# 'I'M NO LONGER AFRAID TO SAY I DON'T KNOW:' BECOMING SCIENTISTS/BECOMING LEADERS

**AN EVALUATION OF THE**
**TEACHERS LEADERSHIP COLLABORATIVE**
**A project of The Franklin Institute funded by the National Science Foundation**

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# INTRODUCTION

## Overview of the Study

The Teacher Leadership Collaborative, a program of The Franklin Institute, sought to create a network of urban teacher leaders who understand an inquiry, hands-on approach to science instruction and who position themselves in their classrooms, schools, districts, and the larger educational community to promote and facilitate investigative, hands-on science. TLC's focus was on the primary grades in Philadelphia public and parochial schools. Its approach to educational improvement evolved during the course of the program to emphasize a model of professional development for teachers which immersed them in investigative science and supported them in constructing leadership roles for themselves which were congruent with their school contexts and the culture of teaching. TLC explicitly focused on individual schools as important units of change. These program elements make TLC an interesting setting for exploring issues, dilemmas, and possibilities that are central to current educational reform efforts. .

This report discusses what happened during the three years of TLC. It seeks to connect research with practice by addressing the issues critical to sustainable reform suggested by Shymansky 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 TLC involvement on participants, their schools, and school districts. It takes up three broad questions in order to explain relationships between the construction of scientific knowledge in classrooms and schools, the professional development of teachers, and current educational reform efforts which seek to make schools central units of change. Those questions are:

- How do teachers who participate in TLC develop new attitudes about science and the teaching of science and how do they change their classroom practice? What program elements supported these changes?

- What does teacher leadership in science look like at the levels of classroom, school, district, and larger educational community? How does involvement with TLC contribute to teachers assuming leadership roles vis a vis science education? What program elements developed and supported teachers in their assumption of leadership roles?

▲ What impact did TLC have on school science programs? In what ways does TLC's impact on school science programs look alike and different across sites?

Findings from the evaluation research show how teachers, during their participation in TLC, have repositioned themselves in relationship to science and scientific knowledge, to their students, and to their colleagues. It shows how teachers move from being fearful of science and anxious about their ability to teach science to curious investigators of natural phenomena. Early in their change process, teachers begin using hands-on materials and increase the amount of time they devote to science in the classroom. As they do so, students respond enthusiastically and teachers become further encouraged and committed to science. As they continue their immersion into science investigation at TLC activities, teachers begin to shed their preconceptions about what science is and what science teachers should do; they also discard the metaphor of teacher as expert and assume the stance of "I don't know. How might we find that out?" Likewise, TLC teachers approach leadership in their schools as facilitators and resource people rather than experts in science. Their goal as leaders is to make science accessible to colleagues and through them to children throughout the school rather than as experts in science.

**The Context**

In recent years, the pressing issue of a well prepared work force has focused national attention on schooling for success in math, science, and technology. At the current economic rate, considering a peak of retirements in the late 1990's, the need for scientists and engineers will increase. At the same time, the number of American 18-24 year olds is steadily decreasing in proportion to the general population and, by the year 2000, minorities, women, and recent immigrants will account for 85% of those entering the work force (Massey, 1992). The coincidence of these demographics has propelled the nation to consider seriously how to prepare minorities to enter science, math, and technology careers. The challenge is a daunting one, given the condition of urban public schools where the majority of the nation's minorities receive their education. Sims (1992) has documented the "pipeline" problem for minorities in math and science; Selvin notes that underrepresented minorities begin to fall behind in math as early as fourth grade, and that by high school only 20% of African American and Hispanics take Geometry as compared to 40% of Caucasian students. Oakes (1985) argues that minority achievement in math and science is constrained from the start because current tracking systems place disproportionately high numbers of minorities in lower level courses where workbooks and rote approaches to learning are emphasized. She notes that current reform efforts are failing because unequal faculties and facilities remain unchanged.

Research has documented that both elementary teachers and urban schools are often ill equipped to implement an effective instructional program in science. For years, science instruction has taken a back seat to language arts and mathematics as teachers have concentrated on the development of their students' "basic skills." Elementary teachers have been especially uncomfortable with science content; and, as a result, they have spent less time on science instruction. The National Science Foundation study on The Influence of Testing and Teaching Math and Science in Grades 4-12 reported that standardized and textbook tests, which emphasize low-level knowledge "were found to have an extensive and pervasive influence on math and science instruction nationwide" and that this negative influence was more dominant for minority populations (Madaus, et.al., 1992). Likewise, because of unrelenting funding crises, urban classrooms in particular have not had the many and varied materials required for a rigorous and engaging science curriculum.

**The Teachers Leadership Collaborative**

The Teachers Leadership Collaborative aimed simultaneously to improve curriculum and pedagogy and to expand the professional roles of teachers by equipping them to play an active leadership role in their schools, their districts, and the national network of science educators. In order to achieve these goals TLC implemented three kinds of program activities for participating teachers and schools:

▲ Summer Institutes The introductory three week institute, offered to two cohorts of primary grade teachers from the Archdiocese and the Philadelphia Public School District in the summers of 1991 and 1992, immersed teachers in investigatory, hands-on science. Institute participants included a team of two teachers and the administrator from each school. These school teams developed a Science Improvement Plan which served to focus their efforts on strengthening their schools' science programs. During the summer of 1993 more than half of the original teachers attended a follow-up one week institute. At this institute participants delved more deeply into inquiry science and thought about the change process in relation to themselves and their schools.

▲ School Year Activities These activities involved teachers in workshops and conferences ranging from overnights at the Franklin Institute to participation in NSTA conferences to sharing sessions in which teachers presented and traded materials and activities they had used in their classrooms. They served to deepen teachers understanding and appreciation of

investigatory approaches to science, strengthen the emerging collegial network of teachers, and further familiarize participants with change strategies.

▲ Curriculum Development Project The focus of this project was to involve TLC participants in the writing of 'teacher-friendly' curriculum activities which would integrate language arts and mathematics with science. Teachers produced a booklet, Science That's Elementary, My Dear.

In general, these activities reflected the direction laid forth in The Franklin Institute's original proposal to the National Science Foundation. This proposal emphasized a focus on teacher developed curriculum and discussed the need for the integration of science across the curriculum, especially the incorporation of language arts and mathematical tasks with science activities; it emphasized science education that is contextualized. It built on previous work by the Franklin Institute on Museum to Go Kits. Evaluation of these kits had pointed to the need for extensive teacher staff development in how to use them in their classrooms and for the contextualization of kit activities into a larger curriculum framework so that their implementation would not result in teaching and learning that was fragmented and excluded the development of language arts and mathematical skills. (Christman and Simon, 1992)

The NSF proposal called for teachers to develop curricular activities and units that would embed the Museum To Go Kits and other hands-on activities into the larger context of classroom teaching and learning. Although TLC produced Science That's Elementary, My Dear, a booklet of science activities as a culminating project, curriculum development by teachers did not unfold in the way it was originally conceived. Teachers entered the program with very little experience teaching science and most of them had virtually no experience with hands-on strategies. Supporting teachers' development in these areas became very important and postponed attention to curriculum writing. Additionally, program staff, after participating in inquiry science summer institutes sponsored by ASTEC, became compelled to make investigative approaches to science education which included open-ended inquiry a central focus of TLC.

**Evaluation Methodology**

The evaluation of the Teachers Leadership Collaborative used a formative approach and examined both program implementation and impact. It focused on understanding how teachers change their classroom practice and move into leadership roles in schools vis a vis science education and how schools' participation in TLC has enriched their science programs. The study

employed quantitative methods to gather information across all participants. Qualitative research methods provided an in-depth look at the experiences of a smaller sample of teachers and schools. (See Appendix A for all survey instruments, case study field guides, and focus group interview protocols.) The evaluation team analyzed the data to examine change over time in both individuals and schools. The following research activities provided a rich variety of information about TLC.

Participant observation in program activities

In order to understand participants' experience in the program, the research team attended and participated in numerous program activities. We spent two-three days at the 1991 and 1992 summer institutes where we participated in institute activities, led a session on alternative assessment, and provided an overview of the evaluation research and preliminary evaluation findings. During each school year, we attended several workshops for participating teachers; we also participated in planning how to field test the curriculum activities.

Conversations with program staff

The research team met with program staff on a regular basis (four-five meetings per year) over the course of the project. These meetings served a variety of functions: staff updated us on program activities; they involved us in ongoing program planning; we provided feedback on preliminary findings from such research activities as the focus group interviews or the questionnaires from the summer institutes.

Focus group interviews of program participants

We conducted two focus group interviews of participants. The first occurred in the spring of 1993 and included six teacher participants from both cohorts of TLC. The second occurred in the spring of 1994 and included the three teachers who had edited Science That's Elementary My Dear.

Surveys of participants

Participants completed questionnaires at three points during TLC:

1. During their first summer institutes both Cohort I and Cohort II responded to questions about their teaching practice in order to establish a baseline of information about how they had taught science previous to their TLC experience. Twenty-seven out of 28 Cohort I participants responded; 25 out of 28 Cohort II participants responded.

2. In the summer of 1993 participants from both cohorts completed a follow-up questionnaire which asked them questions about how they were currently teaching science. These responses were compared to those of their earlier questionnaires. Nineteen participants from Cohort I completed the questionnaire; 25 participants from Cohort II.

3. In the spring of 1994, questionnaires were mailed to all participants. This questionnaire asked participants questions about their teaching practice, about the ways in which they had assumed leadership roles in their buildings and across the district, and about the status of the science improvement plan they had developed during their first summer institute. Thirty-one participants (27 teachers and 4 administrators) responded to this survey.

Case study research

The research team conducted field visits to eight TLC schools, four Philadelphia public schools and four archdiocese schools. We used a stratified sampling process in order to get a range of schools that were representative along the following dimensions: public/ parochial schools; the year the school entered the program (1991: Cohort I; 1992: Cohort II); racial/ethnic and socioeconomic characteristics of students; size of school; region of the city; degree of school's involvement in science education innovations. Table 1 in Appendix B provides information on the demographics of each of the case study schools and indicates a schedule of the visits. During the site visits we interviewed the members of the TLC team (the principal and the two teachers), observed in the TLC teachers' classrooms, interviewed non-participating teachers, and on several occasions, observed school wide activities such as faculty meetings, science fairs, etc. We also reviewed the teams' science improvement plans and other school documents.

## II. RECONSTRUCTING CLASSROOM SCIENCE

*My problem kids are the ones that are more attentive [in science]...because it's okay to be wrong. I'm just going to find out why I'm wrong. So it's okay that my plant didn't grow, because I didn't do such and such....if I mispronounce a word it's not good, but if I do an experiment wrong I can learn from that, so they are [willing] to take chances.* (Public school teacher, 5th grade)

*Since I've been involved in TLC I think, I know that the greatest thing that has happened to me is I have not become more scientific, but I have become the science lady. And I am no longer afraid to say to the children 'I don't know, let's look it up.'...I think that I was always afraid to admit to them that I didn't know everything* (Archdiocese school teacher, 2nd grade).

