the past 25–30 years that there is no single answer; there has to be a range of resources and strategies provided." Over the past few years, there have been three full-time science resource specialists, one liaison teacher, and one mentor teacher in science per school, and a team of 22 "connection" teachers with professional development responsibilities.

The past five years have seen several changes in leadership and administrative organization. In 1997, Linda Lawson retired, but she remains a consultant to the program and was an evaluator for the HSI. One of the resource specialists under Lawson, Frank Newton, served as director of the science program (as well as social science, languages, health, and drivers' education) for three years, and then was promoted in the 2000–2001 academic year to assistant superintendent of curriculum and instruction. The current head of the science program, John Harris, has experience in science teaching and administration both in and outside Hudson. He wants to deepen science implementation and integrate it with other curricular areas without losing time devoted to science.

In May of 1999, the superintendent for the past 16 years retired. A new superintendent, the first ever hired from outside Hudson, came from another district with a hands-on science program. However, he served as superintendent for only 17 months and then retired. The other finalist for his position, who had been an assistant superintendent for curriculum in the district, was eventually selected as the current superintendent in January 2001

THE CURRENT PROGRAM

Curriculum[5]

Vision and Goals

Hudson's science program began as a minimally funded alternative to adopting a new textbook, championed by two determined, competent risk-takers who, through experience and education, had come to believe in inquiry-based science teaching and learning. Linda Lawson and Jeff Winter's initial vision was centered on just getting teachers to open kits and experience the techniques of hands-on science. Lawson had an additional vision, that of moving teachers pedagogically into a more inquiry-based view of teaching in general. When asked to reflect on her vision of inquiry science and what she was trying to accomplish, Linda Lawson described it as follows:

> I would categorize much of what I did personally as a teacher as sort of low-level to medium-level inquiry. I could have done better, but it was definitely not just hands-on. You know my personal teaching, my personal vision, would be inquiry. But in the first few years, the initial vision of the project was more hands-on than inquiry. But the vision changed.
>
> The model for a long time has been that there are three mandated units [at each grade level] and all teachers teach those units. They are expected to teach a fourth unit, but one of their own choice…It allows you to help first-year teachers or very rigid teachers…to have that fourth unit be one that is fairly simple and not very good. To be perfectly honest, it is more of a recipe-type thing, if people want that. It allows you to put on the table some units that are too difficult, in terms of how deep they are in inquiry, for 50 percent of the teachers to handle. Certain units are wonderful but not everyone in the district has the skills to do them really well.

While teachers and administrators tend to have a common view of the program, slightly different comments came from various sources. Teachers in focus groups, for example, talked about the vision of hands-on science that engendered "engagement, interest, and enthusiasm" in their students. They added, "We make a lot of messes." Teachers also remarked that Linda Lawson was "years ahead of her time…and very visionary." According to one teacher, the HSI project contributed to the vision, because "it was saying that teachers are valuable. Not resource people, buildings, or others, but teachers."

Principals see the program's vision in more global terms. As one put it, "The [vision] has to do with process, experimentation, setting up experiments. The hands-on approach is key as opposed to textbooks." Further, the prin-

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

cipal's role in this vision is, as one succinctly put it, "Encouragement." Teachers and principals responding to the RSR survey responded that science is "moderately important" to "very important." Not surprisingly, each group, according to the survey, perceives the other to place slightly less value on science than they do themselves. (See principal survey question 19 and teacher survey question 21 in Appendix B.)

District officials, perhaps not surprisingly, had the most elaborate and academic version of what makes the science program at Hudson special. One official said that inquiry science is where "teachers facilitate instruction, and the kids are actively cognitively involved." He went on to say that, in the Hudson program, "…teachers use higher-level questioning strategies, use different forms of assessment, and use advanced reflective skills to analyze their instruction." One administrator summarized the evolution of program goals over time as moving from increasing science test scores after new reading and math programs had been successful to currently focusing on target outcomes and increasing use of deeper inquiry instruction beyond mere mechanical use of science kits.

One administrator summarized the evolution of program goals over time as moving from increasing science test scores to focusing on target outcomes and increasing use of deeper inquiry instruction beyond mere mechanical use of science kits.

Instructional Materials

The current list of kits used by HPS includes *Full Option Science Systems (FOSS)*[6], *Insights*[7], *STC*[8] and locally developed kits. Many of the kits have been redesigned or adapted by Hudson resource teachers over the years and the curriculum and kits are constantly being reworked to fit the state science standards. Teachers are expected to teach four to five science kits or units per grade. Of these, three or four are required or core units, depending on the grade.[9] Teachers are to select at least one additional unit from a list of optional ones. For a complete list of core and optional units in grades 1–6, see Appendix D. In kindergarten, the district provides science-oriented resource materials (*Science Explorations for the Early Years*) that involve sorting and classifying activities, but they are not complete kits as used at the other grade levels. According to the RSR survey, teachers seem to know how many kits they are expected to use, and a large majority of them reported they typically use the required amount or more (See teacher survey question 9 in Appendix B).

Most of the kits include a writing component in the form of notebooks or journals. These notebooks currently consist mostly of step-by-step instructions and fill-in-the-blank sections for students to complete. One of the goals of the program is for students to eventually use notebooks with

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

7 *Insights*: Developed by Education Development Center, Inc., published by Kendall/Hunt.

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

9 Fourth and fifth grades each have four core units instead of three.

empty lined pages as scientists would: to record observations and systematic data collection, to note hypotheses and speculation, and to explain how they interpret the data and what they conclude from it. This idea has recently been introduced across the district, but many people believe that consistent districtwide usage will take many years to achieve. However the new head of the science program said that journals are finally now being used on a regular basis. He also supports a movement to integrate science and literacy. Many people interviewed believe, as in other districts, that this is necessary for the survival of the science program, given the current state and national focus on literacy. Many of the Hudson science kits have been linked to other disciplines, including social science, math, and reading, since early in the program's history. In current science professional development sessions, the writing and literacy link is being emphasized by providing notebook prompts such as focus questions, explanation questions and the like.

The surveys administered by this research project corroborate the general picture of this district as kit-based with an interest in integrating language arts with science. The vast majority of teachers responding to the survey reported that they often or very often use science kits; half said they also use science-related literature and nonfiction; less than 10 percent reported that they use textbooks often or very often. (See teacher survey question 8 in Appendix B.) Despite a comprehensive and efficient kit distribution process in this district, about two-thirds of the responding teachers reported that they often or very often bring in their own materials to supplement the kits. The survey did not specify what types of materials teachers were referring to. Principals responding to the survey reported the relative importance of these materials in the same order as teachers say they use them: kits most important, followed by teachers' own materials, then science-related books, with textbooks rather unimportant. A majority of teachers also said that they considered the district's kits and science standards "a lot" when planning their science instruction.

