# AN EVALUATION OF THE SCIENCE RESOURCE LEADERS PROGRAM

**A project of the**
**School District of Philadelphia**
**and**
**PATHS/PRISM**

**funded by**
**The National Science Foundation**

**September, 1995**

**RESEARCH FOR ACTION**
**Philadelphia, PA**

**Alisa Belzer with Jolley Bruce Christman, Ph.D. and Elaine Simon, Ph.D.**
**With research assistance from Eva Gold, William Smith and Elspeth Murray**

# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

## Overview of the Project and the Evaluation

The goal of the Science Resource Leaders (SRL) program, a project of the School District of Philadelphia and PATHS/PRISM was to provide professional development for middle school science teachers who could then function as catalysts for improved science teaching and learning in their schools. Contextual features of the District including staff cutbacks of curriculum support staff and the transition to middle school structures which placed many teachers in science classrooms with little or no training and experience, made a professional development initiative in science education extremely well-timed. SRL sought to create a cadre of middle school teacher leaders who understood a constructivist, hands-on and inquiry-based approach to teaching science and who would situate themselves in their classrooms and schools to promote and facilitate this approach among their colleagues. The participants in SRL were primarily middle school teachers from a diverse range of urban Philadelphia schools.

The SRL program's approach to educational improvement emphasized a relatively long-term model of professional development for teachers which immersed them in science content knowledge; opportunities to plan and implement collaborative scientific inquiries; new tools, materials and resources (including technology) with which to carry out their wor;, and small budgets for implementing school-based projects during each year of the program. SRL also developed and connected participants to a network of science educators and professional scientists as a way of supporting teacher changes in practice and their efforts to construct leadership roles within their schools. The central programmatic components of the project included: summer institutes, a school-year inquiry project, funding for a school-based project, a newsletter and support meetings, workshops and retreats.

This report discusses what happened during the three years of the SRL program. Using qualitative and quantitative data, it describes and assesses the impact of SRL involvement on teacher participants and their schools. It takes up three broad questions:

- **What do the classrooms of SRL participants look like?** In what ways do they reflect and enact a hands-on, investigative approach to science education? What program elements supported participants' practice? What was the relationship between the school/district context and their practice?

- **How do SRL participants function as leaders and change agents in their own schools?** In what ways does school culture interact with their leadership efforts? How does their leadership impact on school science programs?

- **In what ways does SRL function as a teacher network?** How does the network support both practice and leadership?

## Summary of Findings

### From teacher to science educator

SRL provided a strong, flexible and responsive support system for teachers developing new approaches to the teaching and learning of science. Findings from the evaluation research show that participants, who represented a wide range of experience and training in science education, developed their science content knowledge and as well as their confidence as science teachers. For those very experienced in the field, a sense of renewal and rejuvenation frequently emerged. Many participants felt, for the first time in their careers as science teachers, like respected members of a community. These developments in professional identity helped participants take more risks in their own classrooms and supported their development as science education leaders within their schools and in the broader science education community.

### Towards hands-on, inquiry-based science pedagogy

The research indicates that the development of a well developed hands-on, inquiry based pedagogy is a process that requires time and intense effort and support. Many

participants eagerly integrated an enthusiasm for hands-on science activities. However, constructing and internalizing a conceptual framework which positions science as a tentative, processual and open-ended task which guides teachers to facilitate learning opportunities that are driven by student questions and constructivist tasks of investigation is a challenging task. Teachers need time and flexibility to listen, observe, and reflect on how science knowledge is produced within their classrooms. While many classroom teachers were drawn towards working more closely with students as co-constructors of scientific knowledge, they often experienced numerous challenges (both intellectually and logistically) which interfered with their ability to align their beliefs and goals with their practice.

Teacher leaders and school change

SRL catalyzed and supported teachers' ability and commitment to act as science leaders and resources inside and outside their schools. By generating more visibility for the school science program, improving access to materials and equipment for their colleagues and sharing information and knowledge about science education, SRL participants worked to improve science education in their buildings. These efforts facilitated the teaching of hands-on science and promoted the use of investigation as a pedagogical. However, school-wide improvement in science education was often elusive. While most schools appreciated any help SRLs provided in supporting their science programs, few made change and improvement a priority. In many cases, principals did not fully utilize SRLs to support the process of rethinking and reforming science programs. Multiple administrative and organizational transitions and a severe lack of materials and equipment--consistent features of middle schools across the District--also created obstacles to improving science programs at the school level.

The development of a professional network

The SRL program supported the development of a professional network which was of great value to its participants. By creating multiple opportunities for participants from across the District to interact in intellectually meaningful ways with each other and other science professionals, participants forged new relationships within the District and in the wider science community which supported the development of their individual practice and their leadership inside and outside their schools. In addition, the network is now viewed as a valuable resource to the wider science education community. The District plans to utilize SRLs for training in future science reform efforts, and SRLs have been asked to make presentations in other districts and at professional meetings and to serve on committees charged with improving and reforming science education.

# I. INTRODUCTION

## Overview of the Study

The Science Resource Leaders (SRL) program, a three-year NSF funded project collaboratively administered by the School District of Philadelphia and PATHS/PRISM[1], grew out of requests for continued professional development opportunities in science education from teachers who had participated in an earlier National Science Foundation (NSF) funded professional development program ("Experiencing Light, Heat and Motion"). These Philadelphia teachers expressed a need for continuing support to improve their science content knowledge and further develop their pedagogical strategies.

This interest in further professional development coincided with several contextual factors in the school district which made a major initiative in science education extremely well-timed. Because of significant budgetary cutbacks, the science supervisor position (a position which provided curriculum support in each region) was in the process of being cut back and was then eliminated soon after SRL began. Concurrently, the District was in the midst of a transitional process of reshaping the middle years of learning from a junior high school to middle school model. Traditionally staffed by secondary certified teachers trained in specific disciplines, many seventh and eighth grade science classrooms would now have elementary teachers teaching science with little or no previous training. Although elementary schools often had science prep teachers and Museum-to-Go Kits to support their science programs, elementary certified teachers thrust into middle schools had few materials, no in-school support, and little or no training.

The SRL program focused on developing teacher leaders who could provide support on a school-by-school basis to address the dual challenges of staff cutbacks and

[1] The Philadelphia Alliance for Teaching of Humanities in the Schools/Philadelphia Renaissance in Science and Math (PATHS/PRISM) has recently been subsumed into a new organization called the Philadelphia Education Fund (PEF).

changing organizational structures facing the District. The project goal was to train a two-person team of teacher leaders from every middle school in the city to plan and coordinate science programs, provide staff development and assist in bringing science resources into their buildings. Given the scale of the problem, the program planners targeted every middle school in the city and also forged a collaboration between PATHS/PRISM (who had administered "Light, Heat and Motion") and the School District of Philadelphia. Both the scale and the collaborative administration of the project were designed to create a powerful model for professional development, teacher leadership, and the development of a highly visible and effective network of science educators.

Although not explicitly a reform effort, SRL promoted many of the most up-to-date approaches in science education. An emphasis on the use of hands-on materials, an investigative and problem solving approach to the development of science concepts and training in technology combined with such innovative pedagogical strategies as cooperative learning put program participants on the cutting edge of science education. As they worked to develop their own practice and promote science education in their buildings, they were in effect working to reform and improve the traditional model prevalent in most middle school classrooms--textbook-based, teacher centered instruction.

This report discusses what happened during the three years of SRL. It seeks to connect research with practice by addressing issues critical to sustainable reform suggested by Symansky and Kyle (1992): cultural and contextual factors, community and school contexts, classroom contexts, and teaching and learning processes in classrooms. Using qualitative and quantitative data, it describes and assesses the impact of SRL on teacher participants, their schools and the broader district context. It takes up three broad questions:

- **What do the classrooms of SRL participants look like?** In what ways do they reflect and enact a hands-on, investigative approach to science education? What program elements supported participants' practice? What was the relationship between the school/district context and their practice?

- **How do SRL participants function as leaders and change agents in their own schools?** In what ways does school culture interact with their leadership efforts? How does their leadership impact on school science programs?
- **In what ways does SRL function as a teacher network?** How does the network support both practice and leadership?

**The Science Resource Leaders Program**

The SRL program approach emphasized a model of professional development for teachers which immersed them in new science content knowledge, provided them with opportunities to engage in scientific investigation, connected them to science professionals, and supported school based leadership efforts.

SRL was based upon several assumptions about professional development and the change process: it is a long-term endeavor; teachers must be at the center of change--they must experience learning science in new ways themselves--and they need a network of colleagues who support them in their professional practice. The central components of the project included:

- Introduction to Science Inquiry and Innovative Teaching and Learning Institutes. Two intensive, four-week summer institutes taken in a two-summer sequence. The first focused on science content knowledge and scientific investigation; the second focused on technology and instructional strategies.

- Directed Research Institute (DRI). Cross-school, group investigative project executed during the school year with the assistance of a team coach (second year only) and a professional scientist mentor.

- School-based project. School-based project designed and implemented by SRL teams to improve science instruction in each school.

- Support meetings, retreats and periodic workshops. Held after school and on weekends during the school year, these events focused on special topics in science as well as on leadership development.

- SRL News. Monthly newsletter listed SRL and other science oriented professional development events and opportunities, news from SRL participants and other announcements and articles of interest.

**Evaluation Methodology**

The evaluation of the Science Resource Leaders program focused on what happened as teachers developed their own practice: how they changed their classroom practice and how their participation in the program impacted science teaching and learning in their schools. As the program evolved, a broader lens focused on the development of a professional network and its impact on science in the District. The research examined changes over time and incorporated quantitative research methods in a research design which utilized a case study methodology.

Although the study focused on teachers, the research also looked at schools. The case study research in five schools provided documentation of contextual factors which effected teachers' ability to implement hands-on science and act as resources and leaders for other science teachers in their buildings. It also provided in-depth looks, over time, at the kinds of learning opportunities SRLs were providing in their own classrooms. The criteria for selecting the five case study schools ensured that they would be diverse along a number of dimensions (e.g. composition of the team in terms of years of experience, science teaching responsibilities and grade levels; student demographics; area of the city; and school organizational structure). However, the extent to which SRLs in the case study schools would enact the goals of the program was unknown at the time of their selection.

Data collection included the following strategies:

- base-line survey of all participants
- summative survey of all participants
- focus group interviews of participants after each summer institute
- participants' evaluation of summer institutes
- field visits including interviews and observations of SRL participants and other science teachers, students and administrators at five case study schools each year for three years

In its ongoing effort to build the capacity of schools and educational organizations to think critically about the kinds of information that would be useful and how to collect and analyze that information, Research for Action encouraged SRL program planners to participate in some aspects of the evaluation research. For example program staff developed and analyzed a baseline survey of SRL participants. In addition, they provided feedback on interview protocols and assisted in planning site visits at case study schools.

**Formative Evaluation in the SRL program**

The evaluation was a formative one with formal feedback occurring each year of the project and informal feedback that was ongoing. Program planners included project evaluation staff in discussions about project activities. "Mid-course corrections" in project activities emerged from these interactions. For example, focus group interviews following the summer institutes suggested several areas in which program planners might rethink their strategies. In response to the fact that many teams had difficulties completing the Directed Research Institute during the school year, the position of team coach (an SRL who had previously completed a Directed Research Activity) was added to provide more ongoing support and direction. In response to concerns during the first summer institute about the effectiveness of investigative teams, during the second summer of the project teachers were invited to form their own teams instead of being placed on one. The atmosphere of the second summer was more informal and less regimented as a way of providing more autonomy for participants.

**Organization of the Evaluation Report**

The following chapters of the report detail answers to the overall research questions discussed above. Chapter II consists of descriptions of the the five case study schools and their SRL teams. These descriptions are provided to create a sense of the context in which SRLs functioned within their schools. Chapters III and IV look closely at what SRLs were able to accomplish in terms of their own practice and as leaders

promoting improved science education, and at the obstacles and supports which impacted on those accomplishments. Both of these chapters summarize the survey data and then use case study data to provide rich descriptions and further detail as a way of enhancing and deepening the meaning of the qualitative data. Chapter V discusses SRL as a professional development network by integrating the survey and case study data. The report concludes with a discussion and recommendations in Chapter VI. The appendices include a more detailed description of the research methodology and other information related to data collection.

# II. PROFILES OF CASE STUDY SCHOOLS

The following descriptions of the five case study schools are overviews designed to give a sense of team composition and function, the role of the principal in supporting science education in general and the utilization of SRLs in particular, and the range of approaches to science education within each building. Although these descriptions are particular to the case study schools, they also serve to set the general scene in which SRLs across the District engaged in a diverse range of efforts to help move schools in the direction of more hands-on science activities based on inquiry and investigation. Throughout the chapters which follow, the report draws primarily on the experiences of individual SRLs. These school profiles foreground the school and District context as influences on the ways in which SRLs worked to develop their own practice and support improved science teaching in their buildings. They also highlight how contextual factors affected program impact.

**Case Study School #1**

This small, desegregation, magnet middle school (grades 6-8) is affiliated with the Coalition for Essential Schools. Two teachers volunteered to become SRLs in Cohort I[2]. One, science certified, described herself as highly involved in the program and, in fact, participated in many SRL sponsored events, acted as a Directed Research Activity coach and took on leadership roles in the larger educational community (by leading workshops and participating on a state educational committee). The other SRL, elementary certified, stopped participating in program events after her first summer. There is only one other science teacher, originally the school's music teacher, in the building.

---

[2] Participants who began SRL during its first summer were members of Cohort I. Participants who began SRL during its second summer were members of Cohort II. Some participants subsequently joined the program but were not officially a part of a cohort.