*I want my students to look at something--to really look at something--and to observe the qualities. And I want them to make some questions up about it and look at it in a different way. Not just take it at face value.* (Public school teacher, 1st grade)

*Last year we did some things on wild animals and made a jungle. We had poetry and we had these wonderful little puppets and animals out in the hallway and we made it look like a jungle. But that was it. What we didn't know was what a jungle was really supposed to be. This year we went and found out about what jungle conditions actually are. We investigated. So I find that I'm going into science through the other subject areas too. I emphasize science wherever it comes up. It's not always about adding a writing assignment to a science activity.*(Public school teacher, 1st grade)

*Children who cannot read or write very well yet are becoming stars with bright smiles on their faces. A child can be a real behavior problem during social studies, but during science the child has something that he can get involved in, something that he's thrilled about.* (Public school teacher, 2nd grade teacher)

This chapter takes up the evaluation questions: **How do teachers who participate in TLC develop new attitudes about science and the teaching of science and how do they change their classroom practice? What program elements supported these changes?** As Philadelphia schools have confronted the task of developing experiential, classroom-based science in primary school classrooms, TLC has played a crucial role in helping classroom teachers gain content and pedagogical knowledge, getting teacher materials for science instruction, providing access to local and regional resources for science education, and developing an inquiry approach to science among TLC participants.

**Where the work begins.**

Before their involvement in TLC, little science was being taught in the classrooms of TLC participants. As reported in baseline surveys, few teachers had access to hands-on science materials or the confidence to use these materials even if they were available. When these primary teachers did teach science, it was often from outdated textbooks, and their students still lacked the opportunity to explore, observe and develop explanations about natural phenomena in the real world. As one teacher wrote in her 1994 follow-up questionnaire,

> Three years ago science in my classroom was a memorization of facts. I dwelled on reading because I figured if they can read, the children can look it up. Today science is an integral part of our day.

Data collected over a three year period demonstrate that over time teachers made substantial changes in their teaching practice as they became increasingly involved with the pedagogy introduced to them through TLC. Primary school teachers involved with the project reported that their students loved hands-on science activities and became involved with the natural world in new ways. The high level of student excitement and engagement encouraged teachers to teach more science, find more opportunities to bring science into their classrooms, and redefine the meaning of science for themselves.

This research shows that TLC participants were teaching more science, using more hands-on science materials, integrating science with other content areas, and using more thematic units. Furthermore, as these teachers became more committed to teaching science, they began to feel comfortable enough taking the risks in their classrooms that were necessary to involve their students in open-ended discovery and investigation of the natural world.

**Teachers are teaching more science.**

A comparative analysis of the teaching practices of TLC teachers shows that the amount of time spent teaching science increased for all teachers (Appendix B; Table 2). In both public and archdiocese schools, teachers attributed their new commitment to teaching science to student excitement stemming from the approach teachers learned in TLC. In focus groups, interviews, and post program surveys, teachers reported enthusiasm in science that they did not see in any other subject area. According to one teacher,

> When we have extra time I teach science in the classroom, we are not required to teach it as classroom teachers because of the science teacher, but we do it as an extra. My children like it. Can we have science today? It's like a treat. And they really love it.

According to another,

> Three years ago science in my school was the subject canceled when there was a need to cancel a subject. Now this is not the case. Today science isn't the subject taught on Monday, Tuesday, and Thursday at 2 p.m. It's recognized by students across the curriculum. Therefore, whenever the need arises for inquiry or investigation the time is given for that purpose.

In addition to an overall increase in the amount of time spent teaching science, Table 3 in Appendix B shows that the increase of time spent on science was particularly important for archdiocese teachers. Before participating in TLC, 50% of archdiocese teachers spent less than 60 minutes a week teaching science and only 8% spent more than 120 minutes teaching science. In contrast, after participation in TLC, almost a third (32%) of the archdiocese teachers spent over 120 minutes a week on science.

One Archdiocese principal explained how this change took place, "As a Catholic school [we] don't have the money for materials. The TLC program offered materials, the teachers got excited, came back and wanted to do more science." "TLC made me think about science more, and try more hands-on activities," another teacher explained, summarizing the experience of many archdiocese teachers.

In public schools, the amount of time spent on science has also increased as the responsibility for teaching science shifted from science specialists to classroom teachers. One teacher explained,

> Before TLC our science instruction was given only from [a] science teacher. We depended on the science teacher to teach the entire curriculum. Today science is taught by more classroom teachers...I teach science to my class with the science teacher supplementing my lessons.

Another public school teacher reported that her students are getting "double science" because she teaches for a longer period than the science specialist, and the students enjoy science more because the science specialist does not provide enough materials for all the students to manipulate.

In addition to teaching more science after participating in TLC, a comparison of baseline surveys and 1993 follow-up surveys indicates that the longer teachers have been in the program, the more science they teach. One third of the teachers who were with the project over a two year period spent more than 120 minutes a week on science.

Several observations indicate that in classrooms in which teachers spend more than two hours a week in science, students are involved in science projects which last over many weeks and in multiple science projects with overlapping themes. For example, in one classroom during one class period, we observed students engaged in different phases of three projects revolving around the observation and description of plant life. These activities included experimenting with growing conditions of squash plants, observing and describing terraria, and comparing the characteristics of plants and animals. In another classroom, students completed their final observations of their terraria during the same class period that they were in the middle of observing, researching, and writing about silkworms. The richness of science activities in classes such as these two suggests that as teachers devote more time to science, they not only teach more science, but they teach science in more complex and richer ways.

**Teachers use new teaching practices in their science classes.**

As shown in Table 4 (Appendix B), participation in TLC increased teachers' likelihood of involving students with hands-on materials in groups, integrating mathematical and writing tasks with science, and using thematic approaches which provided students with opportunities for coherent, contextualized learning. As with the increases in time spent teaching science, this data indicates that these changes occur over time. The longer they are involved in the program, the more consistently teachers engage in the practices supported by TLC. According to this data, over 90% of the teachers who began in 1991 used hands on activities, combined math and writing skills with science, and used thematic approaches "often" or "very often." In contrast, teachers who had only been with the project since 1992 had increased their use of these practices, but not as dramatically.

Observations and interviews with teachers confirm that most, if not all, participants have incorporated hands-on science activities into their classes. As teachers become more interested in using hands-on materials in their classes, they use more of the materials provided by the Franklin Institute and begin to gather more of their own. As one of the archdiocese teachers explained,

I guess that the most important thing that has happened is that I'm definitely more open to hands-on science, than I was in the past since I've had so many positive experiences here last summer.

During site visits we observed teachers bringing in vegetables to teach about food and plants; eggs, to demonstrate the parts of an egg; seeds and potting soil for planting; apples for a lesson on estimation; popcorn to teach about taste; popsicles to demonstrate melting. A first grade teacher boiled vegetables to make dyes for a lesson that linked social studies (Indians), growing (vegetables) and crafts (the class dyed tee shirts and painted clay pots). "Last year I never would have tried this lesson with vegetable dyes," she told us. Many teachers taught metamorphosis using the silkworms they received in a TLC workshop.

Teachers have also integrated hands-on materials into existing science curricula. One teacher demonstrated an AIMS lesson on estimation and sorting with colored candies and plastic sandwich bags. A special education teacher incorporated dry cells, wires and light bulbs into a lesson on systems and subsystems. A TLC teacher procured bottles of fruit flies to teach the SCIS unit on metamorphosis.

Survey data and observations also show that teachers have integrated science with other subject areas in three ways. First, teachers are integrating reading, writing and math tasks into hands-on science activities. Teachers find they can teach measurement when students grow plants, read about Indians when they make vegetable dyes and write when they describe the classroom iguana. A play about conservation promotes memorization and presentation skills in second graders. A lesson on estimation suggests to a teacher a book about winter and melting in the first grade.

Second, teachers begin to see science and science concepts in language, math or social studies lessons. According to one teacher, "You don't look for science in reading. But sometimes it's just staring you in the face, like kicking you, so you do it. So I never looked for it before and now I look." A reading textbook that contains a recipe for pickles yields a demonstration of how brine transforms cucumbers. A class making piñatas for its unit on Mexico writes "laboratory reports" that list the sequence of steps and describe how materials changed when they dried. "We graph everything," a kindergarten teacher observed. "We have a lot of little toys and we graph and sort."

Finally, a growing number of TLC teachers have also learned how to design a thematic unit around science. "I am learning theme learning," a teacher reflected. "It's just starting to click how to carry a theme through." These units engage students in many related activities and often draw in other classes and parents. For example, in one school a first grade with an incubator and fertilized eggs learned about sexual reproduction as well as counting while they waited for the chickens to hatch. The second and seventh grade turned the eggs daily and produce a slide show on the computer about embryology. The parent group contributed by raising money for the incubator and by accompanying the class to the zoo.

**Teachers are beginning to value inquiry in science.**

In addition to changes in particular teaching strategies and the development of thematic units, the ethnographic data indicate that over time, and with experience with hands-on experiential activities, teachers will become more likely to engage their students in discovery learning and inquiry in science. In contrast to our January 1993 interim evaluation report which found that teachers were not developing inquiry lessons in science, more recent ethnographic data indicate that when teachers are involved with TLC over a number of years, they <u>do</u> implement inquiry approaches within their classroom. For example, at a focus group conducted during the spring of 1993, teachers discussed their goals for their students in learning science. Some mentioned goals like having fun, enjoying science, and feeling positive about themselves as scientists; others explicitly talked about the importance of inquiry, discovery, taking risks, and making mistakes.

Site visits after teachers were in the program for two years also support the view that extended involvement with TLC leads to more depth and exploration in science. One parochial school teacher told us during her second year teaching science to kindergarten students, she was more comfortable and willing to try things even "if it felt uncomfortable" or if she didn't know what to expect. She has used caterpillars, butterflies, and plants and has modified one of the Franklin Institute kits on "Growing Up" to meet the needs of her kindergarten students. Even a lesson on brine shrimp which was "unsuccessful" was a "good lesson" because she got kids to think about "why it might not have worked."

At another archdiocese school, the evaluation team noted seventh grade students' intense involvement with their science fair projects during their teacher's second year with TLC,

> Except for one table (the beans) the room is really active. The kids argue about what language to use to describe the process, who thought of the idea, who should do the actual writing. But they all know what a hypothesis is, and they can all explain what their project will demonstrate and they all seem invested in it; after all, it was their idea.

At a public school, we observed students' equally intense exploration of the life cycle of silkworms. Beginning with a detailed review of the previous days' observations, the students described "a web" which looked like "a skinny piece of cotton wrapped around" and "a yellow puddle of water" that "made the web yellow." After they observed the silkworms again, the students opted for continuing science instead of going out to recess and began formulating hypotheses about how to determine the sex of silkworms. For example, they asked if an x on its forehead could show whether it was male or female? Other questions also arose: Why were some of the silkworms were crowding up next to each other? Were they interfering in the spinning process or could they be choosing mates? The teacher, who was as interested as the students, provided a structure for the students to develop and explore their questions about silkworms. The classroom structure allowed the students to go through the complex process of observing, writing their observations in their daily log books, and then using printed materials and further observation to produce collaborative research projects and creative stories about the silkworms.