Materials Management

Science kits are refurbished and distributed from the two-story materials center designed by Lawson in 1980, which is located in the administrative complex of HPS. Teachers order the kits they need and specify a delivery date on the order form. Each school has a weekly delivery date, and teachers can keep kits for a maximum of nine weeks. Eight clerks (seven full-time and one part-time) are responsible for refurbishing the kits. In addition, the resource center relies on volunteer support, recruited from nearby retirement communities, to help restock and prepare kits for use. This consistent contact and communication with older community members is also seen as helpful when school bond issues are up for a vote. The retired population in Hudson is large and growing and, without school-aged children, is more likely to vote "yes" on bond issues when they perceive themselves as valuable assets and included in school affairs.

The 1999–2000 academic year was a year of administrative change for the materials center. Each kit now has a barcode label similar to the tracking labels on UPS packages. The label includes helpful information, such as the name of the teacher who requested the kit, the clerk who packed the kit, and the clerk's direct phone number to call if there are problems with the kit. All of this information is scanned into a computer with a hand-held scanning gun that communicates with the newly purchased software package. The software keeps track of orders and kit usage and can generate new materials orders based on this information. In addition, teachers are encouraged to contact the material center clerks with questions or requests for additional or missing kit materials. Many teachers praised the material center staff and said that without the kits and the support, they couldn't teach science.

As the district has grown, storage space for science materials has gradually become an issue. During the past few years, many kits have had to be stored in the district office hallways. Now the district is reorganizing its use of central office space for the materials as well as staff. The current director of the resource center, hired in 1999, says the district provides sufficient money to manage the materials. There was even enough to send some of her staff to the National Science Teachers Association (NSTA) conference out of state during the HSI grant period. The impact of the loss of HSI funds has yet to be seen or felt, but teachers and ancillary personnel, such as the refurbishment clerk,s have expressed their hope that such professional activities as attending conferences will continue.

Instruction

According to district documents, the goal for science instruction is 120 minutes per week. Actual implementation falls somewhat short of this, although how short depends on the source of one's data. On average, teachers who responded to the RSR survey reported that they teach 116 minutes of science a week, which is very close to the district goal of 120. Teachers in the lower elementary grades teach less (92 minutes) and those in the upper elementary grades teach more (140), reflecting the greater number and complexity of units expected in grades 4 and 5. (See teacher survey question 7 in Appendix B.) These data, however, portray a rosier view than data from a 1999 survey administered by the director of the science program or data from an RSR focus group. In February of 1999, Newton surveyed 430 elementary teachers at 15 of the 50 elementary schools regarding the amount of instructional time they devoted to science. The return rate was 95 percent, and of this group, 77 percent of teachers reported spending 90 minutes or less per week teaching science. Similarly, experienced teachers in a focus group conducted for this project commented that "about 60 minutes" was their usual time spent on science per week.

To obtain a "snapshot" of instruction in Hudson, the research team made a request to interview and observe elementary teachers who teach consistently at a level the district expects from most of its teachers who have had training on the science curriculum. The science program director asked principals to suggest possible teachers and arrange visits. (For more information on research methodology, see the summary of research methodology in this report and refer to the in-depth discussion on methodology in the cross-site report.) Researchers visited 21 Hudson classrooms in 15 of the 50 elementary schools over a two-year period. Class sizes ranged from 15 to 35. The schools were in a variety of neighborhoods of differing economic level and ethnic diversity. The teachers ranged in length of experience from less than one year to more than 20. All had four or five years of college training, but none had majored in science. The student populations in half of the classes was about 90–100 percent white, with the other half was between 60–90 percent white. The remaining students were primarily Hispanic, with a few African American and Asian students. Students' predominant language was English, but in a few schools, Spanish was sometimes spoken between students.

The classrooms varied widely regarding the amount and type of printed material, student work, and art displayed on the walls and around the room. Most classrooms had several computers, which seemed to be used. At least two of the schools were undergoing remodeling to install technology labs during the course of the study. One sixth-grade classroom was dazzling, with displays of student-made art, bulletin boards of student work, and evidence of mummification experiments placed on shelves around the room. In addition, there were teacher-made bulletin boards discussing the scientific questioning process and elaborating on social studies themes. In this classroom, the students were working at long rows of desks, which facilitated discussion with their neighbors. However, student discussion, even on scientific topics, was discouraged as "thinking out loud" except for expressly delineated time periods. In another, more sparsely decorated classroom where student science work was not visible, the students and their teacher were all engaged in producing sound with various kinds of equipment and predicting what kinds of sound the equipment would produce. There was, evidently, little correlation between student work and materials on display in the classrooms and the extent to which instruction in those classrooms reflected the goals of Hudson's science program.

Teachers spent the most time on whole-classroom discussions, question-and-answer sessions, and sharing findings with the entire group. The second-most time consuming activity was small-group work, usually with four to six students per group. Students typically carried out a well-prescribed task, such as making rockets following a diagram provided by the teacher; coloring in the outlines of digestive organs and attaching them to human body outlines; and constructing buildings with paper, marshmallows, and toothpicks. In about a third of the observed lessons, students were asked to make a prediction about the outcome of this group activity. In nearly all classrooms observed, instruction was at what program leaders might describe as "mechanical kit usage."

Introductions to the science lessons ranged from nonexistent to extensive. During the most common type of introduction, observed in about three quarters of the classrooms, the teacher mentioned the object or goals of the lesson, such as "…we'll discover which of the four salts will best mummify the apple." In addition, about the same proportion of teachers elicited students' prior knowledge, such as "Remember when we saw the cells really enlarged in the pictures you got off the Internet? We will be looking at different cells today." Much of the time spent in introducing the lesson was used to give step-by-step prescriptive instructions to the class as a whole, and the teachers often rushed through the introduction to get on to the main activity.