When SRL began, the school was organized into three horizontal houses and each science teacher taught in a different house. During the last year of SRL, the school transitioned to an ungraded, two-phase system. The staff spent time setting up performance based criteria for passage from one phase to another in every content area. The three science teachers developed science standards related to understanding of and ability to implement the scientific method. The science teachers collaborated to establish benchmarks and standards, but, in general, the staff meets in interdisciplinary groups by house rather than by content area . All three teachers value hands-on strategies for teaching science and each is working to develop effective ways of enacting these beliefs.

The principal values their hands-on approach to science education, but her Coalition training has made her far more interested in using "essential questions" to guide teaching and learning rather than a set of activities and materials that are content based. She feels somewhat frustrated that the science teachers have not taken a larger step toward becoming more inquiry oriented and more able to make connections across the curriculum. She does not provide any special release time for the SRL teacher, nor does she create ongoing common prep time for science teachers to work together. In fact, her experiences working with the group when they developed the benchmarks and standards has led her to believe that their diverse styles, backgrounds and interests makes it difficult for them to be productive as a group and she believes that they should spend planning time in other ways.

The active SRL has functioned as a science leader in her building by purchasing (supported in part by school-based project money) and sharing new materials with her colleagues, helping to organize the science fair, functioning as a conduit of information from the larger science education community to the other teachers in her building, and acting as a resource when her colleagues need help developing activities or with science content information.

**Case Study School #2**

This inner city, racially homogeneous (African American), very large neighborhood middle school (grades 6-8) had three teachers participate in the SRL program. Two, who were members of Cohort I, were selected by the Leadership Team of the school. A third teacher volunteered to become an SRL in the second year of the program. She began her participation during the summer of 1994, but resigned her teaching position in February 1995. Of the two original SRLs, one is a long-time, science certified teacher in the building who functioned as the department chair. The other is a relatively new, elementary certified teacher. Previous to her first summer in SRL, she taught sixth grade, but in the subsequent fall, she was assigned to teach seventh grade science for the first time.

With the exception of participation in the summer institutes, neither teacher was particularly active in SRL organized events. The team submitted a school-based plan which focused on coordinating the science fair after the first summer of SRL, but in their year end report they expressed disappointment in what they had been able to accomplish. They noted that "the development of alternative teaching techniques is extremely limited, reinforcing the teacher's anxiety in the teaching of science through a hands-on approach....[Staff development workshops are not enough] to develop a cohesive hands-on science curriculum." They did not submit school-based plans in subsequent years, nor did they participate in the Directed Research Institute.

When SRL began, the school was organized in vertical houses. The principal at that time reported that much of the staff is afraid of science and almost all are textbook dependent. He did not feel that the SRL team found a way to work together to help staff move to a more hands-on approach. Following the appointment of a new principal the following year, the school reorganized itself into eight vertically grouped teams ("Options") in four houses, each with its own curricular emphasis. One SRL was assigned to an "Option" with a special focus on science, math and technology. The new plan called for teachers to have common prep times within their teams, but little provision was made

for departmental meetings. The SRLs do not have any common meeting time, nor were they given any extra time in their schedule to take on SRL responsibilities such as working with other teachers or organizing materials.

During the SRL program, a range of approaches to teaching science in the building co-existed. For example, sixth grade teachers generally build science instruction around Museum-to-Go Kits. Although many feel that the Kits lack background information and follow-up activities, they find the activities generally engaging and successful. Seventh and eighth grade teachers generally teach from science textbooks. Most complain that a severe lack of materials precludes hands-on approaches. A non-SRL teacher stated bluntly, "This school doesn't push science." However, by the end of the final year of the SRL program, science was beginning to be more of a priority. This was signalled by the fact that the principal allocated money to buy new science textbooks for every student in the building--an act which many teachers and staff mentioned in interviews.

The SRLs in this school had difficulty functioning as a science leadership team. Although they worked together the first year in an effort to mount a science fair, they were frustrated by teachers missing deadlines and other logistical problems. After this collaborative activity, they worked separately. While the younger SRL continued to try to support improved science teaching by providing staff development sessions for her colleagues, she was frustrated (and eventually stalled) by their resistance to change and overwhelmed by the diverse levels of need, expertise and willingness to use hands-on teaching strategies. In addition to these difficulties, SRL program staff believed that there were interpersonal difficulties between the two SRLs. They felt that although one of the team members (the younger teacher) was more motivated and energetic, she often deferred to her more experienced team mate. Unfortunately, this SRL devoted little energy to the program. In spite of these impediments, the more energetic SRL was able to initiate more contact with some of the sixth and seventh grade teachers and provided them

with some new ideas and materials. She also was clear that the program was very important in shaping her own science teaching.

**Case Study School #3**

This is a large neighborhood middle school (grades 5-8) with a student population of African American and Latino children. Originally, two teachers--one science certified, the other a Chapter 1 science and social studies teacher--volunteered to participate as members of Cohort I. Neither became particularly active as SRLs during the subsequent year, at which time the science certified teacher transferred to another school. A first year teacher petitioned to get into the program as a Cohort II SRL. This teacher was extremely active in program activities although he struggled to make his involvement felt within his own building.

This school experienced several important transitions during the last few years: it changed from a horizontal to a semi-vertical house structure, it got a new principal and assistant principal, and, perhaps most importantly, it moved from its original converted factory site to a brand new building. This move meant that for the first time in the school's history, students and teachers have two laboratory rooms in which to do science investigations (although the lab rooms were not complete when the new building opened).

The principal at the start of SRL admitted that science had been "on the back burner" at this school. He was hopeful that the SRLs would play an important role in making science more of a priority. To this end, he routed any information he got about science to one of the original SRLs and considered him to be his main informant as to what materials were needed for science instruction. He said, "The SRL's are <u>the</u> science support for the building." As in many schools, there appeared to be a range of approaches to teaching science, from one non-SRL teacher who pursues her own professional development in science education and uses hands-on activities regularly, to those who base most of their class work on science textbooks. The two original SRLs fall in the

latter category. The vice principal observed that among the seventh and eighth grade teachers, even the elementary certified teachers tended to have a "junior high mentality" which committed them to a textbook-based approach.

One of the main tasks that the SRL team created for itself was the inventorying and organizing of existing science supplies in the building. This job never was quite completed although a locked storage area was created to which only SRLs and the principal had keys. The SRLs attempted to inform the faculty of what was available through a mimeographed list placed in mailboxes. In addition, as plans for moving into the new building grew near, the Cohort II SRL stepped up his efforts to survey what the school had and what it still needed to outfit the labs. He submitted a school-based plan for two years in a row which requested funds for purchasing additional equipment. Non-SRL staff members agree that the impact of this SRL on science instruction has been to provide more and easier access to materials.

**Case Study School #4**

This is a large middle school located in an African American neighborhood of middle and working class families. One SRL volunteered for the program and was joined by a partner selected by the principal. The former is certified as a science teacher, the latter is a house director and certified math teacher. The science teacher SRL remained involved in the program by submitting yearly school-based plans, and completing a DRI project and then acting as a coach, but her attendance at SRL events waned as time went on. Both SRLs have led some science oriented workshops and presentations within their school, but have been even more active outside their building in response to invitations to take leadership roles at conferences and other professional meetings.

Like many other middle schools, this school has suffered from instability. While the organizational structure of three horizontal houses remained stable, leadership in the building did not. The school saw two principals and an acting principal come and go

during the course of the SRL program. Changes in administration had a significant impact on the SRL who teaches science. Each year she had different teaching assignments, and although she finally got an extra prep period to do SRL related work in her third year in the program, she worried that a new administrator would not recognize the importance of additional time in supporting the school's science program.

Science teaching in the school is sharply divided between those with an elementary focus and those with a junior high focus. The sixth grade teachers use Museum-to-Go Kits. They operate separately within the school, seldom interacting with seventh and eighth grade faculty. With the exception of the SRL and an exemplary eighth grade science teacher, science education in the upper grades is primarily textbook-based.

The SRL's impact on science education at the school has been to increase significantly science fair participation. The science fair has moved from a marginal activity to a nearly school-wide event for seventh and eighth graders. The SRL team member who is a science teacher took on the official role of coordinator which includes distributing a packet of guidelines and ideas, making presentations to students informing them about the science fair, supplying display boards and other materials, arranging for judging and creating rewards for winning entrants. The last appointed principal made science fair participation mandatory. In addition to supporting the science fair, the SRL used money from the school-based plan to buy materials for a community garden and to add to her own classroom resources (which to some extent were made available to others). Others view the active SRL team member as a source of "up-to-date" information and feel they can go to her with questions if they need to. However, she reported that few do.

**Case Study School #5**

This K-8 school is relatively small and serves primarily a white, Catholic student population. The two SRLs at this school teach at the elementary level in self-contained

classrooms. Both had a strong interest in science before their SRL participation began, but little specific background or training in science education. This team remained intact, completed all SRL responsibilities, and attended a moderate number of SRL organized events. After completing both summer institutes, these two SRLs went on to participate in a summer institute on inquiry-based science instruction at the Franklin Institute which was targeted at SRLs.

The school has maintained relative stability with no major organizational or leadership changes during the program period. However, at first the school had two science resource people in the building, in addition to the SRLs who provided considerable support for science education. These positions were cut after the first year of the program, and the SRLs found themselves stepping in to take up some of the slack. Although science teaching was viewed as a priority in the building and science fair participation was high, the SRLs perceived that many teachers felt too intimidated to teach science and depended primarily on the science prep teachers.

With the departure of the science coordinators, the SRLs defined their role as resources to the staff (by bringing in guests and sharing the additional resources they acquired through SRL participation), models (they did a number of demonstration lessons which were video taped) and "cheerleaders" for science (they organized a science assembly for two years which promoted science as fun). Although being full-time, self contained teachers made the SRLs feel that it was difficult to have a broad impact on their school's science program, they did note that after two years of their own science assemblies, another teacher did an assembly which included a science theme. For them, this was evidence that they had begun to help their colleagues feel more comfortable with and enthusiastic about science education.

* * * *

These school profiles set the stage for the following chapters. Some common threads running through all of the profiles are worth noting. Middle schools have suffered

almost constant change--administrative, staff and organizational. This high level of instability has created a landscape of constantly shifting sets of priorities, and initiatives. At most schools, simply getting science onto the table as a high priority agenda item is a challenge. The fact that buying new textbooks was discussed by so many teachers and administrators at Case Study School #2 is indicative that science is a content area that is often neglected. It also illustrates the severe lack of resources which plague urban schools.

Although middle schools are no longer a new organizational structure within the school district, defining the goals and a sequence of strategies to advance the vision underlying them seems elusive in many schools. Some schools are starkly divided among teachers who lean toward an elementary, child-centered instructional approach and those who favor a secondary, content-centered approach. Although the rhetoric of middle school reform favors the former approach, lack of training and an adherence to tradition still makes it difficult for schools to settle on an effective set of strategies for successfully reaching this age group. Further, these pedagogical divisions often make it hard for teachers to collaborate with any kind of shared vision.

The ways in which SRL teachers function in their schools are clearly shaped by their contexts which include the priorities of the principal, the SRLs' roles in the building relative to the rest of the staff, and the level of experience, training and interest among other science teachers. Being an SRL means different things in different contexts. Regardless of how SRLs are utilized in their buildings, it can not be taken for granted that they will have additional planning time to take up leadership responsibilities either individually or as a team with a common prep. It is likely, however, that in order to support hands-on, inquiry based science in their own classrooms and at the whole-school levels, an urgent priority is to improve access to science materials and equipment. The status of science education in most middle schools indicates that there is ample need for the resources and leadership that SRLs provided.

# III. IMPROVING SCIENCE PEDAGOGY: "I'M NOT AS HOOKED ON THE BOOK"

The major goals of the Science Resource Leaders program were to improve teachers' science educational skills by giving them a deeper understanding of science concepts; by improving their ability to design, implement and evaluate scientific investigations; and by increasing their use of instructional strategies such as content-based inquiry and student directed projects. In general, the SRL program was designed to enhance teachers' ability to create inquiry-based, constructivist oriented science classrooms. This chapter, therefore, addresses the following questions: **What do the classrooms of SRL teachers look like? In what ways do these classrooms reflect active, inquiry-based learning? What program elements and features of school contexts supported/inhibited the improvement of classroom practice for SRLs?**

Initiatives such as the American Association for the Advancement of Science's 2061 project and many NSF-funded professional development programs have set an agenda for science education reform which is constructivist. Although specific strategies for creating constructivist science classrooms is still evolving, researchers suggest (e.g. Saunders, 1992) that classrooms should offer students 1) hands-on, investigative labs, 2) active intellectual involvement in the construction of knowledge, 3) cooperative learning and 4) assessment focused on evaluation of students' problem solving skills. In classrooms which are inquiry-based, students would actively construct knowledge by developing inquiry questions, designing and implementing investigations aimed at addressing those questions, developing hypotheses, and following up on questions with further experiments which evolve from on-going work. In other words, inquiry-based classrooms are designed to enable students to think and act like scientists.

The sections below will examine how, and to what extent, participants in SRL have instituted new and/or strengthened and enhanced current practices to create classroom contexts which encourage such science learning opportunities. The data in

these sections is drawn from interviews and observations with program participants at the five case study schools, focus groups with Cohort I and II participants, baseline and summative surveys and interviews with program staff.

The analysis of this data suggests that most program participants readily see the importance of involving students in active learning experiences and have adopted many activities, materials and pedagogical strategies advocated by the SRL program. However, their efforts to implement project work, hands-on activities and other forms of active learning are not often integrated into an overall inquiry-based framework. The following findings will be discussed in the sections which follow.