At the focus group held in the spring of 1993, teachers explained some of the ways that their changing attitudes about science had allowed them to move into new types of inquiry and discovery in their classes. They exchanged tales of the challenges they and their students faced as they incorporated science, and especially living things, into their curriculum.

According to one teacher,

> You know, you talk about the kids being a bunch of wimps and not wanting to touch something, well I was one. You know, I never would have pictured myself standing over a fish tank popping gravel out of a fish. We have a joke that I did the Heimlich on the fish in my room.

Teachers also stressed that learning to take risks and ask questions also helped their urban students appreciate the natural environment. As one of the principals told us, "It's hard for our students to understand the concept of the environment." However, as teachers and students learned to deal with messiness and uncertainty, they also learned to appreciate the world around them. For example, one teacher shared her students' interest in pigeons on a class picnic,

> Instead of bombing the pigeons ---which is what they normally do when they are together---they were taking the crust from sandwiches and feeding them very nicely. And then they stood their and they watched the pigeon and when the pigeon went to the bathroom and they said, ooh, that's gross." And we talked about it like when we had the chicks, you have the chick in your hand, there is a possibility that it's going to go, and all living things do that; and they are not grossed out any more.

This data suggests that as teachers become involved in hands-on science activities, they eventually become more comfortable making mistakes and trying out new things which lays the basis for their students to also become involved in more in-depth and open-ended processes of scientific investigation. While changes in science teaching were spurred by teachers' initial participation in TLC, it appears that deeper changes come over time as teachers learn that students, even problem students, become excited by science and develop respect for the environment and gain new interest in the world around them.

**The TLC program supported pedagogical change in multiple ways.**

TLC encouraged and supported teachers as they changed their attitudes toward science and science education in several ways. First, TLC activities engaged teachers in science activities that they understood and enjoyed. "I avoided science in college whenever I could," one teacher observed, "but at the museum, I was pushing aside children to see the exhibits." "You can't teach something if you don't have a grasp of it yourself," another teacher explained; "I think teachers need more background." TLC gave teachers background and got them excited about science. "The best thing was making hot air balloons in the rotunda," a teacher reported, "where regular patrons of the museum were standing and watching us. When they worked, we were like little kids."

TLC exercises also convinced teachers that they could teach science in the primary grades. "I never would have believed you could set up a wave bed in your classroom," a teacher said at the end of the summer workshops. "What I got from TLC was self confidence and the ability to want to try," another teacher reflected.

Second, TLC made materials and resources for teaching science accessible to primary school teachers. The program engaged teachers in experiments designed around everyday, affordable objects such as sand, food coloring and earthworms. In addition, every TLC team received a Franklin Institute Museum To Go kit, which contains supplies of manipulatives, as well

as training in using the kit. TLC also encouraged teachers to have fun with materials, even--or especially--if they got dirty or wet or spilled dried beans or touched a worm.

Third, TLC provided access to the rich resources for science education in Philadelphia as well as providing opportunities for professional development outside of the city. For example, one teacher acknowledged that she hadn't been to the Franklin Institute for years, but revisited the museum with a relative following her first Summer Institute. A principal commented that he hadn't known that there was anything like the Schuylkill Valley Nature Center so close to his school. Other teachers arranged for their students to participate in the SVNC's science competition or got them free passes for the New Jersey State aquarium in Camden.

In addition to familiarizing teachers with local resources, TLC connected teachers to statewide and regional resources. TLC paid tuition costs for many participants to attend the state conventions for science teachers. Teachers reported great excitement from the demonstrations they witnessed, materials they collected and science education professionals they met.

Finally, TLC focused on the importance of discovery and inquiry in science, and this aspect of the project deepened with time. During the 1991 Summer Institute, participants were excited and involved in hands-on experiments, and TLC staff talked to the participants about the importance of open-ended investigation. By the 1992 Summer Institute, the TLC staff realized that teachers themselves needed the experience of devising their own investigations rather than following a set of instructions for an experiment. That summer, the participants had a chance to design experiments about growing conditions for plants. During the summer of 1993, the room for applying discovery methods was even wider as the participants explored several areas in depth during three half-day sessions and picked their own area of interest for further investigation.

During these investigations, the participants had a chance to explore and pose problems about and investigate bubbles, balls and ramps, and pill bugs. In addition, staff and participants had a chance to talk about issues related to the pedagogy and practice of inquiry in the classroom. These included discussions of how much direction to give during exploration and discovery, how much students should be left to make their own interpretations, and the relationship between scientific investigation and the unarticulated, but implicit questions about the natural world that often underlie children's play activities. TLC participants also raised crucial questions about how in-depth investigation can realistically be a accommodated within the constraints of a school day. These contextualized conversations provide one example of the way that TLC enabled primary

teachers to being addressing the complex issues that are raised by an inquiry approach to classroom science.

## III. BECOMING TEACHER LEADERS

*Participation in TLC has enabled us to help our fellow teachers to feel more confident about handling science in their classrooms. Though we're not officially 'science specialists,' teachers feel they can ask us for ideas, equipment, or advice (Public school teacher, Third grade).*

*I'm going to give them lessons that match with the curriculum, two per grade level per marking period, two ideas you can get the day before and have the materials on hand* (Public school teacher, first grade).

*As Science Coordinator, I am in charge of ordering books and publicizing workshops and "keeping them on their toes so they don't slip." I send them Franklin Institute kits and badger them until they use them. They would like me to come into their class and use it because they are afraid of failure. I tell them I don't know anything more about science than before I went to the Franklin Institute. Once they use the kits, when they see the simplicity of it, I have a convert* (Parochial school teacher, 1st grade).

This chapter takes up the evaluation questions: **What does teacher leadership in science look like at the levels of classroom, school, district, and larger educational community? How does involvement with TLC contribute to teachers assuming leadership roles vis a vis science education? What program elements developed and supported teachers in their assumption of leadership roles?** Developing teacher leadership in science education was one of the major goals of TLC. One of the major thrusts of current educational reform efforts is the expansion of teacher roles and responsibilities from narrow and routinized classroom roles to broader leadership roles within the larger school context. However, the existing culture of teaching is based on informal and egalitarian peer relationships and the meaning of teacher leadership in this context is still largely unexplored. Furthermore, within TLC, teachers also had to negotiate the ambiguities of peer leadership within science education, a field that is traditionally seen as an intimidating province that is accessible only to specially trained experts.

TLC participants negotiated these ambiguities by stressing the accessibility of science and developing collaborative relationships as they took on a number of leadership tasks. These tasks included helping other classroom teachers gain content and pedagogical knowledge, providing access to materials for science instruction, and coordinating classroom activities with a schoolwide science curriculum and whole school science activities. This research suggests that understanding how teachers develop roles as peers leaders requires a new way of thinking about expert knowledge and a deeper understanding of how collaborative leadership interacts with formal leadership roles.

Within their schools teachers have been able to construct a leadership role that is based not on "expert knowledge" of science or science education, but is based on skill and willingness to make science more accessible to other teachers and students, and to the school community at large. The leadership role of TLC participants included both "formal" leadership activities such as curriculum planning and staff development and "informal" leadership activities such as one-to-one consultations (See Appendix B Table 5). In spite of growing interest in inquiry and discovery methods in their own classrooms, few of the TLC teachers' school level leadership activities focused on the importance of inquiry approaches in science; rather they stressed the ease and accessibility of hands-on science to primary teachers and students. As one teacher explained,

> These [activities] helped bring hands-on science activities into classrooms where teachers wouldn't ever have tried them if they didn't have someone to walk them through the lessons/experiments and show them how easy and wonderful they really are.

Because they have stressed access to science and avoided the role of "science expert" within their schools, TLC teachers have been able to provide ongoing support, generate interest, and create a science-positive milieu. Although they do not emphasize inquiry and discovery methods in work with their colleagues, TLC teachers do create an environment which encourages other classroom teachers to take the risks associated with scientific experimentation. Furthermore, while they play down their own expertise within their schools, at the same time TLC teachers are becoming more comfortable with science education and pedagogy and are becoming part of a citywide network of science educators.

**One-on-one consultations were the most important leadership activity at the school level.**

Informal sharing was the most common type of leadership described at the eight sites visited by the evaluation team. In the surveys, this was also highlighted more often than any other as an important activity and one which was likely to continue in the future. At all but one of the schools that we visited, teachers mentioned the impact of informal discussions about science teaching and science materials. For example, one third grade teacher, who did not lead any formal staff development sessions, did share every science lesson with her friend across the hall who was also a third grade teacher. At the time of a December site visit, these two teachers had already done "ooblik", swirly soup, chromatography, and were currently working on "properties."

In addition to sharing ideas and lesson plans, TLC participants often shared materials with their colleagues. For example, one parochial teacher reported that "several teachers have stopped in to look over the AIMS information and activities from the Franklin Institute. Other teachers used the energy information I picked up from the [science teachers'] convention."

Many teachers felt that one-on-one consultations were especially important because of their colleague's fears about teaching science. For example one explained why one-on-one consultations were the most importance aspect of her leadership role,

> I felt it was important for other teachers to work with one of their peers - not a specialist or scientist. Motivating, and calming the fears of the teachers produced exciting activities taking place in classrooms of teachers who had once hated science.

Similarly, another explained,

> During this year, I passed on more information, one-on-one informally with teachers than in a large group. Word-by-mouth was a much better route to positive hands-on activities because it was non-threatening and the other teachers wanted the information, compared to me wanting to give information whether or not they were ready to hear it.

**Workshops legitimized the role of science in primary classrooms.**

Ten teachers, in three of the parochial schools and two of the public schools where we conducted fieldwork, led formal staff development sessions as well as disseminating information informally. Like the one-on-one consultations, these workshops generated a high level of interest among the school faculties. According to one public school principal who had attended the summer institute,

> My interest was sustained. The two teachers kept me involved also. In those cases I'm a learner like everyone else in the workshop.

At an archdiocese school the principal told us,

> The TLC teachers gave a workshop. Their enthusiasm was obvious. The other teachers signed up for Franklin Institute staff development to use the kits.

In general, staff development sessions initially focused on particular activities and motivated other teachers to try them out. For example, at one school a teacher who had not been

a TLC participant reported that the two TLC teachers gave a demonstration on "pennies" to other teachers. She said that it was a good exercise, the TLC teachers showed it was "doable" and she had in fact, tried it.

**TLC teachers planned curriculum and increased the availability of resources for science education.**

As TLC teachers became more involved with science education and pedagogy, their activities often became tied into broader curriculum initiatives. In several schools, staff development workshops were tied into science fairs. At other schools, leadership around science was connected to schoolwide movement toward thematic units and integrated language arts. For example, at one parochial school a TLC teacher presented a workshop on integrating language arts and science while the other teacher informally talked about her thematic lessons on popcorn and yeast over lunch with her colleagues.