In general, lesson conclusions were very brief and focused only on the activity at hand without regard to previous or future lessons. In a majority of the classrooms, the lesson closure was rushed, with teachers and students hurrying to the next subject, and teachers citing time restraints as a specific impetus. The lesson often jumped from activity to clean up, and teachers tended to conclude with such admonitions as "Stop what you're doing. We're out of time. Will all the materials managers in your groups start the clean-up now?" When asked about the hurried nature of some lessons, teachers replied with a variation of the remark, "It's so difficult to get everything into the day. There's just too much to cover!" However, it is noteworthy that in three hurried lessons, which ended at the close of the school day, the students were reluctant to go home, and wanted to stay and go further with their mummification, their rockets, or their magnet projects. In fact, all observers noted that the students' level of engagement appeared to be high throughout all lessons. Students were obviously enjoying their engagement with science. One teacher stated that her students look forward so much to their science lessons that she uses science as a disciplinary tool—if students are misbehaving, she threatens to take away science.

Each classroom had a variation on a science workbook, which consisted of photocopied worksheets for students to complete. Thus, student writing was limited to answering short, fact-based questions. However, in response to requests from teachers at professional development sessions, Hudson is developing a new notebook model to be used at all grade levels to integrate literacy skills with the existing science units. The notebooks are conceived as a tool, rather than a prescriptive curricular element. That is, each teacher will be able to use the notebooks as repositories for their students' observations, data displays, predictions, and conclusions about their science investigations. Third-grade level notebooks, developed in the summer of 2000 by a group of experienced teachers and a curriculum specialist, were piloted in the 2000–2001 academic year, with similar second grade development following later in that same year. Aligned professional development for interested teachers was planned for the following year.

The RSR survey revealed two main issues regarding science instruction: lack of time and training. Nearly three-quarters of the teachers and principals who responded to the survey reported that they feel there is insufficient time for teachers to prepare effective science instruction. (See teacher survey question 21 in Appendix B.) Half of the teachers reported that they had been trained on half or less of the curriculum they are expected to teach (i.e., trained on two or fewer kits). (See teacher survey question 9 in Appendix B.) And about half of the responding teachers reported that they feel well prepared to teach science, but only a quarter of responding principals reported feeling that most of their teachers are well prepared. (See principal survey question 19 in Appendix B.)

Following is a vignette that provides an account of a classroom lesson in Hudson. This vignette provides an opportunity for the reader to review detailed descriptions of classroom practice, teacher-student dialogue, and lesson structure. This lesson was selected because it was one of the very few observed that reflects the richness of science content and pedagogy that comes closest to Hudson's goals for the science program. As demonstrated in the teacher-student interaction, the students are engaged and learning to think scientifically throughout. The teacher elicits students' prior knowledge at the beginning of the lesson. Then students interact with the materials to acquire some information before making their predictions, and the teacher asks for evidence to support their ideas.

The teacher is a white male, in his late 30s. He has nine years of experience as a sixth-grade teacher, and has achieved a strict but warm rapport with his students. Twenty-one of his usual 24 students are present for the whole lesson—three have left for a pull-out program. The classroom is about 60 percent white, and 40 percent Hispanic, with equal numbers of boys and girls. There is one ESL student in the class, a girl who speaks Arabic at home but seems to be fluent with her English-speaking peers.

The teacher usually teaches science about an hour a week. Sometimes, however, he modifies the prescribed kit to include a "science day." On science day, he consolidates many of the kit activities into one day so his students get an extended view of the subject. In addition, he avoids some management problems "because it's hard to pull out and put away the stuff that they work with. I like the freedom of it. To spread it all out and do it…."

Today, the class is studying which salts will extract the moisture from an apple most quickly, part of a several-months-long, integrated science and social studies unit about ancient Egypt and mummification. The entire lesson takes an hour, and the students are engaged throughout. The topic—mummification—seems to perfectly capture sixth-grade sensibilities about gore, death, and solving puzzles in a hands-on way, using mysterious chemicals.

The classroom is pleasantly cluttered, with all shelf and wall space covered with student or teacher-made art and written work. A sign over the whiteboard says "Your 'I Will' is more important than your IQ." Several large banners detailing the steps of hypothesis making, observation, data collection, conclusion-making, etc., are tacked to the front wall. The teacher refers to the banners and the scientific process throughout the lesson.

The lesson starts with questions about previous knowledge about mummies. How were they made, what steps were used, how long did it take? Students raise their hands to answer, but the buzz gets louder as all compete to answer. Then, an explanation of today's lesson:

[T=teacher, S=student]

T: Today, we are going to cover what we actually do to dry out moisture from an object, observe the data, and compare and contrast. We want to talk about the "puzzling observations" part of the scientific process. How many of you read the mummy report? So how many days does it take to mummify a person?

[Several students say "70."]

T: That's right, 70. But we are not going to take that long; we will mummify an apple. But we *will* take volunteers later! Or you may donate your siblings. [Students chuckle.] Fill in your worksheet with what you do today, but most importantly, take notes. Use the back if you need to.

The teacher is using a teacher-made worksheet to prompt students to make consistent observations (a pre-drawn table is used) and think about important steps in the process. Humor also plays a part in keeping the class on task. Following is an early portion of the lesson, where the teacher is encouraging scientific thinking to set up the observations.

T: Dried things. How many people have seen dried things? What did they look like and where was it?

Ss: Raisins.

T: How did they get to be purple or dark brown raisins?

S: From being dried out.

T: What else have you seen?

Ss: Leaves. Salt on a slug. Pumpkins after Halloween.

T: What does that look like? Right. It turns mushy, turns colors.

S: Skin. Human skin.

T: Ooo. Yeah, like in the summertime. These are things you see everyday. That's what scientists do; they start out with observation. The next thing we will do is observe this. [Passes out dried noodles.] Look at them and make observations. [Walks among the rows talking with students.] Take a good look. What do you see?

T: Go ahead and taste it. What does it taste like? Be descriptive. Use your best scientific description.

Ss: Pretty good, yummy, like white rice, breadish, starch. Dried out starchish bread. Tastes like the smell of cardboard. Tastes like crackers.

The students go on to taste salty things, make observations, and write descriptive words on the board: solid, dry, crunchy.

T: Now let's think about mummies. From the reports we've done, the movies we've seen, what we've talked about: What are mummies?

Ss: Dead, wrapped up people. They were dried up.

T: How do we know they were dried up? [Discusses lack of fluid, lack of moisture or blood.]

T: What did they put on them to dry them up?

S: Salt.

T: Right, they put salt on them to dry them out.

S: Wasn't the salt called natron?

T: [Nodding.] The salt was called natron. [Writes it on the board.] How do we know they were crunchy? When they talked about King Tut, what did they say?

S: When they unwrapped him, he fell apart.

T: Right, he was dry and brittle. There were puzzling observations. I want you to write three things that you've seen today that were puzzling observations.