**Finding One: SRL participants feel that as a result of program participation, their access to science materials, hands-on activities and guidance to support the implementation of active learning strategies in their classrooms have significantly increased.**

**Finding Two: Many SRL participants have adopted hands-on, active learning strategies in their classrooms and decreased their dependence on science textbooks, worksheets and traditional paper and pencil assessment.**

**Finding Three: Engaging students in ongoing, student-driven inquiry has been a challenge for many SRLs and may require further intense and ongoing professional development opportunities which follow-up on teachers' developing interests in using new materials and activities.**

**Finding Four: Although most SRLs are extremely interested in changing their practice, many feel discouraged from doing so because of a number of contextual features which include:**

- **a lack of materials and resources,**
- **a lack of assistance in maintaining laboratory facilities**
- **discipline and management problems with their students**

**What do SRLs say about their practice?**

*Survey responses*

During the late spring of the third year of the SRL program, all participants received a survey which invited them to summarize the impact of the program on their professional lives. The data, which reflected their perceptions of their practice, were extremely positive. For example, 91% agreed or strongly agreed that their science subject matter knowledge had increased and 83% agreed or strongly agreed that they felt more confident about their science teaching.

In addition to more positive attitudes toward science and science teaching, the teachers reported making many changes in their practice that are congruent with creating a hands-on, inquiry based classroom. These changes reflect both a shift in the use of materials and equipment, and a shift in pedagogical strategies. 74% reported an increase in their use of hands-on science and 69% reported a decrease in their use of textbooks. Specific materials and equipment which SRLs added to their classrooms include technological innovations such as computers, laser disc players, video cameras, calculators and CD-ROMS; lab equipment such as gauges and scales; live animals; models and posters; found and household items. They also reported an increased use of Museum-to-Go Kits. In addition, teachers enumerated ways in which they had expanded their resources for students by, for example, creating a larger science reading library and inviting scientists into their classrooms. As one teacher wrote, "I am not as hooked to the book...I have become more familiar with resources and have very full files."

Survey respondents emphasized that the SRL program had played an important part in increasing their access to materials. In spite of clear evidence that SRLs have more

available to them than ever before, however, more than half of the survey respondents said they still do not have enough. Their needs include not only advanced technology, but also basic lab equipment. The fact that SRLs indicated that they valued the influx of materials and equipment combined with their expression of continuing need for more points out the extreme paucity of science resources in many middle schools in Philadelphia. The SRL program clearly began to address a huge need, but in the end, the District will have to provide more of its own resources if middle school science education is to become inquiry-based on a school-wide and District-wide level. Currently, there are not enough materials and equipment to go around.

In addition to depicting classroom changes in practice as the adding on of more "things" to the classroom, SRLs noted their changing approaches to teaching. For example, 81% said they increased their use of cooperative learning strategies. Others said they encouraged their students to use their powers of observation more and that they and their students were learning to ask the "right questions." Teachers used several terms--"investigative approach," "scientific method" and "inquiry approach"--to signal the fact that they were providing more opportunities for students to develop and implement scientific questions and inquiries to investigate those questions. One teacher described her changed approach to teaching science by writing, "I've learned to get out of my student's way and let them be responsible for what they learned."

In their survey responses, SRLs made clear that the changes they were making in their classrooms were having a positive impact on students. The comments below give a cross-sample of teacher observations about students and learning when classrooms began to operate within a more constructivist framework.

"Learning is more concrete, less abstract."

"Students communicate with and learn more from each other."

"Students can actually see animals' life cycles, not just read about them."

> "Children learn better when they actively participate in learning and a higher level of interest and retention is evident in their work and discussions during class. Children began to recognize the importance of science and the reason its as important as math and reading."
>
> "These new materials (hands-on) increase students understanding of scientific concepts."

These teachers see the powerful potential for learning when their students are allowed and encouraged to get engaged in constructing their own conceptual understandings of science and become active in their learning processes.

**What do the classrooms of SRLs look like?**

*Portraits of practice*

The survey data show that teachers have an awareness of and interest in adopting new strategies and practices for their science classrooms. However, an important part of documenting these changes in attitude and awareness is to actually look inside classrooms to see, in action, what these teachers' classrooms look like. The vignettes below, drawn from field visits to case study schools, were selected to illustrate some of the ways in which teachers have integrated their SRL experiences into their daily practice. The physical appearance of the classroom, the activities selected to implement a lesson and the learning formats are all indicators of ways in which they are working to engage their students in science learning. These vignettes capture three not atypical teachers in particular places in their professional development. They are designed to show in what ways they are striving to create hands-on, inquiry based science education and to indicate areas in which professional development programs that come after SRL could focus in order to help them move further towards creating constructivist classrooms.

**Vignette #1**
*Case Study School #1*

Science class had just begun and the kids are settling into their desks which form a circle around the periphery of the small room filled with science materials and decorated lavishly with student work. In the middle, two long tables have been pushed together and are filled with potting materials, plants, coffee cans filled with scissors and rulers. In one corner of the desk, a stack of student proposals for science projects are awaiting the one-to-one conferences between teacher and students planned for the day. Among other "getting-started" statements, the teacher tells the class that the hardest part of developing a science project is selecting questions that are specific and that can actually be answered through an investigation.

The main task of the day is for the teacher to conference with kids about their proposals. He instructs the students to work on repotting their marigold plants and then demonstrates proper transplanting techniques before getting started. Before they all get busy, they measure and record the growth of plants in an ecosystem they have developed using Museum-to-Go Kit material.

Kids take turns doing their repotting in groups of two to four while the teacher talks to one student at a time. The others sit in groups of two or more and chat. They also take time out to discuss their feelings about science with the evaluation researcher observing their class. One student says science is his favorite class because they do experiments and he likes to use his hands. Another states simply, "It's funner to discover something than read it out of a book." According to the students, they do 1-3 experiments a month, with the remainder of their time spent doing "paper work." In addition, their teacher has lately been reading them a novel for which the connection to science is explained, "cause he eats bugs." Their recent projects included researching famous scientists and determining the composition of vermiculite. In general, the students agree that they like science best when the teacher does less talking and they do more activities.

Meanwhile, the teacher is making his way around the classroom discussing project proposals. Most of his feedback to students centers on problems with their questions. He points out, for example that they are unanswerable, on the wrong scale, or impossible to prove in the context of a middle school science classroom. After the teacher clarifies for students the problems with questions, they are left to rework them.

**Vignette #2**
*Case Study School #4*

A few minutes before the period begins, the teacher and her lab assistant are preparing for the next lesson with their special ed sixth grade class. They have recently been working on scientific classification. Today's activity will ask students to distinguish vertebrates from invertebrates.

Nine male students enter as the bell rings. They sit down at four black, lab style tables at each of which a science textbook is opened to a page on classification. The boys are full of questions and comments about the animals pictured on the one-page hand out they are receiving. There are sixteen, unlabeled xeroxed photographs of animals.

"What's number 6?"
"They ugly."
"My cousin has an alligator."
"Bugs aren't animals."

The teacher responds to one of the many comments by explaining that bugs are classified as animals because they can not make their own food. As a formal introduction to the day's lesson, she goes on to talk about similarities between herself and her students as a way of reminding them about like characteristics of a group. She parallels the differences she has identified with the use of vertebrate and invertebrate as classification terms.

After making an empty, two-column (invertebrates/vertebrates) table on the blackboard, the teacher invites her students to choose one of the pictured animals, name it, and then state whether it is a vertebrate or not. Most of the animals (e.g. gorilla) give the students no problems. A few are a challenge. For example, a student recognizes that a picture of a sea gull is a bird, but because he doesn't know what kind of bird it is, he is unsure of how to classify it. To help him, the teacher asks the class to think about the different kinds of birds they eat and to generalize from their experiences to answer the question do all birds have backbones. As the students determine the classification of each animal, the teacher writes it in under the appropriate column on the board. After classifying all 16 animals, the students are instructed to cut out each picture and tape it to a blank sheet of paper. The ringing bell at the end of the period coincides almost exactly with the completion of this task.

This same set of activities is repeated for the seventh and eighth grade special ed classes that come during the next two periods. The seventh grade class shows little curiosity about the animals. They use the open textbooks a couple of times to look up information. When the picture of a toad is incorrectly identified as a frog, the teacher tells the class the difference between these two reptiles and then goes to her closet and comes back with a plastic enclosed, formaldehyde preserved set of specimens which illustrates the stages of development from tadpole to frog. She walks around the room inviting students to look at it.

As the eighth graders come in, the teacher tells the evaluation researcher observing the class that although these students are supposed to be working on earth science, she feels that classification is an important concept. Because she is unsure whether they have had it in previous years, she teaches it to them too. The lesson is basically a repeat of the previous two periods, but these students are asked also to use their textbooks to identify

the phylum of each animal. While cutting out the pictures, a male student complains that they are doing baby work. The science aide disagrees and tells him that adults actually do cut and paste things.

**Vignette #3**
*Case Study School #2*

When the students enter this SRL's classroom, written on the black board is information about science tutoring and the aim for each student that would come through the door that day. For this section, the aim was "To learn the vocabulary of Chapter 15." The assignment for the period was also written down--to copy each vocabulary word and its definition in the glossary, to read four pages, and then to answer five questions in the textbook.

It took the students almost ten minutes to settle into their science table seats and get the textbooks distributed. The room is quiet for most of the period as students bend over the texts and work to complete the assignment. The teacher occasionally paces up and down the aisles checking on her students' work. The teacher explains to the researcher in passing that she always begins a new chapter in the book with a vocabulary lesson like this one. A few students ask for further explanation or help, but most work independently. One girl asks for and is granted permission to get another textbook because a page that she needs is ripped out of the book.

Near the end of the period, the teacher clarifies a scheduling announcement which had earlier been made on the PA. As students begin to show restlessness, she begins to interject more directives such as, "settle down," or "finish your work." A rumble of talking begins to grow. Near the end of the period, the teacher tells the students that if they aren't able to finish the assignment, they will have to work on it during advisory so that they can get into the chapter tomorrow. While two students finish collecting the textbooks, the bell begins to ring.

These three teachers' classrooms indicate the wide range of of approaches to science education found in Philadelphia middle schools. Although some SRLs, like the one in Vignette #3, began with a traditional, textbook-based approach and changed very little during the course of the program, even they expressed in interviews a strong awareness of and desire to provide more hands-on experiences for their students. Others initiated or enriched teaching strategies which encourage students to pose and investigate their own questions by conducting inquiries which use concrete materials, textbooks and other documents as tools and resources. Vignettes #1 and #2 illustrate teachers' efforts and struggles to create a more constructivist science classroom.

One of the main tenets of a hands-on, inquiry-based classroom is that students work individually and cooperatively to generate their own inquiries and then develop and implement investigations to pursue these interests. In these three classrooms, only one approached this model. In Vignette #1, the students were beginning to engage in self-initiated project work as one of several kinds of classroom activities facilitated by the teacher. These students participate in a science classroom in which their questions matter and where time, space and materials are set aside to investigate them. They noted and appreciated the different formats and approaches to learning which they hadin this classroom and the range of opportunities helped create an interest and curiosity among them that was not evident in the students in Vignette #3.

The teacher in Vignette #1 has put in place several important features of a constructivist classroom. However, he still seems to be struggling with what it means to help children move to meaningful questions. Here, we see the difficulty with which a teacher and students approach the task of identifying and shaping researchable questions. For some students, the teacher's strategy of encouraging them to reshape their questions independently after he pointed out their weaknesses may create self-reliance and better problem solving skills. On the other hand, it may leave other students unsure of how to move from an interest to an inquiry. For this teacher to move from valuing student inquiry to being able to help and guide the process of discovery in meaningful ways, ongoing professional development might focus on understanding how scientists formulate research projects, practicing moving from an interest to a question to an implementation plan, and working collaboratively with children to construct meaningful questions.

The teacher in Vignette #2 provided activities and an environment in which her students spontaneously posed questions and made observations. The children's questions and comments emerged from the teacher-planned activity at hand. In this vignette, we see the teacher get engaged with these questions in two different ways. In one instance, she encouraged students to answer their science oriented questions by using their everyday life

experiences (e.g. do the birds you eat have backbones?). In another instance, she was able to turn a "mistake" into an opportunity for learning because she had access to and used an illustrative model (the tadpole to frog model). This teacher clearly values her students' questions and treats them as opportunities for learning. However, she did not treat these questions and comments as opportunities or invitations for student investigation. When she addressed these questions, they were treated as problems for the teacher to solve using her own knowledge and expertise, rather than as opportunities for discovery for students. Further professional development might focus on how to support this teacher's ability to provide a context for students to find (through library research) and/or investigate (through experimentation) answers to their own questions. More emphasis on how to move from questions to inquiries would be an important step in the professional development of teachers like this one.

These vignettes also indicate that some teachers are making efforts to create a science-oriented classroom environment in spite of the fact that many work in non-laboratory classrooms, as do two of the three teachers portrayed here.

For example, the teacher in Vignette #2--the only one of the three who works in a traditional classroom laboratory--has covered her walls with commercially-produced science posters of nature scenes and the steps in the scientific method, information about the science fair, and some student work. Along the back wall is a table with microscopes, and lab tables in another area of the room are used to hold additional equipment. A large walk-in closet is filled with materials, books and other resources from which the teacher is able to draw in response to students interests and questions. Although the students are not involved in doing experiments, the room looks as if it is a place where science can happen. Science textbooks are used as a resource and a reference.