In addition to sharing information informally and conducting staff development workshops, TLC participants we visited were involved in the development of schoolwide science curriculum, materials and activities. In two of the sites, TLC participants were officially appointed science coordinators, and the coordination of curriculum materials and activities was mentioned at all the schools that we visited. At both public and parochial schools these types of leadership activities included inventorying existing resources, organizing the use and distribution of Museum to Go Kits, providing other easily accessible hands-on science materials, and developing curriculum guidelines for teachers to integrate hands-on materials into a coherent science program. For example, at one of the parochial schools, the TLC team, together with the science coordinator, is organizing the materials and using the booklet produced by TLC participants as a guideline.

In addition to these types of activities which span the public and parochial schools, there are some differences in curriculum development and materials preparation among public and parochial schools which reflect the differences in the two contexts. While several public school teachers are involved in team teaching of math and science and in writing grants for special materials or projects, several TLC teachers at parochial schools are working with their principals or science coordinators on developing science laboratories and replacing their antiquated science textbooks. Finally, at parochial schools, TLC teachers were key in getting their peers to participate in an archdiocese training program to use the Franklin Institute kits.

**Developing "non expert," inquiring leadership.**

Even as teachers moved into schoolwide leadership roles, they often downplayed their own impact and attributed their ability to influence other teachers to their own lack of expertise. For example, at one school, where the TLC teachers had given a faculty workshop, had provided materials and ideas informally, and had created an activity for the curriculum development project, the teachers continued to stress the role of the science coordinator as the "expert" who really knew a lot. When asked if she was a "teacher-leader," one of these answered, "Not particularly. Everyone in the building gets along well already. They may come to us about science, but most go to [the science coordinator]. "

Even at the schools where teachers had moved into clearly identified leadership positions as they made science fairs central to a schoolwide focus on scientific experimentation and inquiry, the TLC teachers downplayed their expertise and highlighted the commonalties between themselves and the other teachers in their schools. At one of these two schools, the principal reported that the TLC participants had put science on the agenda of the faculty meetings, were involved in grant writing and schoolwide curriculum projects. At the same time, we wrote in out field notes that "[One of the TLC teachers] insists that [both team members] know how to explain the project to teachers because they're just one step away from learning themselves."

In spite of their reluctance to claim a leadership position, many teachers expressed pleasure and pride in their newfound abilities and attributed their skills to participation in TLC. For example, during a December, 1992 site visit, one teacher expressed some apprehension when her principal told her that their school was going to depend on her more. The science teacher was out on disability, so the principal sent the substitute to the TLC teacher for ideas. According to this teacher, "It's scary, but it's challenging." Eighteen months later, she noted in her follow-up survey,

> I am now a science resource leader...The main thrust in improving our school's science program is the influence on colleagues...I teach science to my class with the science teacher supplementing my lessons.

Another teacher who had received a grant to give short workshops to expand on the science activities in her school also explained the change in her own attitude after participation in TLC,

> Recently, I applied to the Office of Curriculum Support writing position for science. While still too new in the school district to have a fair chance in the role of curriculum writing, I am proud of the fact that I have the confidence to do so anyway.

Still another participant reflected the TLC's profound impact on participants sense of themselves as capable science educators in a final comment on her follow-up survey,

> I would I would like to see TLC continue with former TLC's in leadership/training/co-teaching positions.

**TLC participants are taking on new roles within a citywide network of science leaders.**

At the citywide level, as at the school level, TLC participants are engaged in both informal and formal leadership activities. Informally, TLC has provided a rich opportunity for primary school teachers to share and support each other, especially across the boundaries of the parochial and public districts. At most of the schools in the sample for the site visits, teachers mentioned the value of getting to know their colleagues at other schools. Teachers told us that they enjoyed the follow-up meetings held during the school year since "it's nice to see everyone and people bring in good ideas." One public school teacher talked about a tie-dying project: "[the parochial teachers] said it was a good way to start off the year and it was." Sharing also included ongoing forms of support. One teacher told us that it was "hard to experiment at the beginning," but she spoke to one of her colleagues at another parochial school on a "regular basis." Finally, sharing included sharing information about the most important schoolwide projects these teachers undertook, science fairs. The science coordinator at a school with one of the most successful science fairs told our research team that she had gotten all her ideas about how to do the science fair from a public school teacher at a TLC follow up workshop and in turn hoped to present slides of her science fair to her TLC colleagues.

Teachers also participated in formal leadership activities such as leading workshops at Franklin Institute Overnights and the three Science Saturdays at which TLC participants shared their own knowledge and ideas. This has encouraged several TLC participants who are currently planning to present workshops at regional and national meetings of science educators. Furthermore, as the funding for TLC drew to a close, TLC participants expressed interest in establishing an ongoing teacher network and have organized a steering committee to make sure that the TLC network is maintained.

TLC teachers also reported in the 1994 follow-up questionnaire that they are participating in many other activities outside of their own schools. These include activities like judging science fairs at other schools, giving science workshops to teachers from other schools, and serving on district science committees.

**The process of curriculum development and writing highlighted the ambiguities of peer leadership in science education.**

One of the major leadership activities of TLC participants was the production of a science guidebook for elementary school teachers "written in order to provide "non-science people" with the opportunity to become teachers of science" (from Science That's Elementary My Dear!). The curriculum project was launched and funded by TLC, but the shape and content of the product was determined by the knowledge and experience of elementary school teachers. TLC participants contributed hands-on science activities, developed criteria for good activities and write-ups of activities, field-tested the activities, and compiled and edited them to create the finished product, Science That's Elementary My Dear!

Discussions with staff, observations of curriculum task force meetings, and a focus group with the curriculum writers all indicated that the curriculum development project encapsulated several conflicts teachers faced as they moved into new roles of leadership within TLC. In the first place, the curriculum development project demonstrated discomfort with the role of "science expert" among TLC participants. Although about half of the TLC teachers eventually contributed activities, the staff and the teachers who were the most involved in the process were surprised at the slow pace of contributions and the small number of contributions. In addition, teachers were hesitant to act as field testers of each other's work because they didn't feel right evaluating the activity. According to one of the curriculum writers, "[Other teachers] thought they didn't know enough or didn't want to judge the [teacher who wrote it]."

At the same time that they were hesitant to act as "science experts", TLC participants grappled with conflicting desires to develop the type of curriculum that reflected their own teaching needs and the type of curriculum that they thought would be most appropriate for primary teachers who were inexperienced in teaching science. This conflict often focused on the contrast between developing thematic units and presenting discrete hands-on activities. For example, this occurred when TLC participants brainstormed the criteria for good hands-on activities. On the one hand, criteria like "being foolproof" and "able to do with minimal preparation" stressed simplicity that seemed important for making science easily accessible to new

teachers and teachers who had not taught science before. On the other hand, criteria like "links to various curriculum areas" and "expansions and connections suggested, described, and developed" seemed important for stressing conceptual richness.

When representatives from Cohorts I and II met together to first discuss plans for the curriculum, differences in their expectations emerged. Cohort I teachers explained that their immersion was that they were to submit a single activity for the curriculum project. Cohort II teachers, who had more experience with units during their summer institute, expected to write thematic units or at least activities which would span a two-three week period of time.

The curriculum writers themselves debated what the book should look like, finally deciding that it should be composed of straightforward activities, rather than thematic units since field testing showed that teachers judged activities on the basis of "was it easy or hard to use." In the focus group, the curriculum writers explained that "a teacher who is not teaching science would be more likely to go to the book and use an activity instead of [for example] a unit on apples" and that "teachers who don't teach science would have taught around the science part of the theme."

Subsequent reaction to Science That's Elementary, My Dear confirms the sense that its ease and accessibility makes it attractive. At the TLC meeting where it was distributed, teachers reacted to it with enthusiasm. Teachers suggested using it as grade group and faculty meetings, as a springboard for telling people how they can tap into resources, and as a hands-on teaching guide for new teachers.

Site visits indicated the curriculum guide will indeed be used because of its accessibility. For example, at one school that was visited shortly after the curriculum was distributed, the TLC team planned to integrate Science That's Elementary, My Dear into the science curriculum as a supplement to the textbook. According to these teachers, this is especially important for new teachers because the hands-on activities included in the textbook are "too complicated."

Both the process and the product of the project strongly enhanced the professional identity of those who participated in it. Focus group participants said that the product was "a validation for people who put time in on this," "built confidence among the fold," "felt like their book," and helped them "feel more expert." It also helped the participants develop a more sophisticated constructivist understanding of science education. Participants described themselves as "more willing to try things" and began to "feel more expert." One stated that, "we already knew a lot of

this stuff, why should I be intimidated? Science is not any big secret. You realize that there is so much that you know."

**TLC supported teacher leadership in multiple ways.**

As indicated above, many teachers attributed their changing leadership roles to their involvement in TLC. According to one of the administrators we interviewed, a former science resource teacher,

> TLC presented a tremendous opportunity for teachers who were shy about presenting to other teachers. It gave them confidence in presenting and trying new things. Other teachers got curious. [They] can make the case that it's feasible to teach science and it works...One of the best activities was the lunch for the teachers in the Board room. It gave them the message that they were special, something teachers rarely get. The teachers also got real science experiences, especially the field trips to the Environmental Center. They did science and got excited about it and learned lessons that they could easily plug into the SCIS curriculum.

Support for teachers in expanding their roles out of the classroom and into schoolwide leadership positions was built into TLC in many ways. Design elements that were built into the program included the requirement that schools be represented by teams made up of teachers and principals, the development of Science Improvement Plans by each team during the summer institutes, and specific activities in leadership training. Flexibility and respect within the project were also critical program elements which contributed to teachers' understanding of a collaborative model of leadership.

The importance of team organization to provide support was apparent in the sites that we visited. For example, field notes from one of our site visits include the following comments about the TLC team. According to the principal, "the team had a wonderful time together. They talked a lot and appeared to be in synch." The classroom teacher on the team, "liked being on a team and having a chance to collaborate [with her partner]." According to the other team member, who is a math specialist, "it was good to be on a team, to have somebody to bounce things off. And it's critical to have the principal's support."

School improvement plans developed by the teams provided a useful focus for the activities of the leadership teams. These plans were a specific tool and exercise that encouraged teachers to work as a team, think programmatically about their schools, and to identify arenas in which they could effectively intervene. In all the sites that we visited, TLC participants, usually in

conjunction with team members, were continuing to implement aspects of their plans such as staff development, inventorying resources, and setting up science labs.

One team, which had been unusually successful in implementing their plan, provided the following written self-evaluation during a follow-up TLC seminar. This evaluation demonstrates both the value of the SIP as a guide for thinking about leadership activities and the collaborative nature that often characterized TLC leadership teams (emphasis added).