As students write and think, the teacher discusses with the class how mummies are made. It is very gory and gross and the class loves it and knows a lot.

T: Now we are going to look at three different types of salt and come up with a proposed hypothesis about what would work best to make a mummy. [The class observes and writes about the salts.] This is just you and your paper. Observe and write. We have table salt, Epsom salts, and baking soda. Compare them; describe them. Are they the same? What are the qualities of each?

The students are very involved at this point. There is a low murmur as they write and talk. Then the class reads observations: Table salt is sour and has a tangy taste; Epsom salt tastes like soap; it is thickest; baking soda is nasty; table salt is mouthwatering like a crystal; Epsom salt is a crystal, nasty, sour, dry; baking soda is the whitest, dry, nasty.

T: We need to come up with a hypothesis—what salt will best mummify the apple? That's the next section, proposing a hypothesis.

The students continue to work. Prompted by their teacher, they form groups, write a hypothesis, and predict which of the salts will dry out a slice of apple most quickly.

Ss: We think baking soda, because it's the driest; it's powdery so it will consume more moisture.

S: Epsom salt will dissolve.

S: Table salt. It dries out my mouth, so it will dry out the apple.

The students hold up one, two, or three fingers to vote on what they think. The results are about evenly divided among the three salts.

The teacher explains the upcoming experiment. Working in pairs, students will place a slice of apple in a cup and cover it with one of the salts to see what happens, to see how much moisture is absorbed. One pair will use a control piece of apple by itself, not covered with anything. They will weigh the apple slices before they cover them and after, to see how much moisture weight is lost, how much is absorbed into the salts. As the teacher says, "The lightest one wins." As they plan the experiment, the teacher continues to prompt the students to think scientifically:

T: Why is it important that we write down our expected outcome in science before we do the experiment?

S: Because it might change as you do it.

T: Right. We are going to do our measuring and cutting the apples and putting them in the cups tomorrow. Does anybody want to change their hypothesis before we do the actual experiment? [Several people decide to change.]

S: Mr. S…., Mr. S…. We said table salt because we put a little bit of water on the desk and the table salt sucked it up.

T: So you did a little experiment already. A pre-experiment.

S: Yeah, I wanted to spit, but we used water.

As the students clean up, their teacher continues to probe their knowledge of Egypt, in general, and mummies, in particular. He asks about Egyptian gods, and one boy begins to talk excitedly about several gods they have studied. Some students refer to their recent study of pyramids, where they learned how to use geometry to figure areas and materials needed to build such structures.

Assessment

Elementary students in Hudson are tested a great deal. Testing in the spring can stretch for four weeks or more. Tests include district tests in science that are unburdened by significant consequences but continued by the district for monitoring purposes. As one administrator put it "The state tests change so often, we need something to stay consistent to see how we're doing." Additionally, students are given the SAT9 tests in science, math, and reading (grades 2–11) to satisfy state requirements. These requirements have only been in place since the 1999–2000 school year, and results are published on the district Web site as well as in the newspapers. In addition, Hudson has recently added new state-developed tests in math, reading, and writing.

The newly developed state tests are the most high-profile of the tests given in the district. Beginning in spring 2000, a new state assessment in math, reading, and writing was mandated in the third, fifth and eighth grades. There are plans to include science in the state assessment by 2004, but Hudson administrators said they seriously doubt this will occur because there has been such a history of frequent changes in the state testing program. The state test has very high stakes. Students who do not pass are not to be promoted to the next grade, and eventually in the grades 10–12, students must pass the test to graduate. Administrators and, in particular, parents are upset at the serious consequences associated with this single measure. They worry, with good reason, that the lack of a high school diploma could be a major barrier. Teachers feel the pressure as well.

As one administrator commented, "I just spent all morning with math teachers dealing with 'testing anxiety.' State testing in our state has gone off the deep end."

The state calculates a level of expected performance on the state test for every school based on school characteristics, student mobility, percent of students on free or reduced lunch, and their average second-grade Otis-Lennon reading test scores. In the near future, although the exact date is not yet determined, school principals may be held accountable for their students' reaching this level, and a one percent staff incentive pay will be tied to achieving the target scores.

As mentioned above, in addition to the state tests, students also take district criterion-referenced tests and the SAT9 test in language arts, math, and science at grades 2–11. These tests are used primarily to monitor the program and do not carry the high stakes for students or educators of the state tests. Students reportedly do well on the SAT9 science test. An administrator commented that with all these tests, including some piloting of a bilingual version of the state assessment, some students were being assessed an incredible five to six weeks of the 2000–2001 academic year. Nonetheless, Hudson continues to use the district assessments because they provide a consistent measure of performance that is crucial to monitoring the program's effects since the state tests change so frequently.

Professional Development

John Harris currently oversees the elementary science program. He serves as the director of science, social studies, world languages, health, and drivers' education. Professional development and training has always been voluntary in Hudson and is provided by resource teachers, liaison teachers, mentor teachers or "connection" teachers (these roles are described in detail in the section on leadership that follows). The exception is when a teacher is new to the district or to the grade level. In those cases, kits are not shipped to a teacher until they have had the opportunity to participate in kit-specific training for their grade level. The 52 elementary science mentor teachers (described below) throughout the district (one or more per school) are available to provide kit training to new teachers and others who desire it. In addition, new kit training is available in regularly scheduled professional development sessions.

Professional development available to teachers includes the following:

- Level-one training is kit specific. All new kits require training. They will not be distributed unless all teachers using the new kit have received training. If a teacher switches grade levels, training is required before he/she can teach a kit. If a teacher has requested a kit and has not been trained on that kit, the computer will flag the request and the kit will not be delivered. Teachers who are new to a grade level or the district are required to have level-one training. This training typically is four hours per kit, and can be obtained in a group situation or, if necessary, one-on-one with a resource specialist or liaison teacher.
- New teachers are also encouraged to participate in the "journeys program." This is a four-hour opportunity to discuss the science kits with liaisons or mentors, and it fosters dialogue among teachers. It is not a requirement.
- Workshops are available in various science content areas and take the form of fall and summer institutes. The liaison teachers are responsible for communicating these opportunities to teachers.

- There is also ongoing site-based, in-service training by resource teachers throughout the year.

Almost all the people interviewed believe there is not enough professional development available for principals and teachers. According to the RSR teacher survey, responding teachers reported that they have had relatively little professional development in science recently (about 12 hours in two years). They have had four more hours of training in language arts and nearly 10 more hours in math. (See teacher survey question 18 in Appendix B.)