The two other teachers, neither of whom teach in a lab room, deal with their circumstances quite differently. The teacher's classroom in Vignette #1 is filled with the evidence of investigations in progress--potting soil and plants in peat pots as well as

growing environments created using Museum-to-Go kit equipment. Student work is hanging everywhere. There are no science textbooks in view. The room is small and cramped and was clearly not designed as a laboratory facility, yet it looks like a place where science happens. In contrast, the classroom in Vignette #3 is just that--a classroom. This SRL, like several others we interviewed, complained that her space limits her ability to do hands-on activities. It is essentially bare. At the back of the room is a table upon which science textbooks are stored. This is the only indication that this is a science classroom.

In many cases, SRLs tended to assess their experience in the program in terms of what they could "take back" and use directly in their own classrooms. If they could pick up and directly reuse materials and activities they were more likely to than if they had to abstract and generalize an experience to make it of value with their students. This tendency indicated a willingness to try new things that was not always matched by a conceptual understanding of the "big ideas" behind some activities. For example, in describing what they gained from the Directed Research project, SRLs pointed to new materials and information which they could teach to their students. Few, if any SRLs, talked about this project in terms of the ways it helped them understand how to support students' inquiry.

Creating opportunities for students to actively participate in learning through the construction of knowledge is a fundamental shift in practice for many teachers which involves using new materials and classroom formats, creating new kinds of relationships with students, and using alternatives to traditional assessments. For most teachers there are many (not necessarily linear) steps along the way from textbook-based, teacher-centered traditional science teaching to implementing a constructivist pedagogy. Survey data and field visits indicate that many teachers have integrated into their thinking the importance of actively involving students in their own learning through the use of hands-on activities. In two of the three vignettes, we see examples of these efforts. However,

what these examples also point out is the complexity and difficulty of moving from implementing some critical features of a constructivist classroom to transforming teaching and learning. This reality suggests the importance of ongoing opportunities for teachers to continue to explore and develop their practice.

**Features of School Contexts which Impact Changes in Practice**

From the base-line survey to the summative survey at the end of the program, practitioners typically expressed an interest in creating more engaging, hands-on learning environments for their students, but consistently identified factors within their own schools which inhibited them from more closely aligning their practice with their goals for science education. In general, the school context acted as an inhibitor rather than as a support for hands-on, inquiry based science instruction.

Teachers identified school organizational structures factors in their abilities to implement new practices in their classrooms. For example, both middle school and elementary teachers identified challenges in their contexts which made it difficult to change their science education practice. SRLs in elementary, self-contained classrooms were more able to have a child-centered approach which forefronts the importance of student initiated learning and is congruent with inquiry-based science (as opposed to a content-centered approach of many secondary certified teachers), and they are logistically able to integrate subject matter across content areas. However, the competing demands of "covering" multiple content areas makes it hard for them to concentrate on their practice in any one specific content area. For middle school teachers (particularly in the upper grades), the shifting notions of what works in middle schools and chronic administrative turnover leads to yearly reorganizations which means teaching under different conditions (e.g. lab as a separate class or integrated) with different kinds of kids (regular ed or special ed) and at different grade levels each year. These constant changes force teachers to focus more on adapting to shifting logistics than pedagogy.

Another inhibiting factor at the school level was a shortage of supplies and equipment. One SRL said, "We don't get new materials when things are used up." A non-SRL expressed her feelings about teaching science. "It stinks." She observed that, although the sixth grade teachers get materials supplied by the Kits, her seventh grade classes have nothing but a textbook. "There's nothing you can do on your own because we don't have any materials. The textbook is boring." One SRL observed with a note of irony, that the focus on technology in the Innovative Teaching and Learning Institute had shown her "how the other half lives." Although SRLs noted consistently that the program had been extremely helpful in enriching their supply of materials and equipment, no one ever seemed to feel they had enough. Many teachers complained about even basic level facilities. For example, when students expressed an interest in doing more experiments in one SRL's classroom, he explained that it was impossible because they meet in a regular classroom rather than a science lab.

SRLs also struggled with the norms of appropriate student behavior. Although the the current middle school reform rhetoric includes a strong affirmation of the importance of active learning, the expectations of principals and colleagues that classrooms should be quiet create conflict and pressure for SRLs who provide opportunities for inquiry. Such activities make more noise than those which involve silent reading and written work. Although some SRLs framed classroom management as a challenge they face because of the kinds of students they teach, observations of classrooms indicate that changing practice requires new expectations of appropriate noise level and student behavior.

Teachers also need support in rethinking ways to manage classrooms in which students are active knowledge constructors. Without support they may easily feel caught between their desire to provide an active learning context and pressure to conform to school norms of student behavior. Some SRLs feel worried and uncomfortable about classroom management issues and therefore shy away from hands-on activities. For example, the SRL in Vignette #2 explained that she had tried to integrate cooperative

learning with hands-on activities but found that students have difficulty sharing, get over-excited and she easily loses control. She found that the summer experience of working in groups to implement an inquiry did little to help her deal with these management problems because as interested adults, participants were cooperative and treated materials appropriately. She felt that there was little to draw from this experience to help her in her classroom. At another school, administrators and teachers alike explain that "these kids can't handle hands-on activities" as a rationale for providing a mainly textbook-driven program. The students of one SRL at this school had internalized this perception and explained that their class could not do project work because they were too poorly behaved.

Although these observations and concerns tend to blame students for a teacher's reluctance to implement more innovative approach to science teaching, they may be indicative of the "buck passing" common in many schools in which principals blame teachers and teachers blame kids in a circle of recrimination. At Case Study School 1# the culture of the school places a value on looking for constructive solutions without finding someone to blame. Here, the SRLs struggled to understand students in relationship to their own practice. One wondered how she herself could change as a way to better engage her students in learning. She posed her problem as a question by asking herself, "What makes learning valuable to kids to such a point that they will really engage in the process?" She learned from the SRL program that one answer is to listen more to her students. "If they have a say, the teacher can do more." Another SRL in the same school, while experiencing behavior problems when his students did hands-on activities, strived to analyze the situation without blaming the students. He observed that when tradition is broken and students are actively involved in their own learning, their excitement and stimulation can cause negative behavior and distract them from completing the tasks of inquiry such as observing, recording and drawing conclusions.

These two teachers work in a context which encourages them to reflect on their practice and the students they teach. However, all of these teachers have the sense that their students are not used to taking responsibility for their own learning, and therefore have difficulty adapting to learning strategies which invite them to take an active role in manipulating materials, working cooperatively and engaging in cognitive activity to solve problems.

**Features of the SRL Program which Impact Changes in Practice**

Multiple components of the SRL program exposed Philadelphia teachers to innovative approaches to science teaching, enriched their content knowledge and supported their professional development in ways that were consistent with hands-on, inquiry based science teaching. For example, program activities during the summer institutes and the Directed Research Institute provided teachers with opportunities to themselves engage in inquiry. These experiences helped many teachers understand the components of scientific investigation, and gain confidence in their own ability to conduct science inquiries. The fact that the program equipped SRLs with many new materials was also an important program feature which supported changes in practice. Given the severe shortage of materials in most middle schools, even the most willing teacher would have difficulty implementing hands-on, inquiry-based science without this influx of some new materials.

# IV. TRANSFORMING SCIENCE EDUCATION: SRLs AS SCHOOL SCIENCE LEADERS

The SRL program goals included changing practice at the individual level, but also had an equally important component of developing school-based leaders who could function as resources and supports for their science teaching colleagues. Program planners hoped that participants would fill a leadership vacuum in middle schools, but the presence of teacher leaders in schools who were actively engaged in transforming their own practice also had the potential to reform science education on a school and potentially a system-wide level. This goal, driven by the reality of shrinking resources for supporting science education at the district level, was especially important in middle schools where many people who teach science had little or no training in science subject matter. To do this, the program envisioned SRL participants as teacher leaders who would team up with partners to act as "catalysts for improved science teaching and science learning with the long term goal for increasing the level of interest and achievement in science for all middle school students in the School District." This chapter addresses the questions: **In what ways did SRLs take up leadership in their schools? In what ways did school/district culture interact with leadership efforts? How did SRLs' leadership impact on school science programs?**

In addition to advocating and supporting changes in classroom practice which encompass a hands-on, inquiry based approach to science education, program staff expected that participants would take up leadership roles within their buildings to promote school-wide and ultimately district-wide changes in science education. The program outlined a number of possible leadership roles which SRLs might take up in their buildings (SRL News, October 1993) including: demonstrating lessons, peer coaching, identifying equipment and teaching materials needed in classrooms, providing staff development and sharing plans and information at staff meetings. In addition to taking up leadership roles within their own schools, SRLs were invited to become leaders in the program (e.g. as

facilitators) as well as in the wider science education community (e.g. by giving presentations at local and national conferences, and by participating on committees and task forces).

The evaluation research sought to understand the ways in which SRLs took up leadership and in what ways their efforts impacted on their school's science programs. It looked at teachers through surveys, observations and interviews in order to learn in what ways teachers took up school level (and beyond) science leadership, and it looked at their schools to understand how teacher leadership intersects with school culture and effects school change efforts.

Analysis of the data suggests that most SRLs became known in their schools as science leaders (if they weren't already). Their activities helped make science a more visible part of the school program and their efforts facilitated and/or encouraged the use of hands-on learning. The following findings will be discussed in the sections which follow.

**Finding One: SRL participants became visible as leaders and resources to their colleagues and were often tapped by their principals to take on special roles in their buildings in relationship to the science program.**

**Finding Two: Sharing newly acquired materials and equipment, providing information about workshops and other professional opportunities and coordinating science fairs were the primary strategies by which SRLs gained visibility as leaders in their buildings.**

**Finding Three: While SRLs clearly became visible in their buildings as science resource people, their ability to function as leaders was influenced by the extent to which principals utilized their skills and knowledge to make science more of a priority in their buildings.**

**Finding Four: Organizational structures in schools often created obstacles to SRLs' ability to provide leadership for school-wide improvement of science education. Obstacles included:**

- **o rosters that allowed little or no time for team planning**
- **o house systems which gave time for teacher meetings across disciplines, but not within**
- **o a school culture which divided elementary and secondary certified science teachers in terms of goals, strategies and materials**
- **o extant formal and informal science leaders who were not SRLs**

**Finding Five: SRLs increased science visibility in their buildings using a variety of strategies including strengthening school science fair participation.**

**Finding Six: SRLs provided support and encouragement for their colleagues to use more hands-on activities with their students by using a variety of strategies including increasing access to science materials and equipment and leading staff development workshops.**

**Finding Seven: The SRL program catalyzed and supported participants' leadership skills by providing opportunities inside and outside the program for them to facilitate groups and lead workshops and conference sessions.**

**How do SRLs define their leadership?**

*Survey data*

According to the survey data, SRLs took up a wide variety of leadership activities within their own schools. Their most common activities included conducting science

workshops for teachers inside and outside their own buildings (82%), purchasing new science materials (77%), inventorying science materials and organizing a science fair (both 67%). Although they took up leadership in a wide variety of ways, a large majority (82%) identified coordinating the science fair as the area in which they spent the most amount of time. The second most often named leadership activity on which SRLs spent the most time was purchasing new materials (77% said this is where they spent the most time). Other leadership activities, although less common, also provided support and resources for school science programs. These included working with other teachers to develop and teach multi-disciplinary units, inventorying science materials, offering one-on-one science consultation to other teachers, obtaining outside funding for science, distributing a science newsletter and establishing a laboratory facility.

SRLs were clear that their leadership efforts had benefitted their schools. For example:

- 82% felt that their activity as SRLs had increased science visibility in their buildings;
- 49% reported that more materials are available for teachers; and
- 75% felt that students in their schools are more enthusiastic about science.

The survey data portrays SRL teachers as taking an active role in promoting science teaching in middle schools. Although the survey cannot illustrate where schools' science programs began and where they ended up vis a vis hands-on, inquiry based science education, SRLs clearly took up leadership roles that helped to move science into the forefront in their schools and facilitated and opened up the possibility of more hands-on science.

**What does school-based leadership look like?**

*Portraits of Science Resource Leaders in Action*

Interviews with SRL and non-SRL teachers and administrators in case study schools confirm the survey data which indicate that SRLs have taken up leadership roles in their schools. The SRL program assumed that leadership would look different in each school, and indeed, the descriptive data below confirm that this has been the case. Variation is shaped by a number of factors: the role of science in the building, the position of the SRL (grade level, house, non-SRL leadership responsibilities and informal status in the building), the role of the principal in fronting the SRL as leader, the capacity of the SRL team to work together, and personal circumstances and interests of the SRL. The following descriptions provide examples of the diverse ways in which SRLs have become science leaders in their schools.

**SRL #1**
*Case Study School #1*

After the first summer, one member of the SRL team decided to drop out. This left the remaining SRL with no partner. Because the school is small and there are only three science teachers in all, and because there is a heavy emphasis on collaboration and team work, the SRL functioned as part of a science team. The three collaborated to develop science standards and benchmarks for the school's program. However, there are no department meetings and when this work was done, they had no regular reason to work together.

The SRL is the secondary certified and most experienced science teacher in the building. She also has the most equipment and access to materials. She feels she has made herself available and that the other two teachers did sometimes come to her for help with science content. However, she feels that her colleagues were not always comfortable or happy accepting her expertise. In fact, she describes her relationship with her colleagues as the biggest negative in her ability to function as an SRL. She believes that this has been an important obstacle in impeding her ability to effect any school-wide change in science education.

The principal would probably accept this SRL's assessment. She views the SRL program as more of an individual change process than a support for school-wide change. Despite this, the SRL did use school-based project money to buy materials for the school. One of the other teachers noted that she does often go to the SRL for help and that she

always gets it. She also views the SRL as a "conduit" of information. Clearly, the SRL is functioning as a leader and a resource. However, in a building where all three teachers subscribe to a hands-on approach, her role as a change agent is somewhat hard to define.