> Objectives were carried out. We provided staff development and resources to teachers for Science Fair. There is still some reluctance on our teachers' parts and Science Fair response was somewhat disappointing. So we have planned a more involved kind of staff development in science for primary teachers in Sept. 1992. We will also have a "timeline" for preparing for the Science Fair in December.

In addition to the team structure and the science improvement plans, TLC staff supported the development of teacher leadership through providing training and experience in leadership skills, many in response to suggestions that were made by participants in their evaluation of the 1991 Summer Institute. These opportunities included follow-up seminars on topics like "How to lead workshops," opportunities for TLC participants to lead workshops, and the curriculum development project. Program staff also encouraged the participants to think of themselves as change agents and to think about obstacles to change. Finally, throughout the project, participants were treated by the project staff as colleagues with their own areas of skill and expertise.

## IV. MAKING SCIENCE ACCESSIBLE TO THE WHOLE SCHOOL COMMUNITY

*The lab and fairs were tangible proof of change, especially to parents who are so impressed that they are making private donations are given for the science program...Today science is the most exciting subject for the whole school. The primary children are the biggest fans.* (Parochial school teacher, second grade)

*In our school, we are constantly sharing with each other. If you find something someone can use, you give it to him or her. Maybe we're scroungers because we have no money. If something exciting happens in your classroom, you share it with other classes. The eighth grade has an aquarium; when the fish had babies, they sent them around to the classes.*

*The development and implementation of a whole school science fair has definitely helped to improve our school's science program. The science fair made the staff accountable to a certain extent in teaching various skills...Teachers come to me when they are in need of equipment or teaching resources which says that science must be a part of their day.*

*Getting this lab underway was a way for our school to get all teachers involved in teaching science... Today we have Franklin Institute kits being used, more science being taught, a new textbook series, a working and well stored lab, more enthusiasm and willingness to try new things!*

This chapter focuses on the evaluation questions: **What impact did TLC have on school science programs? In what ways does TLC's impact on school science programs look alike and different across sites?** These question acknowledge a central guiding principle of current reform efforts: schools must be central units of educational change. TLC had an impact in all the schools for which we have information. Across these sites, teachers feel that students are more enthusiastic about science, science is a higher priority in their buildings, and teachers are teaching more science. The following case studies of three schools reveal three different ways in which science education can become a part of primary education. In the first and second schools, science fairs became a dramatic symbol of a new-found school-wide commitment to science education. The first school was an archdiocese school which had virtually no science before TLC. The second school was a public school in which science had been taught, but not by classroom teachers. In contrast to these two examples, TLC's impact in the third school was incremental and less dramatic. But in all three schools, tangible evidence of science --- labs/resource rooms, hallways lined with science fair exhibits, laser disks, community gardens, etc. --- offer richer teaching and learning opportunities for students and teachers and visible symbols to these urban school communities that science is accessible to all.

**St. Luke's School**

St. Luke's has an enrollment of only 186 students in grades pre-K through eighth, with one class per grade and 17 to 24 students in each class. The school enrolls both Catholic and non-Catholic youth from a wide spectrum of socioeconomic backgrounds. Twelve families are on the subsidized school lunch program. Its student body is about evenly Caucasian and African-American; both TLC teachers are Caucasian.

Three years ago science in the school...

The TLC teachers at this school told an observer that they had been chosen to participate because they had admitted the weakness of their science program in their application to TLC. They were eager to attend the Franklin Institute program because they had never had an opportunity of this magnitude before. They wrote that before participation in TLC, science was "boring and outdated!" The students were read to from "antique" books. The primary grades covered only four topics the entire year and these topics were not explored in any depth. During the 1991 summer institute, the team wrote that they had "a weak science program from K to 8." They believed that their plan to convert an unused laboratory room at their school into a working laboratory was reasonable, but were concerned about getting the cooperation and enthusiasm of other teachers once they returned to school. According to the principal, before involvement with TLC, this school had focused primarily on reading and writing, so "had a lot of room for improvement."

Today...

Eighteen months later one of the team members told an observer,

> Our school has been transformed science-wise. We now have a science room. Money's a big issue, so that the fact that faculty and Sister and pastor wanted to channel the money into science shows commitment. We now have a laser disk science program, tables and chairs, and shelving.

In the follow-up questionnaire the same participant commented,

> The lab and fairs were tangible proof of change, especially to parents who are so impressed that they are making private donations are given for the science program...Today science is the most exciting subject for the whole school. The primary children are the biggest fans.

The role of the TLC teachers at St. Luke's.

According to the principal, the TLC team generated enthusiasm for teaching science through their own energy.

> As a Catholic school, [we] don't have the money for materials. The TLC program offered materials, the teachers got excited, came back and wanted to do more science. [The TLC teachers] encouraged other teachers, one of whom went down to the Institute and got several kits.

By the winter of 1992, the teachers in this school had talked up the use of the Franklin Institute kits, encouraged other teachers to attend Franklin Institute workshops so that they would receive their own kits and were evaluating and ordering new textbooks. They had also drawn the interest and cooperation of other teachers and parents for a chick-hatching project and had solicited parents and businesses to provide information about science careers and computers.

The following year one of the team members was made science coordinator and the TLC team told the observers, "For the first time ever, we're having a science fair." The science coordinator "had it very structured, sent around a flyer specifying that each class submit an experiment, not a demonstration." In addition to organizing the science fair with her teammate, the science coordinator signed up her colleagues for the training sessions the Franklin Institute offered the archdiocese schools and was evaluating and ordering new textbooks.

The role of the principal at St. Luke's.

According to the TLC team, the "principal has been wonderful; she sees the need." For the science fair, "Sister said, 'We're going to do it,' so it wasn't hard." The principal provided tangible support at every step along the way. She obtained substitutes for the two TLC teachers when they went to the science fair competition at Schuylkill Valley Nature Center; she honored the six students who participated; she spent her summer organizing the resource room.

The school context

Although this school had no history of involvement with science or other hands on activities, it did have a strong school community which was able to unite around a new curriculum initiative. In the words of one of the TLC teachers,

> In our school, we are constantly sharing with each other. If you find something someone can use, you give it to him or her. Maybe we're scroungers because we have no money. If

> something exciting happens in your classroom, you share it with other classes. The eighth grade has an aquarium; when the fish had babies, they sent them around to the classes.

From site visit field notes,

> This school apparently makes a whole-school commitment to projects, such as its project for ethnic diversity and background for Black History Month. There seems to be an easy converse among grades such as I haven't seen elsewhere.

The sense of community extended to the parish and the parents, some of whom also worked as teachers. During the science fair, the TLC participants told us that the " parents are wonderful...Home and School got excited and offered financial backing if we need it, plus a parent helper." In this context, the science fair and lab became visible symbols of excitement, sharing, and academic excellence within an urban school.

**The Thomas School**

This school is located in one of Philadelphia's poorest neighborhoods. The school has 700 students from pre-K to fifth grade and also has several Get Set classes. It is a Chapter I school and 90% of the students are from AFDC families. The entire student body receives free lunch and its students include families from at least one homeless shelter. The school is 100% African-American; one of the TLC teachers is Caucasian; the other, African-American.

Three years ago science in our school...

Thomas, unlike St. Luke's had been giving science some attention for several years. The school held a science fair, although participation was quite limited; it sent homeless students to an environmental education project; it created a community garden; a chick-hatching project in one of the fifth grade classes drew school-wide attention. Like many other public schools, Thomas has a science specialist who is responsible for teaching science during classroom teachers' preparation periods. However, little science was being taught in primary classrooms. According to one participant's follow-up survey,

> Science was handled in the primary grades by a Specialist Teacher, so first, second, and third grade teachers were not really comfortable with science activities in the classroom.

Additionally, in their science improvement plan, the TLC team identified "lack of hands-on activities in teaching science" and "materials and resources are unknown to teachers" as major problems in science education in their school.

Today...

One of the team members wrote in her follow-up questionnaire,

> The development and implementation of a whole school science fair has definitely helped to improve our school's science program. The science fair made the staff accountable to a certain extent in teaching various skills...Teachers come to me when they are in need of equipment or teaching resources which says that science must be a part of their day.

In the spring of 1993, our research team noted the richness of the science that took place around Thomas's science fair. In her field notes from a visit shortly after this fair, one of our team members described the science projects in the halls of the school and students' explanations of their hypotheses on topics like strength of paper towels, amount of popcorn which successfully pops, distances that it is possible to throw a water balloon. She concluded,

> The less accomplished posters convince me that everyone got involved, that science was accessible even to the lower achieving students. We certainly have ample evidence of cooperative learning.....Teachers were creative enough to match a project to kids' innate interests such as playing games or eating.

The role of the TLC teachers at Thomas.

By the winter of 1992, this team had shared ideas, materials, and teacher resource books with teachers in grades K-5 in preparation for the science fair that they organized. According to the principal, the TLC teachers worked effectively with the staff and "are more intense than the current science leader." The first science fair held after becoming part of TLC elicited a disappointing turnout. But the following year, 1993, the principal mandated participation in the fair for all classes, and the TLC teachers provided support for it by working with their science committee who planned experiments and gathered materials for teachers in each grade group.

The following spring, in 1994, the acting principal told an observer that TLC team members "are very comfortable with science and eager for information which they pass on to other teachers." Evaluation of students has been changed to focus on participation in the science fair, and the TLC team members are leaders at staff meetings, providing updates, working on school plans. They have requested staff development on the changes in student assessment and on the 2061 benchmarks.

The school context.

Our observations indicate several ways in which the school encouraged teachers to participate in curriculum development and planning. As mentioned above, the TLC teachers turned to the school science committee as well as the principal for support in building the school science fair, felt comfortable raising topics for staff development, and were involved in curriculum writing. In addition, to expanded roles within the school, teachers at Thomas were involved with parents and community surrounding the school. One of the TLC team members administers an after school enrichment program and is involved with the local girl scout troop. The reading coordinator, who is also intensely interested in hands-on science and works closely with the TLC team, has started an intergenerational literacy program. One TLC teacher told us,

> One positive thing about the school is that there is a continuum from parents to staff, no sharp divisions. When I first came last year it was hard to tell who was staff, who was volunteer, everyone was so committed.

As in the archdiocese school discussed above, the TLC teachers at Thomas have been able to push science into high visibility in a school in which they are deeply embedded. In this impoverished African-American community, the visibility of science is an important signal that the school is eager to challenge the traditional barriers of racism and elitism.

**Sacred Heart School**

In 1992-93 this archdiocese school had 438 students in grades K through 8. Approximately 50% are Chapter I, but this percentage is higher in the lower grades. The school is 100% African-American, but the teaching staff is Caucasian. Like other archdiocese schools, this school had few science resources before its involvement with TLC. Although changes in this school were not as dramatic as those at St. Luke's and Thomas, TLC did have an impact.

<u>Three years ago science in our school...</u>

One TLC teacher explained in her follow-up survey,

> Three years ago science in my school [was characterized by] old textbooks, lack of enthusiasm, and not much science being taught.