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Principals responding to the RSR survey also reported that they would like to have more time to attend meetings and talk to one another about science, so that they know what to expect for classroom practice and how to support it. In fact, two principals started a Principal's Roundtable for this very purpose. Principals see themselves as far more supportive of science teaching than teachers do. About three-fourths of principals said they strongly support science teaching whereas only about one-fourth of teachers reported that their principals support science. (See principal survey question 19 and teacher survey question 21 in Appendix B.)

Release time is a serious obstacle to professional development in Hudson. There are not enough substitute teachers in the district to provide adequate coverage. One reason for the shortage is that other districts pay substitute teachers more (the going rate in Hudson is $80/day). Another reason for the shortage is that substitute teachers are getting jobs at charter schools, which don't require certification. Hudson came up with a creative solution to the release-time problem. A "special presenters" program was instituted in which "special presenters" (parents, retired Hudson School District personnel, people from the community, etc.) receive training on one kit. They become specialists on this unit and come to the classroom for a 2-1/2 hour session, allowing classroom teachers some release time for planning or development. This program costs $80,000 per year and was originally funded through the HSI NSF grant. Over the course of the grant, release time decreased significantly. At the beginning of the HSI, science connection teachers were allotted 12 release days. Currently there are no release days for them.

Through the HSI grant, principals were viewed as critical to maintaining the program's philosophy and were encouraged to take part in professional development. The director of the HSI grant found that allowing principals to attend NSTA conferences helped obtain their support for the science program. He said they often found it "an eye opener" where they saw a lot of high-quality science and "now they will recognize good science when they go into a teacher's classroom." Another district official noted that they "are trying to get principals to see that science is important for literacy."

In spring of 2000, a year prior to the end of the HSI grant, the superintendent met with district administrators to confirm commitments for continuing the professional development aspects of the grant into the future to maintain the high profile of science.

DECISION MAKING AND LEADERSHIP

The Hudson science program's successful development is a reflection of its strong leadership and support from the district administration, school board, and community.

District-Level Leadership

Lawson wisely developed strong relationships with her superintendents over the years, keeping them informed and showing them how support for science was good for the district. But she also had an advantage because she worked in a stable community where superintendents have been chosen carefully, often from within the community, and have tended to have extraordinarily long, successful terms. At the beginning of the RSR study, the district had had only four superintendents in over 60 years. This stability and the close relationships that existed among many administrators over the years helped provide the science program a secure base from which to develop.

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Michael Johnson, superintendent for over half the life of the science program, was a key source of support for it. Teachers, staff, and administrators all spoke very highly of him. Several district officials commented that he trusted his staff, and Johnson in turn remarked that "the staff has to believe in their leader." Hudson staff, teachers, and administrators put a lot of trust in him as indicated by this typical comment:

> We could discuss and disagree with people and argue about things, but they were never personal and so everybody has always remained friends. It has been a great district to work in, and Michael has a lot to do with it… I think I learned trust from [Michael] because he was very open and so all of the cards were always on the table.... I think he had a big hand in the attitude and the openness and the honesty that was exhibited…

The School Board

The Hudson School Board consists of five members who serve without compensation and are elected for staggered, four-year terms. The board has final control over local school matters, constrained only by the laws of the state legislature and State Board of Education regulations. The board sets policy for the management of the district, while the school superintendent and staff are responsible for policy implementation. According to one administrator, there is large public input into district decisions about curriculum and other issues, and parents frequently share their concerns with the school board. Given the rather conservative nature of the community, district administrators take care in the language they use to discuss potentially controversial issues in public, such as hands-on math.

According to many sources, the Hudson School Board has always been supportive of the science program. One long-time school board member maintains that there was always open and honest communication between the board and the administration. District officials agreed. In particular, Superintendent Johnson and Linda Lawson were especially helpful to the board, frequently giving presentations and demonstrations on science. They were always available and eager to answer any questions the board might have had, and the board was regularly apprised of the program's status. One board member who served for 16 years recalled that in that time, only one board member had reservations about the science program, but he was won over by the administration and the other board members. Until recently, the board was very apolitical. In the last election, however, two candidates spent $30,000 each to run, and many of the candidates were reportedly "single-issue candidates." A retired board member interviewed pointed at these circumstances and expressed his concern about the future nature of the board.

Science Program Leadership

Linda Lawson was undoubtedly the critical force in the creation of the Hudson elementary science program, and she guided it very successfully until her retirement after 23 years. Her strengths included her knowledge of science, tremendous knowledge of effective teaching and learning, dynamic commitment to her work, creative problem solving, hiring excellent staff, and her strategies for dealing with people. She obtained the support of the board and the superintendent, for example, by having them participate in science investigations just as the students would. They respected her for her knowledge and dedication, and her passion for science education. In interviews, she touched on several of the "rules" she tried to live by:

- We have to trust each other. There's no point in getting ahead by doing something that will get you into trouble later. You have to be honest and follow the rules, but it's okay to look at the rules very carefully.
- Always make sure that other people profit significantly from whatever they do with you…but not necessarily financially. Make people an offer they can't refuse.
- It's amazing what you can do if you don't care who gets the credit.
- Under-promise and over-deliver.
- Take a long-term view of things.
- Spread out your leadership as much as you can.
- Evolution, not revolution (e.g., saying to teachers, "We have something new; if you are interested, here it is and I'll come to your classroom and help you; if you're not interested, keep doing what you're doing.")

As these "rules" suggest, Lawson was a strong, thoughtful leader who was highly respected by her colleagues who described her as an extraordinary person. One person remarked on her character, " She is a unique person…She has a heart of gold and she would do anything. She worked hard, she was dedicated, she was motivated; …she is a brilliant lady." Another person commented on her leadership abilities: "She has the capacity to accommodate all of the different points of view and all of the needs of different people. She listens without losing track of where she wants to go and she makes some adjustments, but the essential element is her own belief." By another person's account, Linda Lawson was the "keeper of the vision" and "by nature…a bulldog. She gets hold of an idea and when she believes in it, she hangs on for dear life and she is not shaken in her own belief." And yet another person commented on her trustworthiness, saying, "When she submitted her budget, I knew it was as tight as it could be. I never questioned her about that…she was a good manager and a good steward."

Lawson also shared science program leadership responsibilities with several categories of teachers with positions that were supported by the Hudson Systemic Initiative (HSI), Eisenhower funds, and general district funds. These included resource teachers, liaison teachers, mentor teachers, connection teachers, and instructional specialists.