**SRL #2**

*Case Study School #2*

This SRL team had difficulty with each other. Made up of a new, inexperienced elementary teacher and an older, experienced science certified teacher, their energy levels, enthusiasm and motivation varied greatly. In addition, SRL staff members agreed that the difference in their school status contributed to a power struggle between them. In the end the younger SRL seemed to defer to the other who failed to take the lead. Although the younger SRL took some initiative at the school level, more experienced teachers did not think of her as someone to turn to for help. Even the principal noted that their ability to function as leaders would be stymied until they found a way to function as partners.

The primary way in which the more active SRL tried to take some leadership was by organizing the science fair--the focus of their first and only school based project proposal. A few teachers did become involved as a result of her efforts, but most classes finished too late to go to the city-wide science fair Carver High School. Because teachers ignored the deadlines, and projects were completed at different times, it was difficult to organize judges and the quality of the judging, which seemed to focus almost exclusively on spelling and penmanship, was disappointing. The SRL found that the students were motivated and enthusiastic about participating in the Science Fair. Many other teachers expressed great pride in their students' ability to complete projects. However, the SRL observed that the school had little to offer them in the way of materials and they did not have what they needed at home either. This experience seemed to sour the SRL on the potential of the science fair as a vehicle for spreading hands-on science throughout a school.

The SRL also led three workshops (one on the science fair, two on hands-on science) during the second year of the program. However, in frustraion she gave this up. She realized that the lack of supplies meant that the staff did not have access to hands-on materials even if they did want to try some new activities. The huge range of needs for staff development among the staff overwhelmed her. Although she recognized the fact that many of her colleagues were afraid to teach hands-on science, she felt that given the resources available there was little she could do to help them. She hoped that the reorganization planned for the next year would do more to support efforts to improve the science program.

SRL staff observed that this school, with its openness to try new things and its many organizational innovations had the potential to reshape its science program. But it seemed to feel the impact of SRL only marginally. As one person said, "It's a school that should have done better." She observed that more might have happened on a school-wide level had the SRL program been able to provide more support and improve the ways in which the team tried to worked to improve science education in the building.

**SRL #3**
*Case Study School #3*

As a team, the SRLs at this school have had difficulties. Of the first two SRLs, one transferred to another school after the first year. The third SRL in the building, who joined the program as part of Cohort II, observed tension between the first two SRLs and made an effort to get along better with the remaining SRL. Nonetheless, the team had a falling out during the third year. The Vice-Principal and the two SRLs made a successful effort to resolve tensions late in the year by clearly articulating the distinctive responsibilities of each team member. In effect, the newest SRL was the more active leader in the building. However, his leadership sphere included mainly newer, younger teachers like himself. As he explained, "They [newer, younger teachers] see me acting like a leader and assume I am. Others, who've been here 20 years say, 'who's he?'" The VP concurred with this observation by explaining that most older teachers naturally gravitate to the older SRL. Given this reality and the fact that seniority has filled the upper grades with older teachers, they agreed to divide responsibilities by grade level. The younger SRL works with the fifth/sixth grades, and the older SRL focuses on the seventh/eighth grades.

The primary area on which the SRLs focused was improving access to materials and equipment. The original two SRLs decided that it was important to organize and then inventory what was already in the building. They then made arrangements to store materials in a locked room to which only they and the principal had a key. They felt that it in order to maintain access for everyone, it was important to control it. They put out a memo announcing the existence of the room with a list of its contents. This arrangement made the SRLs the science materials people. In subsequent years, the school-based plan focused on the purchase of more materials. One non-SRL who does hands-on science reported that when she requests materials from the SRLs, she gets them. She said the fact that they have made materials more accessible has improved science teaching. The following year, the VP said that she sees SRLs primarily as the keepers of the science materials--and they are getting used. During the second and third year, the SRL has taken responsibility for ordering and organizing materials for the science labs in the new building. It is assumed that the SRLs will take an as yet to be defined role in running the labs once they are usable. One SRL has also tried to increase science visibility and improve communication about science by making a bulletin board in the main office called "Science FYI."

During the first two years of the program, the SRLs did almost no staff development for their colleagues although both teachers and administrators expressed a desire for them to do so. The more active participant, as a new teacher and graduate student, did not explained that he did not have time to take on this added level of responsibility. During the third year, the SRLs acted as facilitators for teacher meetings to

select science textbooks. After attending an SRL event where he heard about its availability, the more active SRL arranged for Star Lab (a portable planetarium) to come to the school. He provided an after school staff development demonstration workshop. About 25 teachers from a variety of content areas participated. This session generated a great deal of excitement and teachers talked informally about how they could integrate Star Lab into their teaching. Everyone signed up to bring their students. The SRL reported, however, that few teachers had fully utilized Star Lab, treating it mainly as an add-on.

The SRLs are clearly viewed as science resource people in their building. The first principal reported that he viewed them as the science support for the building. A non-SRL observed that SRLs are "esteemed" and that awareness of them is widespread in the building. "People think they know a lot about teaching science and think of them as helpful resources." Another said they communicate about activities, events and resources. One teacher reported that she joined an area professional organization as a result of information an SRL had passed along. The more active SRL said he is viewed as "Mr. Science" in his building. The current VP summarizes this SRL's position in the building by saying, "They call him. They stop by his room. He puts notices about science events in the daily bulletin."

This SRL feels that, to date, his main leadership function has been to distribute science materials. His own practice is less a reflection of what he has learned in the program than he would like. As a member of an experimental team next year, he hopes to be more of a model of innovative science teaching. He sees this as more powerful strategy than workshops for transforming science education in his building. Therefore, he constructs his role in school change as continuing to evolve.

**SRL #4**
*Case Study School #4*

Because one SRL is a house director and math teacher, the other SRL took on primary responsibility for science leadership in the building. As the only science certified teacher in the building, this was a good match with her position. Her main focus, on the seventh and eighth grade science program, reflects the elementary/junior high school split philosophy toward the three grades among teachers and administrators in the school.

One of the SRL program staff described the SRL at this school as a hard worker who has not met with much success in changing the school's science program. "I think she leads, but the other teachers just don't follow." The SRL explained that all but one other teacher in the upper grades uses textbook-based instruction. They don't see a need for staff development because they find it simple to follow the books. She feels that unless the principal provides some real leadership in this area, there will be little movement. "If the principal doesn't have a focus on science, it won't be taught." She would like to

function as an "instructional coordinator" but the principals have been unwilling to give her the time.

One way in which this SRL has tried to improve the science program is by acquiring more materials for her science lab room. She has used her school-based plan and the SRL program materials to support this effort. Some of the materials, equipment and resources she has acquired can be borrowed, but she requires that most stay in her room. For example, she now has every microscope in the building in her room. Teachers can arrange for students to come to her for a lesson on using them. An actual protocol for arranging lab lessons is unclear, however. A seventh grade science teacher complained that although he knew the SRL was available to do lab lessons, he did not know whether he or she was responsible for initiating such an arrangement. Consequently he had done nothing to take advantage of her resources or her willingness to supplement textbook teaching with lab lessons.

The primary way in which the SRL at this school has become visible is to take an active role in organizing the science fair. She has created booklets for students which include project ideas, guidelines and an application; set deadlines for participation; made presentations about the science fair in almost every classroom; distributed materials and arranged for judges to come to the school. As momentum for the science fair has grown in the building, the principal has come to recognize her leadership in this aspect of the science program. During the third year of the program, she was given release time to coordinate activities and feels she has come to be designated by the principal as "my science person."

In summarizing the impact of SRL on the school as a whole, a program staff person observed, "They had a nice science fair, but hands-on science hasn't caught on. There has not been buy-in as a school."

**SRL #5 & #6**
*Case Study School #5*

This SRL team was composed of two teachers who had a history of working together. Their classrooms were adjacent and the school context supported their efforts as a team. An SRL staff person observed that they were well matched, shared the SRL responsibilities evenly and complemented each others' skills.

Although these two teachers taught in a school with middle school grades they are elementary teachers and they defined their role in terms of supporting elementary science teachers. In response to their perception that many of these teachers were intimidated by the idea of teaching science, they wanted to make their colleagues more comfortable as a way to increase science teaching. Especially given the fact that the school lost their science prep teachers during the SRL program, this seemed to be a well placed focus. They encouraged the use of science logs, invited a summer institute teacher to the school

to replicate a summer activity they had especially appreciated for their colleagues, and developed a series of ten hands-on demonstration lessons. In addition, they created assemblies for two years that featured science. Finally, the SRLs purchased and shared science equipment and materials and set up a science resource room.

Each school benefitted in some way from the SRLs' commitment to improving science education. As the survey data above indicates, SRLs assess these benefits very positively. The fact that science education has not been more markedly transformed, by the work of the SRLs at the case study schools indicates the intensity of effort needed for teachers to make such a radical shift as that involved in moving from a textbook-based to a hands-on inquiry-based curriculum on a school-wide basis. The challenge is especially great in schools that lack materials and resources and nearly impossible in schools where principals have not made it a priority. Many schools have so few resources and so many teachers who lean heavily on science textbooks, that even an awareness of other strategies and some signs of teachers providing opportunities for students to do investigations (even if only once a year for the science fair) should be viewed as a positive step forward.

In almost every case, SRLs improved access to materials and resources for their colleagues. The importance of this activity in schools that have had very little can not be underestimated. In some cases, this type of leadership simply means taking responsibility for organizing what is already available and then setting up a system for communication, distribution, sharing and other strategies to improve availability. In many schools, however, there is little to organize. SRL participants received materials and/or information about accessing materials. Many of them availed themselves of these opportunities and then shared with other teachers. In addition, in many cases SRLs chose to spend school-based project money on the purchase of materials. Although these were not always widely shared, more materials came into buildings this way. In some cases, the SRL brought special resources such as Star Lab into the building above and beyond what was needed for day-to-day classroom activity. In every case in which access to materials was increased, it can be assumed that the teaching of hands-on science was facilitated. In

addition, taking responsibility for organizing materials and improving access to them helped SRLs gain visibility and become defined as "the science person" in their buildings.

Another key leadership strategy employed by SRLs was to increase and improve science fair participation. Many used school based money to support these efforts and the increase of participation was notable at many schools and in the district as a whole. The science fair did not catch on at every school where SRLs tried to make this a focus, but it does appear to be a concrete activity with a relatively well defined set of activities in which many SRLs could easily take on leadership. In many cases, like SRL #1, taking on leadership responsibilities such as becoming the materials person helped to define SRLs as the science person in the school. In addition, science fairs improved the visibility of science, contributed to the students' sense of excitement about it and reinforced for teachers that investigative project work is valued at the school, district and national level.

Many SRLs excelled in leadership activities that involved coordination and took the form of concrete, visible activities such as providing more materials for science education or coordinating the science fair. They had more difficulty assuming the role of instructional leader and staff developer. Although 82% of survey respondents reported conducting workshops with other teachers in their schools, the descriptions above indicate that these efforts may have focussed primarily on the science fair or on other single, isolated efforts rather than an overall approach to science instruction. Several of the SRLs expressed their belief that their efforts at providing such one-shot workshops had little potential for altering their colleagues practice.

**Features of School/District Context which Impact on School-based Leadership and School Change**

Although SRLs readily took up some leadership responsibilities in their schools, they also faced obstacles which hindered their efforts. The composition of the team and the position of SRLs within local school contexts shaped the range of ways in which they

could function as leaders. For example, teams composed of a less experienced, younger teacher and a veteran teacher had difficulty collaborating as partners. Their leadership often appealed to different constituencies within the building. Although not necessarily an obstacle, this split often ran not just along lines of age and/or years of experience but also along pedagogical differences in schools where upper grades tended toward content centered, traditional, text-book based teaching and lower grades were more student-centered and hands-on. This fact often shaped the ways in which SRLs could function (e.g. a focus on materials instead of ongoing consultation with other teachers).

Organizational issues at the middle school also impeded the leadership potential of SRLs. The house structure of middle schools, while intended to create more connected learning communities often separated and isolated same-discipline teachers, making it difficult for them to meet (SRL teams even had difficulty meeting), collaborate or work on the development of a content area program for the school. The District's transition to a middle school structure and massive retirements under the Pennsylvania Mellow bill continues to contribute to staff and administrative instability. This instability has necessitated the repeated repositioning of the SRL team vis a vis administration and re-assessment of staff needs for support and professional development as new teachers come into schools. In addition, the relationship between the old junior high school structure of departments and a focus on content and the newer middle school structure which includes a focus on the child has created role ambiguity for the (usually one) secondary science certified teacher in the building. Finally, because the concept of middle school is still being shaped and defined, many schools are caught up in a swirl of reform and restructuring which sometimes leaves little time or energy for focus on specific content areas.

Much of the middle school reform rhetoric posits the importance of integration--of content knowledge, school and home contexts, intellectual and emotional growth--and suggests many structures which support such integration. Professional development programs such as SRL, by focussing on one content area, are potentially problematic

given this climate in the reform movement. On the one hand, teachers can not successfully integrate content without a deep understanding of their own subject areas, and SRL did help teachers develop their content knowledge of science. On the other hand, by separating out teachers and encouraging them to take leadership in a specific content area, the SRL program ran the risk of encouraging segmentation. In response to current reforms which forefront the importance of subject matter integration, professional development programs like SRL could work explicityly with teachers to help them make connections accross disciplines and develop strategies for collaborating with colleagues who teach in other content areas in spite of structural and organizational features of schools which make this difficult.

Despite the school level difficulties which SRLs encountered, the fact that they often took on responsibilities that no one else had time for meant that they gained recognition as the "science person" in their buildings. The elimination of district support people, science coordinators and department chairs, has created school contexts ready and wanting for leadership where there is none. In many cases, SRLs have taken on necessary responsibilities in contexts where there was no one else to do the work. In some cases, their volunteerism is beginning to be recognized through the provision of additional prep periods and other release time which in turn enables them to function better as leaders.