During a site visit to this school after the 1991 Summer Institute, an observer noted that the classrooms still had few signs of science and that only a few students were engaged in the science lessons which were teacher-centered. Furthermore, the team had postponed implementing the activities they had proposed in their science improvement plan (a staff development session for

teachers and the establishment of a science lab), due to unexpected teacher departures and the demands of the Middle States Evaluation process.

Science today...

By spring 1994, the follow-up questionnaire from one of the teachers in this school indicated that the science lab was ready and being used. According to this respondent,

> Getting this lab underway was a way for our school to get all teachers involved in teaching science... Today we have Franklin Institute kits being used, more science being taught, a new textbook series, a working and well stored lab, more enthusiasm and willingness to try new things!

The role of the TLC teachers at Sacred Heart.

During the first year after their participation in the program, the teachers in this school said that they were "not doing much" in terms of teacher leadership. However, the principal was encouraged that six of the teachers had participated in a Franklin Institute overnight and commented "You can't do it all at once." Four months later, one of the TLC teachers at the school told the evaluators that she and her partner "are trying to work on being teacher leaders in the school." They had submitted one curriculum activity for the TLC booklet; one was field testing another activity; both were planning to attend the second phase summer institute. Another teacher in the school had participated in a Museum to Go Kit training session and had used the kit activities in a variety of ways, even supplementing them with other materials and teaching ideas. According to the principal,

> [The TLC teachers] are rubbing off. There's more talk in the school about hands-on activities. They're taking time to plan the lessons. Things such as [a show of animal habitats organized by one of the other teachers in the school] make a difference.

The role of the principal at Sacred Heart.

The principal at Sacred Heart secured funds for the science lab and got it up and running during the second year of the school's involvement with TLC. The principal alerted her staff to workshops and paid the fees for activities like the Franklin Institute Overnight and special activities at the Schuylkill Valley Nature Center. One of the teachers commented that "our principal has really helped get our science lab underway and all our efforts in TLC." The principal herself commented at the end of the project, "Please keep TLC going."

The culture and community of the school.

The TLC teachers organized lessons with hands-on activities and the principal describes her instructional emphasis as hands on,

> I just think for any children, when you manipulate and work things out, you have a better understanding. If students manipulate or record information, they can explain it and then they're not afraid of it.

However, observations showed immaculate classrooms without the messiness of active science and teachers who focused on classroom control to an extent that was not evident in the other site visits. Teachers did not have students working in groups, used bells to maintain order, and one assigned demerits for misbehavior during a science activity. Moreover, the principal explained to us that she did not see the value of teachers continuing to immerse themselves in hands-on, investigative science during the second summer institute when they were already convinced of its value.

Science education did manage to get off the ground even in this environment that seems to contradict so many of the pedagogical assumptions of TLC. The school not only set up a lab and new materials, survey results also indicate that teachers began using hands-on activities that they had not even been aware of before their involvement with TLC.

**Factors that influence TLC's impact on schools**

Program factors

TLC program planners made use of research on school change in the design and implementation of program structures and activities. They created school teams which included two teachers and the school administrator, thus providing the opportunity for these staff members to support one another and to develop a common vision of what they wanted science to look like in their buildings. The program also required that the teams assess their needs in science and develop a plan for addressing those needs over the course of the project. TLC provided materials to the participating schools, so that they would be able to implement the kinds of rich activities that they were learning about at the Franklin Institute. The program also provided resources to teachers who were not participants in the program. It held "bring a friend" events so that TLC teachers could entice their colleagues with hands-on approaches in science and it gave materials to them. All of these program components made it more possible for schools to move forward the agenda of hands-on science.

School factors

These case studies indicate that in addition to the enthusiasm, persistence, and savvy of teacher participants, the support of principals and the culture of a school is a key factor in making science visible in urban schools. The impetus for schooled change can come from principals or from teachers, but in either case, the teachers must feel that they have the active support of their administrators. Teachers need financial support for hands-on science materials, but they also need administrative and moral support to prioritize science, provide time for science (both for staff and students), and to legitimate the activities of teacher-leaders.

These case studies demonstrate that the culture of a school is as important as particular actions of a principal in building a visible and effective science program in urban schools. In two of the cases discussed above, hands-on science was able to take off because it was introduced into a community that had the social resources to support a creative curriculum initiative. In contrast, in the third school, TLC did have an impact, but one which was slower and more subtle. The difference between the two parochial schools discussed above was not particularly a difference in pedagogy; neither of them had a strong commitment to hands-on inquiry learning before they were involved with TLC. Rather it was a difference in the schools' social contexts and their interest in new ideas that allowed these schools move forward into an intellectually challenging and symbolically laden content area.

District factors

In addition to factors which varied from school to school in both public and archdiocese districts, contextual factors at the district level also influenced TLC's impact at schools. As mentioned earlier, in general, before involvement in TLC, archdiocese schools were teaching less science than public schools. When these schools entered TLC, they had fewer science materials and resources, and throughout the project, archdiocese teachers were more likely than public school teachers to focus on the importance of acquiring resources for teaching hands-on science and making them available to their colleagues. At the same time, several diocesan schools were just beginning to use an integrated approach to language arts and articulated more clearly than public schools, a schoolwide focus on the role of science within a newly developing approach to an integrated curriculum. In addition, several teachers found the archdiocese curriculum guidelines limiting and several archdiocese schools experienced high levels of teacher turnover which made it challenging to develop a coherent science curriculum.

# DISCUSSION AND RECOMMENDATIONS

## Discussion

The Teachers Leadership Collaborative offered Philadelphia public and parochial teachers a rich professional development experience that diverged considerably from the training and coaching model that pervades many curriculum reform efforts and that Little (1993) argues is "inadequate to the conceptions or requirements of teaching embedded in present reform initiatives." TLC immersed teachers in investigative science, provided them with many opportunities to shape program direction, and supported them as proactive change agents and leaders. By working with teachers to build a network of public and parochial teachers, TLC offered a setting for teachers to gain new perspectives on their own situations.

It appears that TLC's approach catalyzed and supported a change process among participating teachers and schools. The evaluation research reported here indicates that classroom teachers' development as science educators and leaders is a gradual process. Students respond enthusiastically to the introduction of hands-on science activities within their primary classrooms and this enthusiasm encourages teachers to teach more science. However, the use of hands-on materials alone does not automatically translate into classrooms in which children and teachers are willing to take the chances associated with scientific exploration. A context in which mistakes are valued and seen as learning opportunities for students and teachers is essential. Such a context applies to classrooms where the spirit of scientific investigation and, at least, an implicit philosophy of constructivist knowledge converge to transform teachers and students into scientists. It also applies to schools as larger organizations where the goal of educational improvement must release schools from the bureaucracy's press for order and standardization so that they can become real learning organizations in which staff and students feel free to involve themselves in the messiness of learning from trial and error. This evaluation suggests that with time, and with outside support in the forms of material resources, ideas, and encouragement, teachers can move from using hands-on science activities to creating classroom environments in which students are encouraged to explore, observe, experiment, and test out their own explanations about natural phenomena.

As discussed earlier, children's positive response to hands-on, investigative science is a primary ingredient for stimulating teachers to explore and develop more deeply a stance toward their teaching which makes them co-creators of knowledge with students. Our data also suggest that teachers highly value the new ways they see their students interacting with the natural world.

They see urban students becoming more aware of and attuned to the living things around them and they value experiences which cultivate students' knowledge and appreciation of nature.

The research also illuminates what it means to be a "teacher leader" by describing the set of beliefs teachers have about themselves in relation to colleagues and how they go about actually constructing the role of science leader in their schools. It indicates that, as TLC participants implemented new instructional approaches to science in their classrooms, they began to articulate an egalitarian vision of science. This vision, which stressed the importance of making scientific knowledge accessible to all students and teachers, helped TLC participants develop leadership activities that were grounded in collegial relationships, not scientific expertise. Teachers developed leadership roles which do not fit existing models of leadership, which frequently assume that knowledge or expertise is the basis of power. Instead, TLC teachers based their leadership on their roles as resources and facilitators in the process of making science knowledge accessible to all. A strategy for doing this was disclaiming their own expertise and putting forward a stance of "If I can teach science, you can too." This stance emphasized leadership built upon collaborative consultation and the provision of information and resources. It is congruent with Welker's (1991) argument that the metaphor of teacher as expert is "questionable because it diminishes the moral and social responsibilities of teachers and tends to turn students and the wider public into passive receivers of expert service" (p.19).

Likewise, teacher leadership in curriculum development unfolded differently than was originally intended by program planners for two interacting reasons which further illuminate how teachers' perceptions of their own change processes and the culture of teaching influence the ways in which teachers take up the task of writing curriculum. Although by the end of the program, many of the TLC teachers were using thematic approaches to teaching that frequently involved students in inquiry learning, based on their own experience with change and their knowledge of their school contexts, they did not see these innovations as beginning points for themselves or for their colleagues. Instead, they wanted to produce curricula that would invite even the most reluctant teachers into the world of science and offer their colleagues concrete and accessible images of science-filled classrooms and schools.

TLC teachers undertook activities in their schools that would literally get science materials and activities into classrooms and would make science visible to the entire school community. Most of the science improvement plans focused on initiating or expanding school science fairs and/or setting up resource rooms for science materials. In order to get science fairs going, TLC teachers provided their colleagues with display boards, step-by-step instructions, classroom

consultation. Principals sometimes mandated participation, but TLC teachers were there to soften the directive with support and encouragement. The science projects teachers encouraged their students to complete were often "recipe-like" in their approach to scientific investigation. However, science fairs as highly visible school events engendered a sense of pride and accomplishment in parents, students, and teachers. Again, the theme of making science accessible to all permeates TLC efforts at the school level.

**Recommendations**

Deepening changes in classroom practice

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

- Introducing integrated curriculum and inquiry learning to participants as the central foci of the program earlier in its implementation.

- Providing opportunities for teachers to reflect on their change processes by having teachers talk about how they are coming to understand how they learn science, how they are changing what they do in their classrooms, etc.

- Providing opportunities for teachers to look deeply at a few students' work in order to understand how students are constructing knowledge about science and to reflect on the kinds of learning tasks they are giving students.

- Including site visits to every school as part of the role and responsibilities of program staff. These visits would provide opportunities for program staff to become familiar with the teaching contexts of TLC participants and moments of conversation about the school's progress.

Strengthening science across the school

Recommendations for additional supports which would both broaden and deepen school impact include:

- Increasing the school budget so that schools will have more discretionary funds to allocate to science and the school governance bodies can be brought into the process of decision making. Such increases would enhance the message that science is a priority in the school and would involve the larger school community in discussions about what is valued and in decisions about where the school ought to be headed in science. These funds might not be allocated until the second year of the program, when teams have had a chance to clearly think through what is needed and what they might want to do at their schools.

▲ Including a parent on the school team so that representation across the school community is a central feature of TLC.

▲ Increasing the involvement of the principal.