Resource teachers (also called science specialists) are full-time teachers whose job is to provide professional development and curriculum support throughout the district. These teachers were the first special support positions to be incorporated into the program, during Linda Lawson's tenure, circa 1980. There are currently three elementary resource teachers in Hudson, and two secondary resource teachers. That level has remained constant for about 20 years. Resource teachers hold site-level as well as district- level meetings and discussions with interested groups of science teachers. They also provide ongoing professional development expertise, at least 10–15 days/year, as presenters at the summer professional development institutes, and they provide in-service training at schools. In addition, they are active in state, regional, and national meetings in their curriculum areas. According to district officials, they are funded primarily with Eisenhower funds.

Liaison teachers are recruited by the resource teachers to provide site-based leadership and serve as sources of district-level information in their subject area for their colleagues. This position began around 1985 with one liaison per school using small stipends funded mostly by Eisenhower money. With the arrival of the HSI grant in 1996, the cadre was increased overall to 96 (however, there continues to be one liaison in science; the others were in math, language arts, and social studies), and the grant funded the stipends. All liaisons form a site-based leadership team with a yearly budget of about $5,000 to use for professional development at their site. They attend annual state-level meetings and receive monthly in-service training on pedagogy, critical issues, and team building related to science instruction. In 2000, the intention was that the positions would continue after the grant ended in 2001.

Mentor teachers were established and funded by the HSI grant. These teachers meet monthly with new teachers in order to familiarize them with inquiry and the science curriculum they will teach. They also provide help to other teachers when requested. One focus of the mentor teachers is assessment, that is, helping all teachers understand what effective assessment is and how to implement it. There are a total of five or six mentor teachers, some of whom are also liaison teachers, at each school across the curriculum.

Connection teachers, another innovation of the HSI grant, are responsible for intensive training in science for new teachers and those new to a grade. There are 22 teachers who each serve for two years, selected from the group of liaison teachers on the basis of an application, observation, and principal recommendation. Their terms are staggered so that each year, 11 members leave and 11 new members are chosen. They receive in-depth in-service training on current research, teaching practice, standards, curriculum, and "special areas of concern." In addition, they take a 48-hour team building course.

Instructional specialists are site-based teachers who are independent of the science program staff but who may work with them. They are funded by general district funds and provide general in-service training around such topics as cooperative learning, classroom management, critical thinking, and using achievement data. They help principals develop professional growth plans for selected teachers, supports for identified students, and school improvement plans.

Teachers are usually recommended by their principals for these leadership positions and then observed by the director of the science program. When Frank Newton was director of science, he used a written rubric to evaluate teachers wanting to take on leadership roles. It included criteria for best practice such as: teachers should facilitate the lesson, as opposed to delivering a lesson; students should be engaged cognitively, processing the experience, and involved in manipulating materials; teachers should be using higher level learning strategies; inquiry activities should be going on; evidence of classroom assessment; and in an interview the teacher should exhibit advanced reflection skills.

Additionally, teachers in these positions tend to have a can-do attitude as illustrated by this reflection from one of the science specialists:

> I always tell my folks, "Listen, if this was easy, there would be a bunch of lightweights here doing it. That is why you are here. You are here to solve the problem, not to be happy that somebody else did it for you." I think our team was always looking at it as part of a constant process. Where are we today? Where do we want to go tomorrow?

In fact, several of these teachers stayed in the district through retirement, serving later in positions where they continued to support the science program, such as director of the NSF grant.

With the shift from central office to site-level accountability in the past few years, teacher leadership is now a key issue for sustainability in Hudson, and the focus of the HSI as evidenced in the descriptions of the teacher leaders above. Since Lawson's retirement, there has been less administrative stability overall and more room for slippage in daily operations, although people generally feel the program still works well. Some classroom teachers and all of the kit replenishment clerks, however, feel there is a lack of effective teacher leadership. For example, some teachers do not know what training is available or whom to ask for help. When they need help, they may turn to another teacher but not necessarily to the designated mentor teachers. Many teachers feel there is not enough training. These teachers have suggested training videos or CD-ROM instruction, but said their suggestions receive little or no feedback. The kit replenishment clerks also noted their suggestions about what kits are not being well used pass without follow through, and planned meetings are frequently cancelled and not rescheduled. Two principals tried to institute a monthly "principals' roundtable" to get more of their colleagues "on board. " They said it's a difficult task, but that they are starting to make headway.

RESOURCES AND SUPPORT

Funding

The elementary science program budget has been part of the department budget since the program was established in the 1970s. It currently covers two classified staff, three science specialists, and the materials center staff (5.0 full-time equivalent positions (FTEs) for 12 months and 3.75 for 10 months). Each year the director of science and social sciences submits a budget request for science/social science textbook money. The total amount of this annual budget has been approximately $1.4 million dollars per year for the past six years. The annual science/social science budget actually covers health, social studies, traffic safety, and world languages in addition to science. This budget is fluid: available money can be shifted between programs throughout the year. The director of science has final say over day-to-day spending once the annual budget is approved, giving this person some flexibility. Science accounts for approximately $145,000, with $57,000 of that amount allocated for maintenance of the program. This works out to $1.40 per pupil. The "rule of thumb" is that $5.00 per kit per year is available from the textbook budget for kit refurbishment. The director of the science program says he has enough funding available for science. If he needed to make changes to the budget, he would approach the superintendent, who might bring the desired changes to the board of education.

Past Superintendent Johnson said he focused on long-term planning during his tenure, leading to a stable source of funding. His philosophy was to have a strong infrastructure and small central staff—"a lean administration." "Not more schools, but larger schools with more support. The only part of the budget that has increased is the classroom budget."

Hudson's five-year (1996–2001), $6 million Hudson System Initiative (HSI) grant covered math, science, and technology. The goals of the HSI were to create site-based learning communities for math and science that would facilitate moving beyond the mechanical use to deeper inquiry and understanding. Under the HSI grant, each school had to submit a site plan, against which the school was assessed. The HSI money then went directly to each school and helped support the teacher leaders. The long-range goal was to get teachers to look at what constitutes good science instruction and to focus on outcomes.

External funds, like NSF and Eisenhower, are viewed by district administrators as having a minimal or insignificant impact on the science program in Hudson.

External funds, like NSF and Eisenhower, are viewed by district administrators as having a minimal or insignificant impact on the science program in Hudson. People expressed no fear that the science program would suffer when the external funding ends, but the director of the HSI said he was planning to write a teacher enhancement grant proposal.