**Program Features which Support Leadership Development and School Change**

The SRL program had two important components which explicitly promoted leadership as a strategy for improving science education in middle schools. The design included the requirement that participating schools send teams of two teachers who would function as partners in providing resources to teachers. The funding of a school based plan provided teams with financial resources and a structure for implementing specific strategies for acting resources for improving science education in their schools.

The emphasis on recruiting teams of participants from each school meant that no one was alone in his/her building as s/he tried to implement classroom changes and take on leadership roles. Therefore, the potential existed for supportive, in-school partnerships focused on the common goal of improving science education. However, in spite of the fact that summer institutes used team structures for many of the activities and even engaged in team building activities, SRLs were never given explicit time or help to build a productive relationship with their school partners. Frequently they were thrown together by a selection process in which they had little input or choice. Because teams got little or no help in forming partnerships, and sometimes faced real challenges (either logistically and/or interpersonally) establishing a working relationships, they did not always function as supportive structures for leadership and school change.

A second program component that was designed to support leadership and school change was the opportunity to write a school-based project proposal which was then funded by the SRL program. The school-based plan had several components that helped make it an important program feature. Teams had time to write their proposals at a planning retreat , administrators and other staff were invited to participate in the retreat, and money was provided to support implementation of the plan. However, SRLs received no feedback from program staff about the quality of their plans. Such feedback might have helped them think about strategic ways to work with colleagues, choose an appropriate scale for the plan and develop useful ways to make science education a priority in their buildings. SRL program staff did not work with participants explicitly on thinking through the important elements of a change process, nor did they work with teachers strategically to identify obstacles to meeting their goals and strategies for overcoming them. As in the case of Case Study School #4, the implementation of some school-based projects might have profited from SRL staff support during the year. Although the original intent was for a teacher on special assignment in the Office of

Curriculum Support to provide ongoing support for teams during the school year, staffing needs in that office and the growing number of SRLs made this task nearly impossible.

Although some effort was made to connect the SRL program with building administrators (e.g. by inviting them to attend retreats), it did not explicitly set out to build relationships that would encourage principals to utilize what SRLs had to offer nor did it illustrate ways in which the school science program could benefit from the presence of a teacher leader. Therefore, only some principals made full use of the increased knowledge and skill of SRLs to work on school-wide improvement of science education.

The SRL program, while modeling an innovative approach to professional development did not make explicit or provide time for participants to reflect on their experience in ways that might encourage them to utilize these alternative approaches for supporting science teachers' practice at their schools. It is logical then, that given the many contextual challenges they faced in their schools and their experience in the summer institutes, that SRLs emphasized concrete leadership activities such as coordinating the science fair, and developing better access materials. These were activities that were easy to transport from the program to their schools.

To support teachers in the role of instructional leader, a professional development program needs to work explicitly on this aspect of leadership development. For example, many SRLs assumed that taking on more instructional leadership meant leading workshops. Although no SRLs pointed out the contradiction, their observation that workshops were not an effective means of supporting teacher change, hints at the fact that a workshop approach to learning is antithetical to hands-on, inquiry based science. While the former reinforces a transmission model of learning, the latter stresses ongoing inquiry to promote knowledge that is constructed. Although various aspects of the summer institute were congruent with this model, participants had little opportunity to think about their own experiences in relation to taking on instructional leadership and supporting other teachers' practice according to this model.

**Leadership and School Change**

It is clear that SRLs increased the visibility of science in their buildings, made it easier for teachers to gain access to materials and resources, and raised the consciousness of teachers in regard to hands-on, inquiry based science instruction. Yet observations at case study schools indicate that it is far easier for teachers to integrate specific activities and materials into their own repertoire of classroom strategies than it is to fundamentally rethink their approach to science. Likewise, it is far easier for SRLs to support concrete efforts like science fairs than to initiate and support fundamental change in their colleagues' beliefs and practices.

It is clear that the experience of participating in SRL helped teachers become more aware of and comfortable with hands-on, inquiry based science education and encouraged them to make changes in their own classrooms. It is also clear that they readily and easily moved into some leadership roles within their buildings. The extent to which this leadership impacted on science programs is less clear. SRLs provided knowledge, resources and leadership which schools could draw on to support the improvement of the science program. However, many schools were not actively engaged in making science a priority much less transforming their science programs. This contextual condition raises questions about the relationship between leadership and change in the absence of a commitment to changing and strengthening a program on the part of the principal, other teachers in the building, and the District . The case study schools never--neither at the outset of the SRL program, nor as a result of their SRLs' activity--explicitly decided to work on improving their science programs. At best, administrators and teachers hoped that the SRLs could and would establish, maintain and/or improve the program without anyone else having to expand significant energy to improve it. This lack of focus limited the SRLs' ability to provide resources and function as leaders.

# V. THE DEVELOPMENT OF A PROFESSIONAL NETWORK: SUPPORTING PRACTICE, LEADERSHIP AND SCIENCE EDUCATION

The SRL program was designed primarily to support the professional development of middle school teachers to improve their practice and develop their leadership skills so they could function as science resources for their buildings. As an undergirding support to these goals, the program was designed as a curriculum-based teacher network. Teacher networks are defined by their high level of intensity (multi-year programming) and the opportunity they afford to engage in "inquiry, to learn and reflect on subject matter and pedagogy, to play leadership roles at many levels, to create collegial professional communities at school sites and broader educational contexts, and to become connected to a range of intellectual and community resources" (Useem, Buchanan, Meyers and Maule-Schmidt, 1995). This chapter addresses the question: **In what ways does the SRL program function as a professional network for participants?**

In a recent analysis of the relationship between urban teacher curriculum networks and systemic change, Useem et al. found that professional networks not only enhance and renew the practice of individual teachers, but also that participants become active change agents at both the school and district level and sometimes even become part of the national conversation on reform. The authors noted the potential of network members to have influence far beyond their numbers. Indeed, at the conclusion of the SRL program it was clear that participants were viewed within the district as an able pool of science leaders who were to be drawn on for subsequent development of a district-wide focus on science education.

The evaluation research sought to understand the different ways in which SRL functioned as a network for its participants. It looked at this issue through participant interviews and surveys. Analysis of the data suggest that participants truly view SRL as a

professional network and that they value highly its role in their professional lives. They see it as a resource for themselves as well as for the broader science education community. The following findings will be discussed in the sections which follow.

**Finding One: Program participants perceive SRL as a network which they value highly.**

**Finding Two: Membership in an SRL network is viewed by program participants as an important professional support for**

- **improving practice**
- **encouraging leadership development**
- **increasing professional identity**

**Finding Three: The SRL network has helped participants connect to the wider science community.**

**Finding Four: As a network, SRL is viewed as providing a pool of expertise from which other science education efforts can draw for professional development, consultation and feedback.**

When asked to identify the most important aspect of the SRL program, networking with others was selected by a wide majority of respondents (55% percent identified networking, the next most frequently chosen aspect was the opportunity to learn, chosen by 43%). More important than new knowledge or materials, the ability to interact with other like-minded professionals was extremely important to teachers who often feel alone in their own schools. As one SRL stated, "The Networking has been most beneficial because my school is small and I worked alone (as an SRL) so being able to

access others was fantastic." The high number of participants who identified the opportunity to participate in a network as the most important aspect of the program makes clear the importance of connection that SRL provided. Responses to the open-ended survey questions and interview responses from SRLs at the case study schools begin to flesh out the ways in which participation in a network functions to support teachers as they work to develop their own practice and act as leaders in their schools.

**The SRL Network as a Resource to Participants**

*Collegiality and Connection*

> SRL's are a source of information and inspiration to each other. We communicate with each other, share problems and solutions and often press each other forward. It may sound corny, but it's true.

SRL participants made clear that they had forged new relationships with colleagues within their own schools and across the district through opportunities to meet and interact with other science teachers in intellectually meaningful ways. As one SRL stated, "The summer institutes were a good opportunity to meet others and hear what they're doing. It was also a chance to renew one's sense of adulthood." Another talked about the importance of his new found colleagues.

> They're my friends. I talk to them regularly for information. We're in activities together and we debrief them. Or sometimes we trade off going and then share. They're an important source of support for me.

The SRL directory helped facilitate this contact. "I have a list of many peers to call on for help." Not only did program participation create new relationships across schools, school teams had time and opportunity to interact with each other in ways they rarely had time for during the course of the school day. One SRL explained that the time spent riding in the car to the summer institute with her school team mate gave them more time to discuss their practice than they had ever had before.

*Links to the wider science community*

SRLs also perceived the network as providing them with entry into a broader professional world of science educators and professional scientists. At a practical level, for many SRLs this meant knowing who to call for help, access to materials and expertise. For example, SRLs used their contacts to recruit science fair judges. A school-based team called on one of their summer institute teachers to lead a staff development session in their school. One SRL explained that her participation in the program gave her a sense of direct access to District level support.

> Both the students and teachers at _____ have benefitted from my participation and the networking abilities that have evolved from it. Being able to call the office of Curriculum Support and speak to a colleague that I know personally has helped me to deal with questions and problems quickly and efficiently.

Another concurred. "I have made many helpful connections in the school district." In addition to these personal kinds of contacts, many SRLs joined and/or participated in professional organizations such as PAESTA and other science oriented professional development activities (many of which were listed in the SRL newsletter).

**The SRL Network as a Resource to the Science Education Community**

Program staff, at both the School District and PATHS/PRISM, agree that SRLs are viewed as a talented and knowledgeable pool of teachers leaders from which the district can and will draw for staff development and consultation. For example, District personnel have made clear that they expect to have SRLs provide training as part of the Urban Systemic Initiative, a new NSF-funded project aimed at system-wide reform of science education. SRLs are participating in other projects at the district level such as 2061's New Standards Project which is aimed at developing science lessons that are congruent with the "benchmarks" of achievement. One SRL explained that recruitment for this project was aimed at teacher leaders and that many SRLs had chosen to participate. They are expected to do turn-around training after completing their work.

SRLs are also being called on to make presentations and do workshops in other districts and at the national level. For example, an SRL at one of the case study schools has been invited to sit on a state committee charged with the task of developing science standards for the entire state. Participants feel ready and able to fulfill these roles. As one SRL wrote, "SRL has increased tremendously my ability to be an effective presenter on the national level." Another noted, "As a result of this program I have felt prepared to present at staff development sessions in my school district and beyond. At the NSTA convention I even discussed the possibility of doing workshops for Prentice-Hall with their representative. I would not have been prepared to have this conversation without the program."

**Network Participation and Professional Identity**

The creation of new professional relationships, the increased knowledge of and access to help and resources and the sense of expertise evidenced by invitations to do presentations and serve on committees combined with more content knowledge and improved practice have contributed to SRLs' developing sense of professional identity. On the summative survey, 91% agreed or strongly agreed that their confidence in their science teaching had increased. In interviews, SRLs at case study schools noted that the program had given them more energy and renewed their commitment to science teaching. They feel more respected in and outside their schools. Although the networking aspect of the program was not solely responsible for this outcome of participation it clearly played an important role.

By creating new relationships, the network helped participants feel connected to other professionals, and by positioning them as leaders and experts it helped them to feel confident and respected. As one SRL explained, "SRL helped me to know I'm an important person in education...It connected me to other worlds...Being recognized [as having something to contribute to the field] reinforces that what you did is important.

Also it helps you be more reflective." The importance of a sense of connection to a larger science community and the esteem to feel like a respected member of that community can not be underestimated. Teachers who feel this kind of affirmation are certainly more able, willing and confident to make changes in their practice and function as leaders in their school and the wider community.

**Program features which Supported the Development of a Network**

Program features which supported and enhanced the development of the network included formats which brought teachers from across many different schools together: the summer institutes, the Directed Research, retreats and support meetings and workshops during the school year. In addition, the SRL Directory and the SRL News helped participants connect with each other and professional development opportunities. As SRL participants formed relationships with Institute leaders and branched out in their professional development, they made connections to other science educators and professionals with whom they could connect for expertise, resources and support.

The SRL program itself helped to position participants as a network of leaders in the field into which other educational organizations could could tap for expertise and leadership. It did so first by developing a pool of teachers with increased knowledge of and experience with state of the art science education, then by providing leadership development opportunities within the program (e.g. positions such as group facilitators and Directed Research coaches), and finally by matching participants with outside opportunities as they arose (e.g. recommending SRLs for workshop presentations and professional organization and reform-oriented committees).

# VI. DISCUSSION AND RECOMMENDATIONS

## Discussion

The Science Resource Leaders program offered participants a rich professional development experience which was considerably different from many opportunities which rely heavily on traditional models of training and coaching but which Little (1993) argues are "inadequate to the conceptions of requirements of teaching embedded in present reform initiatives." SRL immersed participants in new science content knowledge and scientific inquiry and investigation. It exposed them to a wide variety of new materials and equipment (including technology) and linked them to a community of science educators. SRL illustrates well how teachers become proactive in shaping their program involvement to fit their professional development goals and their school context when given the opportunity to participate over an extended period of time in a diverse range of program activities.

SRL catalyzed and supported the development of improved science education among participants. SRLs have clearly raised their consciousness about hands-on, inquiry based science education and have adopted many of the structural features associated with this approach. However, the use of some new strategies and tools alone does not automatically translate into classrooms in which children and teachers are willing to explore and investigate their own scientific questions. A context in which an openness to questions and a flexibility to pursue them are valued and seen as the primary learning goals for science education is essential. Such a context applies to classrooms where the spirit of investigation and a philosophy of constructivist knowledge converge to transform teachers and students into scientists. This evaluation suggests that many teachers travel a great distance towards making such a transformation, but that such radical shifts in beliefs about teaching, learning and science education are extremely complex and difficult to make and may require ongoing opportunities for professional development.