▲ Developing additional images of vibrant school-wide science activities and providing supports such as materials and professional development for these activities.

▲ Including site visits to every school in the roles and responsibilities of program staff. These visits focus attention on the program and science in general and provide moments of conversation about the school's progress.

## REFERENCES

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

Massey, W.E. (1992) A success story amid decades of disappointment. *Science*, 258(13)1177-1180.

Rallis, S. (1988) Room at the top: Conditions for effective school leadership. *Phi Delta Kappan*, 70(1)643-647.

Saunders, W.L. (1992) The constructivist perspective: Implications and teaching strategies for science. *School Science and Mathematics*, 92(3)136-141.

Selvin, P. (1992) Math education: Multiplying the meager numbers *Science*, 258(13)1200-1201.

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.

Sims, C. (1992) What went wrong: Why programs failed. *Science*, 258(13)1185-1187.

Welker, R. (1991) Expertise and the Teacher as expert: Rethinking a questionable metaphor. *American Educational Research Journal*, 28(1)19-35.

# APPENDIX A

## Survey Instruments, Case Study Field Guides, and Focus Group Interview Protocols

**Philadelphia Elementary Science Leadership Institute**
Summer, 1991

**INSTITUTE EVALUATION**

1. Name (optional) _____

2. Position _____ 3. Grade Level _____

4. Public School _____ Archdiocese _____

5. Have you used hands-on science materials in your classroom in the last two years? **YES** _____ **NO** _____

If yes, please describe briefly the kinds of materials you have used and how you have used them.

6. Approximately, how much time per week did you spend on science instruction in your classroom last year?

_____ less than 60 mins. _____ 60-90 mins. _____ 91-120 mins. _____ more than 120 mins.

**PLEASE CIRCLE THE FREQUENCY WITH WHICH THE FOLLOWING OCCURRED IN YOUR CLASSROOM LAST YEAR.**

7. My students worked in small groups with hands-on science materials.

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

8. I used a thematic approach and incorporated science activities into the units.

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

9. I incorporated writing activities with science instruction.

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

16. **Assignments/Readings**

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Superior | Excellent | Good | Fair | Poor |

Comments:

17. **Field Trips**

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Superior | Excellent | Good | Fair | Poor |

Comments:

18. **Involvement of Principals**

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Superior | Excellent | Good | Fair | Poor |

Comments:

19. **Logistical Arrangements** (Meeting place, schedule, etc.)

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Superior | Excellent | Good | Fair | Poor |

Comments:

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

20. I learned much about science (both concepts and process skills) in the Institute.

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

Comments:

21. I learned much about how to involve my students in working with hands on science materials.

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

Comments:

22. I learned much about how I might be a teacher leader in science.

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

Comments:

23. The Institute provided expertise and support in helping my school's team develop an action plan for the coming year.

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

Comments:

24. I am confident that my school team will be able to implement our action plan.

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

Comments:

25. Please discuss any ways that you think the Philadelphia Elementary Science Leadership Institute could support your team's efforts to strengthen science instruction in your school next year.

26. What activities would you like for the Philadelphia

Elementary Science Leadership Institute to sponsor in the coming years?

**TEACHERS LEADERSHIP COLLABORATIVE**
Summer, 1993

**PARTICIPANT SURVEY**

1. Name _____

2. Position _____ 3. Grade Level _____

4. Public School _____ Archdiocese _____

5. Approximately, how much time per week did you spend on science instruction in your classroom last year?

_____ less than 60 mins. _____ 60-90 mins. _____ 91-120 mins. _____ more than 120 mins.

COMMENTS:

6. Do your students receive science instruction from anyone other than you? **YES** _____ **NO** _____

If yes, from whom and under what circumstances?

7. Have you used hands-on science materials in your classroom more frequently since you began participation in TLC? **YES** _____ **NO** _____

Why or why not?

If yes, please describe briefly the kinds of hands-on materials you have used and how you have used them.

What other kinds of science curriculum materials did you use in your classroom?

What do you think are the strengths of these materials?

What do you think are the weaknesses?

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

**PLEASE CIRCLE THE FREQUENCY WITH WHICH THE FOLLOWING OCCURRED IN YOUR CLASSROOM LAST YEAR.**

8. My students worked in small groups with hands-on science materials.

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

COMMENTS:

9. I used a thematic approach and incorporated science activities into the units.

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

COMMENTS:

10. I incorporated writing activities with science instruction.

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

COMMENTS:

11. I incorporated math activities with science instruction.

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

COMMENTS:

12. I used a textbook to teach science.

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

COMMENTS:

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

13. I have enjoyed learning about science in this program.

| 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 understanding of the scientific process.

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

COMMENTS:

16. I have confidence in my ability to teach science to my students.

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

COMMENTS:

17. I believe that I must have complete mastery of relevant knowledge and concepts before I introduce specific science topics in my classroom.

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

COMMENTS:

18. In my school teachers share ideas about teaching science

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

COMMENTS:

19. I have worked informally with other teachers in my school to strengthen science in their classrooms.

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

COMMENTS:

20. Because of my school's participation in TLC, science has become more of a priority in the primary grades and/or throughout the school.

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

COMMENTS:

21. My students like science.

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

COMMENTS:

22. 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:

23. Please describe the progress your school made in implementing your science action plan. Include in your description: what you planned to do; what you did; how you think it was successful and/or unsuccessful; what were the factors that supported implementation; what were obstacles to implementation.

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

**THE FRANKLIN INSTITUTE'S TEACHER LEADERSHIP COLLABORATIVE**
**TEACHER SURVEY**
June, 1994

The purpose of this survey is to document the kinds of efforts TLC teams launched and the impacts of these efforts in schools. In this survey, you are asked to choose among several possible responses to the questions. You can choose as many as apply. Please add your own comments where you think they will clarify your answers.

Name_____

Current School _____

Are you still teaching at the same school from which you originally applied to TLC?_____

What subject/grade(s) do you teach? _____

Please indicate which Summer Institute(s) you attended:

_____1991
_____1992
_____1993

Please indicate which best describes your participation in TLC sponsored activities (after school/Saturday workshops, conferences, etc.) which were offered during the school year:

_____ attended 1 - 3 school year activities
_____attended 4 - 7 school year activities
_____ attended more than 7 activities

## I. School plans and activities

1. Please indicate which activities you carried out during your participation in TLC. Check as many as apply.

_____ a. Conducted workshops

_____ b. with other primary grade teachers in my school

_____ c. with teachers from across grades in my school

_____ d. with parents

_____ e. other? (Please describe) _____

_____

_____ f. Offered one-on-one consultation to other teachers (including sharing materials, planning, peer coaching, demonstration lessons, etc.)

_____ g. Inventoried my school's science materials

_____ h. Purchased new science materials

_____ i. Obtained outside funding (grants, etc.) or in-kind support for science efforts

_____ j. Integrated TLC effort with ongoing initiatives in the school or school district.
(Please specify) _____

_____

_____

_____ k. Developed/implemented whole school science activity (for example, a science fair)
Please describe the activity._____

_____

_____

_____ l. Distributed a newsletter

_____ m. Set up a resource room

_____ n. Other (Please describe.)

_____

_____

2. Please go back and star or circle the activities which you consider were the main thrust of your efforts and the most important to improving your school's science program. Please explain why.

_____

_____

_____

_____

3. Which of these activities are likely to continue beyond the duration of TLC?

4. How would you describe the ways in which science instruction has changed in the past two or years?

Three years ago science in my school...

Today science...

## II. Impact

1. How would you characterize the impact of TLC on your own **teaching practice?** (Please check all that apply)

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

_____b. I started using hands-on techniques after participating in the TLC Summer Leadership Institute.

_____c. I was already using hands-on techniques before TLC, but I use hands-on more frequently than before in my class.

_____d. I feel more confident about using hands-on techniques as a result of my participation as a TLC team member.

_____e. I didn't know much about science investigation before TLC, I became more aware of inquiry approaches.

_____f. I started using science investigation after participating in the TLC Summer Leadership Institute.

_____g. I was already using science investigation before TLC, but I use inquiry approaches more frequently than before in my class.

_____h. I feel more confident about using science investigation as a result of my participation as a TLC team member.

_____ i. I began to use hands-on or active learning techniques in other subject areas too. (Please specify)

_____

_____

_____

_____ j. I began using inquiry approaches in other subject areas too. (Please specify)

_____

_____

_____

_____ k. I spend more time teaching science.

_____ l. I do more interdisciplinary teaching.

_____ m. Other impacts on your teaching practice. (Please explain.)

_____

_____

2. How would you assess the impact of TLC/Summer Leadership Institute on you in **your leadership role.**

_____ a. I gained skills in how to lead workshops with other teachers.

_____ b. I gained confidence in leading workshops with other teachers.

_____ c. Other teachers come to me for information or help about science education.

_____ d. I have more interaction with other teachers about science curriculum and planning.

_____ e. I have more interaction with my administrator(s) about science curriculum and planning

_____ f. I have become part of a network through which I have increased the amount interaction I have about science education.

_____ g. I have attended professional meetings/conferences related to science.

_____ h. other impacts on your role (Please explain.)

_____

_____

_____

3. How would you assess the impact of TLC **in your school?**

_____a. Science has become a higher priority in the school.

_____b. Generally, teachers are spending more time teaching science.

_____ c. There is an atmosphere of acceptance about hands-on as an approach to teaching science.

_____ d. There are more science materials available for teachers to use in their classrooms.

_____ e. Students at my school, generally, are more enthusiastic about science.

_____f. Generally, teachers are feeling more comfortable about using hands-on approaches.

_____ g. In assessing how the TLC effort has affected teachers' attitudes towards hands-on science, choose one of the following statements that best characterizes your school:

_____ Generally, teachers are unaware or resistant to using hands-on approaches in science.

_____ Generally, TLC stimulated teachers' interest in hands-on methods and they are beginning to try hands-on methods.

_____ Generally, teachers are using hands-on approaches more frequently.

_____ Generally, teachers are more likely to use hands-on approaches than other approaches when they teach science.

_____ h. Primary teachers are using the activities in "It's Elementary, My Dear" which was developed by TLC teachers.

_____ i. Other impacts on the school (Please explain.)

_____

_____

_____

## III. Support and Hindrances to Implementation

Using the list below, please indicate whether the factor supported your TLC team's efforts, was no influence (neither supported nor hindered), or actually presented an obstacle or hindrance to your efforts.

| | **Supported** | **No influence** | **Hindered** |
|---|---|---|---|
| a. District/Archdiocese policies | _____ | _____ | _____ |
| b. Principal | _____ | _____ | _____ |
| c. Other ongoing initiatives (e.g., curriculum assessment/testing, etc.) | _____ | _____ | _____ |
| d. Summer Leadership Institute | _____ | _____ | _____ |
| e. Teacher networks within school or district | _____ | _____ | _____ |
| f. Other networks Please List_____ | _____ | _____ | _____ |
| g. Teachers attitudes toward change | _____ | _____ | _____ |
| h. Priority of science in school or district | _____ | _____ | _____ |
| i. Capacity to influence other teachers/lead workshops_____ | | _____ | _____ |
| j. Franklin Institute staff | _____ | _____ | _____ |

_____

What other factors supported or hindered implementation of your plans or of your efforts?