Community and Partnerships

There has been an ongoing connection between the local state university and the district, though not a formal partnership, for most of the history of the program. Two professors at the university had been very good friends of Linda Lawson since her graduate school days. One, in fact, had been the dissertation advisor for two of the science directors (Lawson and Frank Newton). According to Lawson, the reason Hudson's science program did not have a formal partnership with these professors was that they were needed elsewhere. The professors felt they needed to invest their time and energy in the many other neighboring districts who needed their help since Hudson already had three people on staff (including Lawson) who were quite capable as well as dedicated to improving science education. Nonetheless, Lawson said she often tried to handle problems or issues with the thought: What would my professor think about this?

More recently there is a somewhat more formal relationship with Dr. Claudia Welton, an astronomer and university professor who is co-principal investigator on the HSI grant. Lawson initially approached Welton with the idea of being co-PI on the grant. Welton, however, had never met Lawson, but was persuaded to join the project by colleagues who were familiar with Lawson and the science program. Welton joked that "the day the money arrived is the day the partnership began." She taught a content course at the Summer Institute in 1999 and is PI on her own NSF pre-service grant. This grant plays an informal and tangential role in preparing some Hudson teachers during their pre-service programs to think critically, solve problems, and become lifelong learners. Welton's fundamental, inquiry-based science course and lab uses the concepts found in the Hudson kits but not the kits themselves. Welton wants her teachers to be "conversant with the fundamental concepts of physics." Hudson teachers can take two graduate-level science courses at the local university for which they receive three credit hours (in biology or physics). Tuition for the class has come from the HSI grant and Welton's.

An additional informal partnership, the Carson Delta Project, is a consortium of business people who volunteer to assist the schools. Employees from participating businesses have talked with students to emphasize the science and math applications used every day in jobs such as mechanical engineer.

ACCOUNTABILITY

One Hudson administrator summed up their situation regarding accountability by saying, "Science faces a continual uphill challenge to have a place in the limited school day. As more and more things are added on to that school day, more pressures are put on teachers for testing and accountability." While the district collects data on teachers' use of curriculum kit materials, these data are used at the discretion of the principals, and there is little evidence that it plays a major role in shaping classroom practice or the science program. The Hudson materials center staff includes an evaluation form with each kit sent to the schools, which they collect upon the kits' return to the center. Teachers are expected to detail how they used the materials and what changes they would make.

> "Science faces a continual uphill challenge having a place in the limited school day."

As an accountability measure, an aggregate report on kit usage at the school goes to each elementary principal at the end of the academic year to use at their discretion. The report indicates which teachers have used which kits. Some principals pass the data on to their liaison teachers for coaching purposes, while some use the information to discuss kit usage with teachers across grade levels. The professional development specialist at the district office does keep track of teachers' requests for professional development indicated on the evaluation forms. She also makes informal "piles" of evaluations that are returned but not filled out, or that have been completed but returned with kits that appeared unused.

According to data collected by the materials center, about 85 percent of the kits are used, but one administrator estimated that perhaps 80 percent of the kits are not used to their full capacity. Frank Newton's doctoral thesis in 1999 provided data indicating that only two-thirds of the science kits were being used at the time of his study. During the 1997–98 school year, 6,121 core science kits were ordered and processed for use by over 900 elementary science teachers. Of those required units ordered, approximately one-third of them (2,025) were returned without having been used. When asked for reasons for the lack of use, teachers consistently responded that they did not have time to teach the unit. Most of the respondents identified the pressures of preparing students for language arts and mathematics tests (state and district) as the main reason for the inability to teach the required curriculum units.

A recent evaluation report on the HSI suggests that many teachers and principals share the belief that math is a primary curriculum focus at the expense of science. As a result, many teachers feel unable to include science regularly, if at all, because they feel the need to emphasize math and reading and, as evidenced in the 1999 survey, some teachers return kits to the materials center unused. Others only teach the part of the kit with which they are comfortable, and skip over the parts that they feel are beyond their abilities. The HSI evaluators believe math has a stronger presence in the program than science for three reasons. First, far more professional development is offered in math (15,175 hours) than in science (5,170 hours); second, many people think the science curriculum works well so there is no need for many teachers to seek professional development in elementary science; and third, the HSI has focused on developing a cadre of teacher leaders rather than direct support and service to the teachers themselves.

EQUAL ACCESS TO SCIENCE

Equity does not appear to be a topic in the foreground of discussion in Hudson Public Schools, although the district is concerned about the issue. The district sees itself as a middle-class suburban district, with a mostly white, homogeneous population. Several of the classes visited had a small minority of children who did not speak English at home, but never more than four per classroom, and usually only one or two. These children were immersed in the class activities, and, as one teacher said, "They're getting it just fine." This is not to imply that the teachers were insensitive to the limited English speakers, but in the observed classes, the issue of equity regarding limited language proficiency did not come up. However, the number of English language learners and minority children is increasing in Hudson and the district is addressing it. A recent issue of a leading practitioner journal features an article by Hudson's science program coordinator. In it, he describes steps taken by the district to expressly attract and keep minority teachers.

Equity issues, however, reach far beyond concerns regarding English language learners and minorities. They also include ensuring that all students have at least an opportunity to learn science. Although all kits are shipped to all schools on a consistent and equitable basis, there is no guarantee that all students' teachers are implementing the kits as expected or at all. In the classrooms observed, implementation of the kits varied greatly. Further, even those teachers who desired to teach the kits struggled with a lack of time to do so. The new science coordinator conducted a teacher survey in fall 2000 that confirmed that lack of time to teach science was a top concern. Additionally, though Hudson has data on kit use and participation in professional development, no one has examined and analyzed the data to determine how implementation problems are distributed across the district. The question of equity, then, depends to a large extent on principal and teacher understanding of quality science instruction as well as the training, classroom management skills, and commitment to implement it.

ANALYSIS

The story of elementary science in Hudson 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 programs in less tangible but still powerful ways.

These factors do not operate in isolation. Rather, they interact with each other and shift in importance and influence over time. Factors that were particularly striking and pertinent in Hudson are discussed below. For an in-depth discussion of all of the factors, see the cross-site report of this study[10].

Factors that Pertain to Surrounding Conditions

Culture: Stability Supporting Sustainability

The sustainability of Hudson's program has been influenced by the stability of the staff within the district. School board members typically have 14–16-year tenures. The superintendent during much of the science program's history held his position for 16 years and was a teacher in the district prior to that. He worked in the district for a total of 34 years and even attended elementary and secondary school as a student there. There have been only five district superintendents in about 70 years and the district has taken great pains to select the right person to fill that position each time. One person we interviewed noted the importance of continuity of leaders this way:

> A lot of us have been in Hudson all of our lives. It provides continuity. A lot of times they [other districts] get a new leader in and they want to change things…so the people are fighting that all the time, and there is never continuity.