Through their enthusiasm for the program and their interest in new teaching strategies, SRLs show great readiness to make major shifts in their practice. However, this shift takes time and many opportunities for teachers to observe and analyze systematically what is going on in their classrooms in order to understand how to support the scientific thinking of students. Such a process requires support from inside the school (access to materials, prep time, opportunities to share and reflect with other science teachers) as well as support from outside the school (ongoing professional development opportunities which stress reflection and the development of conceptual understanding in addition to concrete activities which provide teachers with specific activities and materials they can use). Without such support, teachers may adopt only parts of the desired change--focusing on discrete activities (e.g. participation in the science fair) and use of specific materials.

The research also illuminates what it means to be a "resource leader" by describing how teachers construct leadership in a variety of school settings. The research indicates that the range of leadership roles was circumscribed by the SRLs' own particular school contexts as well as the context of middle school culture in a large urban district. For example, simply making science visible at a time when middle schools are inundated with organizational and administrative transitions proved to be an important first step in functioning as a science resource. Taking on concrete tasks such as organizing materials and coordinating science fairs promoted hands-on science in schools without necessarily working to transform the conceptual understanding of science education for others in the building.

The development of a professional network was both a program feature and a program outcome. While program structures and formats put in place the logistics and laid the groundwork for a network, the ongoing interaction of program participants in SRL activities actually gave life to a robust network which functions as a support to its own members and provides a pool of knowledge and expertise from which others too can

draw. This network can and does support the improvement of science education at the middle school level and beyond in Philadelphia because participants feel that other network members are there to help, support and share with them as they work to improve their classroom practice. It is also a pool of able teachers, committed to functioning as leaders, from which other science education improvement efforts can draw.

The Science Resource Leaders program was successful at creating a context which seeded and nurtured a dynamic change process for individual teachers. It developed a cadre of leadership which could support improved science education in middle schools. It also developed a teacher network which is already serving to promote this process as it provides leadership in the diffusion of numerous science education initiatives throughout the Philadelphia school system.

**Recommendations**

Deepening changes in classroom practice

Recommendations for additional supports which would deepen changes in teachers' classroom practice include:

- Increase opportunities for teachers to grapple with the "big ideas" in science education by creating extended opportunities to reflect on the purposes of science education and the distinctions and subtleties between concepts such as active learning, hands-on learning, inquiry and investigation.

- Provide more opportunities for teachers to look deeply and reflectively at their own practice and students' work in order to understand how students construct scientific knowledge and to analyze the kinds of learning tasks they are giving students.

- While continuing to improve access to materials and equipment, help teachers identify and utilize inexpensive, homemade and found materials that can be used as alternatives to expensive, commercially produced materials and equipment.

- Create more opportunities for teachers to identify key features of their school contexts which support and inhibit hands-on, inquiry-based science. Collaboratively develop problem solving strategies which build on the strengths and minimize the difficulties of local contexts.

- Assist teachers in making stronger connections between their own experiences as learners and those of their students. For example, provide more concrete examples of hands-on, inquiry based curriculum for teachers and then create opportunities for them to build on these examples to develop and implement curriculum for their own students.

Strengthening science education across the school

Recommendations for additional supports which would strengthen the ability of SRLs to broaden and deepen the impact of their leadership within their schools include:

- Increase the involvement of school administrative leadership and designated school science leaders (when relevant) in all project activities. Include a parent on the school team so that representation across the school community is a central feature of SRL.

- Involve broader representation of teachers and administrators in developing school-based plans designed to strengthen the school science program. Plans should develop goals and a sequence of strategies to address such areas as: professional development activities for teachers; communication with and involvement of parents; development of "authentic assessment" activities for each grade level based on standards for student achievement; and criteria for deciding on the kinds of materials needed to support science teaching and learning

- Engage participants in exploring alternative models of leadership so that they can shape their school-based leadership activities to fit the cultural contexts of their schools and the District.

- Encourage cross-visitation among school teams. These visits focus attention on a school's overall science program and how it is approaching the change process; they also call moments of conversation about the school's progress in improving science education.

- Create more outside support for teacher leaders by providing increased opportunities for feedback and visibility for their efforts. For example, develop a process for feedback and revision of school-based plans and a systematic strategy for "mid course" changes as needed. Commit program staff to visiting SRL schools both as mentors and guides to program participants and to increase their visibility with their peers and administrators.

Sustaining the professional network to support classroom practice and science leadership

Recommendations for additional supports which would strengthen the ability of the SRL network to sustain its ability to support program participants as they continue to improve their practice and act as science education leaders include:

- Develop teacher leadership that can take responsibility for developing and sustaining network governance.

- Ensure that the network maintains good relations with the subject area coordinator in the Office of Curriculum Support and other District offices which are important to network success within schools and the District as a whole.

- Work to maintain an identity as a teacher-led, professional network committed to providing leadership in science education into which schools, clusters and other districts can tap for help in science education reform.

# APPENDIX A:
# RESEARCH METHODS

The evaluation utilized both qualitative and quantitative reserach methods. The following is a description of methods and the kinds of data that were collected.

## Case Study Research

Researchers conducted semi-structured interviews and classroom observations between March 1993 and May 1995 at five schools: one 5-8 middle school, three 6-8 middle schools and one K-8 school. (See Appendix D, Table 1 for a chart showing the demographic characteristics of the schools.) SRL participants were observed and interviewed; administrators and other science teachers were also interviewed, in order to provide additional sources of information about the contextual factors affecting the science program, leadership and change. Interview schedules were designed to explore teachers' perspectives about the following areas:

o their development as science teachers;

o the impact of SRL on their classroom teaching;

o the school environment as a context for teaching science and as an arena for participants to provide leadership support in the imporvement of the science program;

o their participation in the larger community of science educators

In addition, the semi-structured format, unlike standardized survey research, allows the interviewer to pursue any individual question in as much depth as necessary with each interveiewee. The initial interview format was modified for use in subsequent years of the study. (See Appendix C for case study research instrumentation.)

Classroom observations covered several dimensions including: physical environment and materials, teacher-student interactions, student-student interactions, and lesson design and implementation. Special attention was given during the observation and

follwing interview to what aspects of the SRL tprogram eachers were implementing during the period of observation.

Field notes and notes from interviews were analyzed according to the following method. All interview notes and fieldnotes were coded for references to classroom practices, the school context for teaching science, the development of teacher leadership, the challenges described in implementing goals and the development of a professional network. This yielded a list of teaching strategies which teachers used. These include: hands-on activities, student inquiries, cooperative learning, use of textbook, Museum-to-Go kits, journals and other writing, and integration of science with other subject areas. The notes from each teacher were tallied to indicate the extent to which each strategy was used. A simlar process was followed for analyzing the data about leadership and school change and the deveopment of a professional network, except that the analysis also drew, to some extent, on interviews with adminsitrators and other teachers. In every case teachers were asked in what way they were sharing information about science teaching with other teachers, what other science activities are taking place at their school, what other mathematics activities they would liek to do in their school and classroom, and what supports and obstacles they encountered in using an experiential problem solving approach. The analysis of this data is discussed in Chapters II-V of this report.

**Surveys**

The evaluation research used surveys to collect information across all participants. Baseline surveys were administered to both Cohorts of participants in order to collect information about the kinds of materials teachers used, their teaching strategies, their attitudes toward science and science education and the goals for program participation. A follow-up, summative survey was administered to all project participants in the Spring of 1995. This data provided information about teachers' implementation of a hands-on, inquiry-based approach as well as their leadership activities and efforts to support science education in their schools. They offer a larger programmatic context for understanding

the case study research, just as the case study research offers a more detailed and nuanced understanding of the survey data. The evaluation report integrates the quantitative and case study research on teachers in Chapters III-V.

**Participant observation in program activities**

In order to understand participants' experience in the program, the reserach team attended and participated in program activities, including summer institute and Directed Research Institute sessions.

**Conversations with program staff**

The research team met with program staff over the course of the project. These meetings served a variety of functions: staff updated researchers on program activities, they involved researchers in program planning; researchers and staff discussed preliminary findings from such research activities as the focus group interviews and the base-line survey, and gave feedback on various data collection tools.

**Focus group interview of program participants**

Focus group interviews were conducted in the fall of each year of the program. (See Appendix C for the interview protocol.)

## Appendix B:
## Survey Instruments

**Baseline Questionnaire**

1. Name _____

2. Position _____

3. Please indicate the kinds of programs/organizational structures in which you will teach during the 1992-93 school year. (For example: the PRIME program; a house consisting of 6th, 7th, and 8th Chapter I students; a self-contained classroom of fifth graders within a house consisting of 5th and 6th graders, etc.)

Is the same as the 1991-92 school year? _____ Yes
_____ No

If not, what program/organizational structure did you teach in?

4. Please indicate the grade level(s) you teach; the number of periods of science; and the kinds of students. (We have provided two examples of the kind of response you might make
to this question.)

| SUBJECT | GRADE | # OF PERIODS/ BLOCKS | STUDENTS |
|---|---|---|---|
| Science | 6 | 2 | Regular Ed |
| Math | 7 | 2 | Chapter I |

5a. What science curriculum materials do you use? (For example, AMES, Franklin Institute Science Kits, teacher-made materials, textbooks, etc.)

5b. What do you think are the strengths of these materials?

5c. What do you think are the weaknesses?

5d. What else would you like to have available for your use?

**PLEASE CIRCLE THE FREQUENCY WITH WHICH THE FOLLOWING OCCUR IN YOUR CLASSROOM.**

6. I use a textbook to teach science.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

Comments:

7. My students complete worksheets and/or chapter questions to increase their knowledge of science facts and concepts.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

Comments:

8. My students are involved in scientific investigations, experiments, and/or work with concrete, hands-on science matherials.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

Comments:

9. My students work in small groups to complete learning activities/tasks.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

Comments:

10. I incorporate writing activities (journal writing, learning logs, lab write-ups, reports) with science instruction.

| 1 | 2 | 3 | 4 | 0 | |
|---|---|---|---|---|---|
| Very Seldom | | Seldom | Often | Very Often | Not Applicable |

Comments:

11. I incorporate science activities in interdisciplinary thematic units which may involve language arts, social studies, and/or math.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

Comments:

12. I work with other teachers to develop and teach multi-disciplinary units.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | Not Applicable |

**PLEASE INDICATE THE DEGREE TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS.**

13. I enjoyed science when I was a student.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | Not Applicable |

Comments:

14. I have confidence in my knowledge of science subject matter.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | Not Applicable |

Comments:

15. I have confidence in my ability to conduct scientific investigations.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | Not Applicable |

Comments:

16. In my school teachers share ideas about teaching science

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | Not Applicable |

Comments:

17. My students like science.

| 1 | 2 | 3 | 4 | 0 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | Not Applicable |

Comments:

18. My students demonstrate curiosity about science and the natural world by asking questions.

| 1 | 2 | 3 | 4 | 0 | |
|---|---|---|---|---|---|
| Very Seldom | Seldom | Often | Very Often | | Not Applicable |

Comments:

19. What are 3-4 of your primary goals for your students in science?

20. What are your goals for your participation in this program?

**Follow Up Survey**

1. Name _____School_____

2. Please describe the grade level(s), content areas and type of students you teach.

3. What other roles do you fill in your school (e.g. Governance Council, Leadership Team, House Director, Building Rep, etc).

4. Which summer did you begin your participation in SRL?
   ___1992
   ___1993
   ___1994

5. Using the scale below, how would you describe you level of involvement in SRL?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| minimally involved | | | | highly involved |

6. Which of the following SRL experiences have you participated in?

| | Attended | Provided training or facilitation |
|---|---|---|
| Introduction to Science Inquiry Institute | _____ | _____ |
| Innovative Teaching and Learning Institute | _____ | _____ |
| Directed Research Institute | _____ | _____ |
| Lancaster Retreat (August, 1992) | _____ | _____ |
| Lancaster Retreat (May, 1993) | _____ | _____ |
| Lancaster Retreat (August, 1993) | _____ | _____ |
| Lancaster Retreat (May 1994) | _____ | _____ |
| West Chester Leadership Training (May, 1994) | _____ | _____ |
| Franklin Institute Teacher Overnight (1992) | _____ | _____ |

Franklin Institute Teacher Overnight (1993) _____ _____

Franklin Institute Teacher Overnight (1994)_____ _____

After-school workshops _____(1-2 times)_____(more than twice) _____

Spring/Fall Support Meetings _____(1-2 times)_____(more than twice) _____

**USING THE SCALE BELOW, PLEASE INDICATE THE DEGREE TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS.**

7. Since participating in SRL, my knowledge of science subject matter has increased.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | NA |

Comments:

8. Since participating in SRL, my confidence in my science teaching has increased.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | NA |

Comments:

9. Since participating in SRL, my confidence in my ability to conduct scientific investigations has increased.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Agree | Strongly Agree | NA |

Comments:

10. What changes have occurred in the materials you use in your classroom since you began participating in SRL? What do you use now that's new, what have you dropped?

b. What do you think are the strengths of these materials?

c. What do you think are the weaknesses?

d. What else would you like to have available for your use?