This stability has contributed to an environment in which expertise has emerged from many collective years of experience.

Other key staff members have also worked in Hudson for most or all of their adult lives. The recent director of the science program, Frank Newton,

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

has been working for HPS for over a dozen years. Before accepting the position as director, he was a science resource specialist. He replaced Linda Lawson who was with the district for 23 years, longevity typical of teachers and science specialists in the district. The district has a low teacher turn over rate, in part because of the high quality of life in the surrounding area and because changing districts, even within the region, means a loss of seniority. This stability has contributed to an environment in which expertise has emerged from many collective years of experience. Together, these cumulative years of experience and support for the program have not only helped guide and shape it, but they also have established a continuity to the program that is not threatened as individual leaders or participants leave.

Factors that Pertain to Science Program Components

Implementation: Soft Sell Goes a Long Way

Several people articulated the importance of the supportive relationships between Lawson and district officials as providing a context within which the program was allowed to flower. For example, they pointed out how Lawson was able to work closely with various administrators and auditors to find the resources needed to establish and maintain the program despite the district's limited resources. People respected her and allowed her to do what she thought was best. In addition, the state did not try to oversee the district and micromanage their curriculum in those days, so administrators did not feel a lot of outside pressure. A veteran of the program credited the district leadership with knowing how to let Lawson run with her ideas:

> In a way it was hands-off, and I think in some cases that is a much better way of approaching a program, where they don't get in your way… The district said, here are your parameters that you have to operate within. It can't cost anymore than a textbook program because that is how the program was started. We will trust you. But it's not that they were disinterested. They just didn't interfere, and I think that was significant.

Lawson's approach with her most important constituency was a soft sell: she did not try to push the program on to teachers and made it clear in the first years that implementation was not mandatory. Realistically, the district could not afford enough materials to mandate instant, large-scale implementation, but such an approach was also simply not her way. One high-level administrator who had been with the district since the inception of the program described it this way:

> It was pretty hard to say [to Lawson] no, I am not interested, when she said to the teachers, "You can have these materials and you can have the training if you want to try it." It was a kind of no-pressure situation, and I think that meant a lot to the early adopters.

Leadership: Then and Now

The sustainability of the elementary science program in Hudson over the past three decades is clearly a function of the vision, passion, and creative problem solving of its founder and leader, Linda Lawson. The successful development of the program was also greatly facilitated by the stability and quality of district superintendents, the school board, the science staff, and the generally cooperative and respectful nature of the community. One of the early science specialists, who more recently headed Hudson's systemic initiative, reflected on the long process of building the science program and how other districts often do not realize what it took to achieve their current status:

> We had [only] one teacher on half contract, and that was Linda Lawson. We have to point this out to folks because they think, "Why don't we just start?" And they come through in droves thinking, "Well, we just want to be Hudson." Well, it is going to take you 20 years. Are you in a hurry? This was Linda Lawson starting out with just a vision and a bulldog approach to change, and working up through the layers.

Current and future leadership will depend largely on the framework of site-based leadership established at the sites.

Current and future leadership will depend largely on the framework of site-based leadership established by the HSI. Liaison teachers, mentor teachers, and connection teachers will assume a large share of the professional development desired at each school, although, due to the lean administrative structure of the schools, all these teachers are classroom teachers as well. With the end of the HSI and its financial support for such roles, it is unclear how active the teachers and teams will be, although teachers and administrators believe either money will be found for stipends or the teachers will assume their leadership roles as part of their usual job. At the district level, professional development and specific kit training will remain unchanged.

Money: Always Adequate, Never Ostentatious

The program has always had district financial support, although the overall district budget has always been quite lean. The passion and commitment of Lawson and her staff allowed science to succeed with few resources. Despite another new science director in 2000–2001, the program will certainly receive continued support by the assistant superintendent for curriculum and instruction, who was the past science director. The $6 million HSI grant for K–8 science, math, and technology attempted to push implementation beyond mechanical use to deeper inquiry methods, and promote site-based leadership, but it ended in 2001, with questionable success and at a time when professional development opportunities in science seem most precious.

Quality and quantity of professional development for teachers and principals remain a challenge, particularly with external relationships—with a nearby state university, local science organizations, and industries—being somewhat sporadic and modest. It is not clear how the elementary science program will cope without future external funding.

Factors that Pertain to the Whole Science Program

Perception:
Placing Stock in Reputation

Hudson very much identifies with the science program and its recognition. Anecdotes told about the program (e.g., the 96 percent of students who chose science as an elective in middle school) reveals the pride district administrators and teachers have in the program and the recognition it has garnered. Such anecdotes serve as evidence that the program has become an important part of the district identity.

In the absence of mechanisms for knowing the actual classroom practice with regard to the science program, perceptions of the program can vary greatly from that program's actual status.

The national recognition of the program, while instilling great pride in leaders, also raises a challenge for the program. In the absence of mechanisms for knowing the actual classroom practice with regard to the science program, Hudson finds itself in a situation where the perceptions of the program can vary greatly from that program's actual status. Though touted as a model program in the field, this study revealed evidence that the actual instruction is highly variable and, in fact, doesn't even take place in some classrooms due to competition for time and priority that comes from literacy and mathematics. This leaves Hudson in a situation in which decisions about the program are made based on program leaders' perceptions of the program, not on data about what is actually happening. Thus, those decisions may or may not appropriately address program and participants' needs.

SUMMARY

As is true with most school programs, no single circumstance wholly shapes success or failure. In Hudson, one of the longest lived programs in this study, success has come over time, and has been the result of stability, dedicated leadership, and a commitment to shared ideals. Hudson's science program has long been institutionalized as a valued part of the core curriculum in the district, and its existence does not seem threatened by any pending crisis. Nonetheless, it is not clear that implementation in Hudson is any more widespread than in other districts of the study. There exists in Hudson, as elsewhere, state test-driven pressure on teachers and principals to worry first about literacy and math, often stealing time, attention, and priorities away from science. Thus, the breadth and quality of science classroom practices in the future might well be affected by recent changes in leadership, impending retirements of long-term staff, literacy and math challenges to science for attention and resources, and ongoing professional development needs at a time when external funding is ending.