11. Using the scale below, please indicate the degree to which your use of the following classroom practices has been changed by your participation in SRL.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Big decrease | Moderate decrease | No change | Moderate increase | Big increase |

| | | | | | |
|---|---|---|---|---|---|
| a. I use a textbook to teach science. | 1 | 2 | 3 | 4 | 5 |
| b. My students complete worksheets and or chapter questions to increase their knowledge of science facts and concepts | 1 | 2 | 3 | 4 | 5 |
| c. My students work with hands-on science materials | 1 | 2 | 3 | 4 | 5 |
| d. My students design their own investigations and experiments | 1 | 2 | 3 | 4 | 5 |
| e. My students' questions form the basis of science investigations in my classroom | 1 | 2 | 3 | 4 | 5 |
| f. My students work in small cooperative learning groups to complete learning activities/tasks | 1 | 2 | 3 | 4 | 5 |
| g. I incorporate open-ended writing activities into science instruction | 1 | 2 | 3 | 4 | 5 |
| h. I incorporate science activities into interdisciplinary thematic units which may involve language arts, social studies, and or math | 1 | 2 | 3 | 4 | 5 |
| i. I initiate science learning activities outside the classroom (e.g. field trips, library, community experiences) | 1 | 2 | 3 | 4 | 5 |
| j. I use performance assessments in science (e.g. essay, demon- | 1 | 2 | 3 | 4 | 5 |

stration, oral report, art, exhibit, journal, portfolio)

k. My students use technology as part of science learning 1 2 3 4 5

l. I make connections between students' experiences and science 1 2 3 4 5

12. How would you characterize the impact of SRL on your use of hands-on science activities?

___I didn't know much about hands-on science before SRL; I became more aware of hands-on approaches.

___I started using hands-on techniques after participating in the SRL Summer Institutes.

___I was already using hands-on techniques before SRL, but I use hands-on more frequently than before in my classroom.

___I feel more confident about using hands-on techniques as a result of my participation in SRL.

___I began to use hands-on or active learning techniques in other subject areas too, or to do more interdisciplinary teaching.

___Other impacts on my teaching practice (please explain)

13. How would you characterize the impact of SRL on your use of investigative/inquiry approaches to teaching science?

___I didn't know much about investigative/inquiry approaches to teaching science before SRL; I became more aware of investigative/inquiry approaches.

___I started using investigative/inquiry approaches to teaching science after participating in the SRL Summer Institutes.

___I was already using investigative/inquiry approaches to teaching science before SRL, but I use investigative/inquiry approaches more frequently than before in my classroom.

___I feel more confident about using investigative/inquiry approaches to teach science as a result of my participation in SRL.

___I began to use investigative/inquiry approaches in other subject areas too, or to do more interdisciplinary teaching.

___Other impacts on your teaching practice (please explain)

14. What are 3-4 of your primary goals for your students in science?

15. Please indicate which activities you carried out in your school since becoming an SRL. Check all that apply.

a. ___Conducted workshops on issues related to science/science teaching
___with other teachers in my school
___with teachers from other schools
___with teachers from other school districts

b.___Offered one-on-one consultation to other teachers (including peer coaching, demonstration lessons, etc)

c.___Organized a science fair

d.___Inventoried materials for science

e.___Purchased new materials for science (please describe)

f.___Made presentations to raise awareness about hands-on approaches to:
___parents
___other teachers
___others_____

g.___Obtained outside funding or in-kind support for efforts (please describe)

h.___Integrated SRL effort with ongoing initiatives in the school or school district

i.___Distributed a newsletter

j.___Established laboratory facility in the school

k.___Worked with other teachers to develop and teach multi-disciplinary units

l.___Other _____

_____

16. Please circle the one activity above (Question 15) on which you spent the most time and effort.

17. In assessing how your participation in SRL has affected other teachers' attitudes towards hands-on/investigative science, choose the **one** statement below that best characterizes your school.

___Generally, teachers are unaware or resistant to using hands-on/investigative, approaches in science.

___Generally, SRL stimulated teachers/ interest in hands-on/investigative methods and they are beginning to try hands-on methods.

___Generally, teachers are using hands-on/investigative approaches more frequently.

___Generally, teachers are more likely to use hands-on/investigative approaches than other approaches when they teach science.

___Generally, teachers were already using hands-on/investigative approaches but SRL has strengthened and supported this teaching approach.

18. How would you asses the overall impact of SRL in your school? Check all that apply.

___Science has become more visible in the school.

___There are more science materials available for teachers to use in their classrooms.

___Teachers are beginning to use inquiry/investigative approaches in other content areas.

___Teachers are more likely to collaborate.

___Generally, students at my school are more enthusiastic about science.

___Other (please explain)

19. Using the list below, please indicate what kind of role each of these factors played in supporting your SRL team's school-based efforts.

| | Helped | Made no difference | Hindered |
|---|---|---|---|
| a. House structure | _____ | _____ | _____ |
| b. SRL team composition | _____ | _____ | _____ |
| c. Principal | _____ | _____ | _____ |
| d. Other ongoing initiatives in your school | _____ | _____ | _____ |
| e. Other teachers' attitudes toward change | _____ | _____ | _____ |
| f. Relationships with other teachers in your school | _____ | _____ | _____ |
| g. Priority of science in your school | _____ | _____ | _____ |
| h. Teacher networks within school/district | _____ | _____ | _____ |
| i. SRL staff | _____ | _____ | _____ |
| j. Summer institutes | _____ | _____ | _____ |
| k. SRL programing during the year | _____ | _____ | _____ |
| l. Lancaster retreats | _____ | _____ | _____ |
| m. Development of a school-based plan | _____ | _____ | _____ |
| n. Access to additional resources and information | _____ | _____ | _____ |
| o. Development & implementation of a directed research activity | _____ | _____ | _____ |
| p. Other (please explain) | | | |

20. What have been the two or three most important aspects of your participation in SRL? Why?

## Appendix C:
## Interview Protocols

**Site reporting form for Site Visits (1993 & 1994)**

I. School Context

What is the school's student composition?

What is its size/grades/average classroom size?

Are there other programs in the school?

How has the school changed in the last five/ten years?

II. School and Science

What is the historical place of science in this school?

What is the instructional emphasis the principal wants to promote in the school?

How does he/she and other leaders perceive SRL's impact on the school?

How well did the SRL team work?

What have been the impediments to implementing the goals of the SIP?

III. Classroom Practice

What impact has SRL had on classroom practice?

How is science integrated into the classroom?

Do science lessons use: hands-on materials, cooperative learning, surprise; what is student response to the lessons?

IV. Teachers' Professional Development

What impact has TLC had on developing teacher leaders in science?

In what ways are teachers demonstrating expanded interest in science and science teaching?

Are teachers more active science learners and/or more confident about science?

What do SRL participants think they gained from SRL:
*summer institutes

*follow-up sessions
*developing curricular activities
*being on a school team/collaborating with a partner
*being a teacher leader in science

**Fieldwork Guide for Case Study Schools (1995)**

Suggested activities:

- Observations--All SRLs and at least one non-SRL science teacher

- Interviews--All SRLs , at least one non-SRL science teacher, principal and/or assistant principal, SRLs' house director(s).

- Focus Group--Students' of SRLs.

SRL Interview Guide

1. What is your science classroom like this year (what projects have you done, materials have you used, what are your formats for instruction)? How does this fit with your goals for science instruction (i.e. where is your actual practice in relationship to your goals)?

2. What's going on with science instruction in the building this year. (what's new, what have been the challenges, what has been going well)? How would you describe science teaching in the building?

3. In what ways (if any) do you feel you have acted as a science leader in the building this year? What happened (e.g. how did it go, what challenges have you faced, what has been a positive outcome of your efforts)?

4. Who do you talk to about science teaching (What do you talk about, under what circumstances do these conversations come up, what is the outcome)?

5. In what ways (if any) have you been involved this year in SRL activities outside of your building?

6. How would you trace your history as an SRL (in terms of changes in your own practice, leadershop activites inside and outside of the building, participation in SRL program activities)?

Non-SRL Interview Guide

1. What's going on with science instruction in the building this year. (what's new, what have been the challenges, what has been going well)? How would you describe science teaching in the building?

2. Who do you talk to about science teaching (What do you talk about, under what circumstances do these conversations come up, what is the outcome)?

3. In what ways have you observed _____ acting as science leaders in the building?

4. Have you had interactions with any of them about science teaching? What was the nature of the interaction? What was the outcom?

Focus group questions fo students

1. What is a typical science class like this year (What do you do? What does the teacher do? What materials do you use?)?

2. How would you rate how much you like science compared to your other subjects? Why?

3. Of what use (if any) is science to you in your life now, in the future?

4. What makes (or would amke science interesting to you?

5. Did you participate in the science fair this year? Why or why not? What was your project? What did you learn from doing this project?

**Protocol for Focus Group Interviews**

**Fall, 1992**
**Cohort I**

1. What was the most memorable aspect of the summer institute?

2. What would you like to have seen done differently?

3. What are the primary goals in science you have for your students this year?

4. What do you see as the main supports/obstacles to implementing your goals?

5. In what ways do you forsee functioning as a science leader in your school?

6. How did you decide on a school-based plan for your school?

7. What do you see as the main supports/obstacles to implementing your school-based plan?

8. What can the SRL program do to support you during the coming school year?

**Fall, 1993**
**(Cohort I protocol was repeated with Cohort II)**
**Cohort I**

1. What was the most memorable aspect of the summer institute?

2. Compare the two summers in terms of science content, science teaching and science leadership development.

3. In what ways have you been a science resource leader in your school during the past year?

4. How did what went on in your classrom during the year between your first and second summer institute impact on your experience during the second summer institute?

5. What are the primary goals you have for you students in science this year?

6. What is your vision for science education in your school?

7. What was most successful about your school-based project last year?

8. Discuss your experience with the Directed Research Activity.

9. In what ways did you and your teammate collaborate?

**Fall, 1994**

1. What's going on with science in your building?

2. What are the primary ways in which you are functioning as a resource leader?

3. If we wanted to see evidence of your efforts, what should we try to see at your school? Who should we talk to? When should we come?

4. What suggestions can you make for implementing a final survey of all participants? What are the important questions to ask that will help us understand the impact of SRL in middle schools in Philadelphia?

## Appendix D:
## Tables and Charts

**TABLE I: Participating Schools**

| School | Demographics | | | |
|---|---|---|---|---|
| | **Grade Org.** | **# of Students** | **% of Low Income Students** | **Race/ Ethnicity of Students** |
| Case Study School #1 | 6-8 | 235 | Afr-Amer 75.0<br>Asian .04<br>Latino 1.3<br>White 23.0 | 65 |
| Case Study School #2 | 6-8 | 1,311 | Afr-Amer 98.0<br>Latino 1.9 | 92.5 |
| Case Study School #3 | 5-8 | 1,175 | Afr-Amer 28.1<br>Asian .7<br>Latino 66.2<br>White 2.0 | 93.6 |
| Case Study School #4 | 6-8 | 899 | Afr-Amer 99.0<br>Latino 0.2<br>White 0.4 | 67.6 |
| Case Study School #5 | K-8 | 864 | Afr-Amer 15.5<br>Asian 2.5<br>Latino 5.1<br>White 76.6 | 65.1 |

**TABLE II: Summary of Changes Reported in Teaching Practices Summary Survey, Spring 1995**

| | % of Teachers who Report Change in Practice | | | |
|---|---|---|---|---|
| **Teaching Practice** | **Big to Mod. decrease** | **No change** | **Mod. to Big increase** | **N/A** |
| Use of textbook | 69 | 2 | 3 | 7 |
| Use of worksheets and/or chapter questions | 53 | 31 | 9 | 7 |
| Use of hands-on science materials | 1 | 5 | 88 | 6 |
| Students design investigations & experiments | 5 | 21 | 73 | 5 |
| Use of cooperative learning groups | 1 | 14 | 81 | 4 |
| Incorporate science into interdisciplinary units | 1 | 16 | 77 | 5 |
| Use of science activities outside classroom | 1 | 24 | 72 | 4 |
| Use of performance assessment in science | 3 | 10 | 84 | 4 |
| Use of technology as part of science | 3 | 26 | 69 | 3 |
| Make connections betw student exp and science | 0 | 4 | 94 | 3 |

N = 81.

**TABLE III: Summary of Leadership Activities Reported**
**Summary Survey, Spring 1995**

| Leadership Activity | % Participation |
|---|---|
| Conducted workshops for teachers in own school, or other schools, other districts | 82 |
| Offered one-on-one consultation to other teachers | 35 |
| Organized a science fair | 66 |
| Inventoried materials for science | 67 |
| Purchased new materials for science | 77 |
| Made presentations to raise awareness about hands-on science for parents, other teachers or others | 30 |
| Obtained outside funding or in-kind support for efforts | 35 |
| Integrated SRL efforts with ongoing school and District initiatives | 57 |
| Distributed a science newsletter | 10 |
| Established a laboratory facility in the school | 14 |
| Worked with other teachers to develop and teach multi-disciplinary units | 68 |

N = 81.

# REFERENCES


Little, J.W. (1993). Teachers' professional development in a climate of educational reform. *Educational evaluation and Policy Analysis 15* (2), 129-151

Saunders, W. L. (1992) The constructivist perspective: Implications and teaching strategies for science. *School Science and Mathematics 92* (3).

Shymansky, J.A. and Kyle, W.C. (1992). Establishing a research agenda: Critical issues of science curriculum reform. *Journal of Research in Science Teaching, 29* (8), 749-778.

Simon, E. L. (1995). Inquiry-based life sciences for middle school teachers: Evaluation of the Summer Institute July 18-29th 1994. Philadelphia: Franklin Institute

SRL News (1993). Philadelphia: PATHS/PRISM

Useem, E., Buchanan, J., Meyers, E., Maule-Schmidt, J. (1995). Urban Teacher Curriculum Networks and Systemic Change. Paper presented at the Annual Meeting of the American Educational Research Association.