_____

_____

Please offer any further comments or explain any of the responses you wish in this space or on additional sheet. Thank you for your help.

Franklin Institute
Teacher Leadership Collaborative

Interview Topics and Prompts for Site Visits

1. Characteristics of the School

   A. What's this school like?
      1. What's the faculty like?
      2. What are the students like?
      3. What's the community like?
      4. How has this school changed over the years?

2. School's Involvement in TLC

      1. How did you and your team partner become involved in this Franklin Institute program?
      2. What got you involved?
      3. What would you say are the goals and purposes of TLC?

3. Description of self as a teacher/administrator

   A. Teaching background?
      1. How long have you been a teacher?
      2. How long have you been in this school?
      3. Why did you become a teacher?

   B. Description of self as teacher
      1. How would you describe yourself as a teacher?
      2. What are your beliefs and philosophy about teaching?
      3. What have been the important influences on you as a teacher?
      4. What's worked particularly well for you in your teaching?
      5. How would you like to change as a teacher?

4. Influence of TLC on your classroom practice

   A. Description of self as science teacher
      1. How has your conception of yourself as a science teacher changed since your participation in TLC? More confidence about science content? More process oriented? A science teacher leader?

   B Changes in classroom practice
      1.How has your science teaching been influenced by your participation in TLC? What are you doing differently or more of or less of in the classroom as a result of your

# TLC CLASSROOM OBSERVATIONS

## I. School Context

A. How large is the school; how many grades?
B. What is the poverty level/racial composition of the school?
C. Has the school changed in the last five/ten years? If yes, how?
D. What is the condition of the residential-business surroundings?
E. Does the school participate in any other programs?

## II. School and Science

A. What is the historical place of science in this school?
   *How much time a week is normally devoted to science in the primary grades?
   *Is there a science coordinator? If yes, who is it?
   *What constraints/supports are imposed by the School District/Archdiocese?
B. What instructional emphasis does the principal promote in the school?
C. How do the principal and other teachers perceive the TLC team and the contribution it could make or already has made to the school?
D. What were the goals of the SIP? Have they been implemented?
E. How well did the TLC teams work together?
F. Has TLC resulted in any restructuring or reorganization of science instruction in the school?

## III. Classroom Practice

A. How visible is science in the classroom?
B. Is there any evidence of interdisciplinary teaching?
C. Science lesson:
   1. Where did the lesson come from?
   2. What materials does the lesson use? Where did they come from?
   3. Does the lesson require students to work in groups? If yes, what is the size of the groups?
   4 Does the lesson require any cooperative learning? If yes, describe.
   5. How do students handle/manipulate materials: continuously/intermittently/never?

6. How does the teacher introduce and close the lesson? Does she identify the concepts at either juncture? If yes, what concepts?
7. Does the activity contain any element of surprise? Does anything unexpected happen, or is the unexpected structured into the activity in any way?
8. How do students respond? Do they seem excited/absorbed/bored/confused? Are there any indications that they understand the concepts?

## IV. Teachers' Professional Development

A. Have the TLC teachers presented an in-service workshop on science? If yes, what was it? How well was it put together?
B. Have TLC teachers worked in any informal ways to promote science instruction in the school? Any shared materials, curricula, trips?
C. Are TLC teachers more confident about science and/or more active science learners?
D. What do TLC teachers think they gained from:
   *Summer institutes
   *Follow-up sessions
   *Developing curricula activities
   *Being on a school team
   *Being an identified teacher leader in their school

participation in TLC? Content? Curriculum? Materials? Does your classroom look different (physical changes)?

2. What specifically do you feel particularly good about? A lesson, activity, unit?

C. What aspects of the program have not been useful to you? Why?

5. Influence of TLC on your school

1. What's the history of the school's science program, particularly in the elementary grades?

2. Have you been able to address your science school improvement plan that you developed over the summer? Why or why not?

3. What has helped you to implement that plan? What have been obstacles?
(I saw in your proposal you said _____, how has that worked?)

6. Influence of TLC on your students

1. As a result of the changes you've made in your science teaching, what have you noticed about how your students are learning in science?

2. What do you notice about the work itself?
3. How much of this would you attribute to TLC?
4. How do you evaluate students in science? Have your evaluation criteria or methods changed?

7. Summary

1. What obstacles have you found within your school, within yourself, within your students to implementing what you've learned?
2. In summary, what have been the most important effects of your participation in this program? Why?

# INTERVIEW PROTOCOL FOR FOCUS GROUP INTERVIEW OF TLC PARTICIPANTS MAY 1993

1. How was the TLC program similar to what you expected? How was it different from your expectations?

2. How would you describe a "teacher-leader"?

Do you think the TLC program helped you to become a "teacher-leader"?

In what specific ways, has it helped you to be a teacher-leader"?

3. Why have you stayed active in TLC?

Why do you think some TLC participants have been very active, while others dropped out immediately after the summer session?

What sorts of things could have been done to hold onto those people?

4. How have you worked as a "team" at your school?

Was it helpful to have more than one teacher attend the TLC program? Why?

Was it helpful to have an administrator attend? Why? What role has the administrator played in accomplishing an "action plan"?

5. What do you hope to accomplish during this summer's week long institute? What kind of programming would you like to see?

6. What would you like to see happen next Fall, as the funding of the program ends in December? How would you like to see the program continue past December? Would you be interested in participating even after the NSF funding runs out? Why or why not?

# INTERVIEW PROTOCOL FOR FOCUS GROUP INTERVIEW OF TLC CURRICULUM WRITERS- APRIL 1994

**1)** Please tell me what you know about the history of the curriculum writing piece of TLC.
When did you first hear about it?
What did you think of the idea when you first heard about it?

**2)** Did you write and/or field test any of the activities yourself?
What was that experience like?

What motivated you to do it?

What is your perspective on other teachers' experience with activity writing?

What would you say they got out of it?

What seemed difficult for them? What was easy?

**3)** Tell me about your process for putting the booklet together.
What process did you develop for choosing what you would use; how you might revise?

How did you collaborate?

**4)** What did you learn about science curriculum in putting the booklet together?

# APPENDIX B

## Tables and Charts

## TABLE 1
## PARTICIPATING SCHOOLS

| Public Schools | Demographics | | Dates of Site Vistits | | | | |
|---|---|---|---|---|---|---|---|
| | Grade Org. | #Students | Race/Eth. | Spring 92 | Fall 92 | Spring 93 | Spring 94 |
| | | | | | | | |
| Thomas | K-5 | 675 | 75% African-American<br>25% Hispanic | ✓ | | ✓ | ✓ |
| Howard | K-6 | 700 | 66% African-American<br>33% Hispanic | ✓ | | | |
| Edison | PreK-5 | 600 | 82% Caucasian<br>16% African-American<br>1% Asian<br>1% Hispanic | | ✓ | ✓ | |
| Witherspoon | K-4 | 390 | 86% Hispanic<br>14% Black | | ✓ | | |
| **Parochial Schools** | | | | | | | |
| St. Luke's | PreK-8 | 186 | 50% Black<br>50% White | ✓ | | ✓ | |
| St. Paul's | 1-8 | 700 | 2 % Hispanic<br>97.45 % White | ✓ | | | |
| St. Francis | PreK-8 | 225 | 66% White<br>10% Black<br>23% Hispanic<br>2.7% Pacific Islander. | | ✓ | | ✓ |
| Sacred Heart | K-8 | 438 | 100% Black | | ✓ | ✓ | |

**TABLE 2**
**Amount of Time Teachers Reported Spending on Science Instruction**

| **Archdiocesan Teachers** | **Less than 60 minutes per week (%)** | **60-90 minutes per week (%)** | **91-120 minutes per week (%)** | **More than 120 minutes (%)** |
|---|---|---|---|---|
| **Before** TLC | 50 | 31 | 12 | 8 |
| **After** Summer Institute | 23 | 32 | 14 | 31 |

| **Public School Teachers** | **Less than 60 minutes per week (%)** | **60-90 minutes per week (%)** | **91-120 minutes per week (%)** | **More than 120 minutes (%)** |
|---|---|---|---|---|
| **Before** TLC | 17 | 37 | 25 | 21 |
| **After** Summer Institute | 10 | 42 | 24 | 24 |

N = 26 for the Archdiocesan Before Group
N = 22 for the Archdiocesan After Group
N = 24 for the Public Before Group
N = 21 for the Public After Group

**TABLE 3**
**Amount of Time Teachers Reported Spending on Science Instruction**

| Cohort I | Less than 60 minutes per week (%) | 60-90 minutes per week (%) | 91-120 minutes per week (%) | More than 120 minutes (%) |
|---|---|---|---|---|
| **Before** TLC | 35 | 23 | 27 | 15 |
| Two years **after** attending first summer institute | 21 | 21 | 21 | 36 |

| Cohort II | Less than 60 minutes per week (%) | 60-90 minutes per week (%) | 91-120 minutes per week (%) | More than 120 minutes (%) |
|---|---|---|---|---|
| **Before** TLC | 33 | 46 | 8 | 13 |
| One year **after** attending first summer institute | 13 | 50 | 17 | 21 |

N = 26 for Before Cohort I
N = 19 for After Cohort I
N = 24 for Before Cohort II
N = 24 for After Cohort II

**TABLE 4**
**Comparison of Science Instructional Practices Reported by Teachers Before and After Participation in TLC**

| | | Seldom or Very Seldom (%) | Often or Very Often (%) | Not Applicable (%) |
|---|---|---|---|---|
| Students worked in small groups with hands on materials | Cohort I: | | | |
| | Before | 48 | 48 | 4 |
| | After | 11 | 89 | 0 |
| | Cohort II: | | | |
| | Before | 40 | 44 | 16 |
| | After | 24 | 68 | 8 |
| Used thematic approach and incorportated science activities | Cohort I: | | | |
| | Before | 45 | 48 | 7 |
| | After | 10 | 91 | 0 |
| | Cohort II: | | | |
| | Before | 50 | 33 | 17 |
| | After | 36 | 52 | 12 |
| Incorportated writing activities with science | Cohort I: | | | |
| | Before | 44 | 51 | 4 |
| | After | 11 | 90 | 0 |
| | Cohort II: | | | |
| | Before | 52 | 48 | 0 |
| | After | 23 | 77 | 0 |
| Incorportated math activities with science | Cohort I: | | | |
| | Before | 51 | 48 | 0 |
| | After | 5 | 95 | 0 |
| | Cohort II: | | | |
| | Before | 39 | 48 | 13 |
| | After | 36 | 56 | 8 |

N = 27 for the Before Cohort I
N = 19 for the After Cohort I
N = 25 for the Before Cohort II
N = 25 for the After Cohort II

**TABLE 5**

**School Level Activities During TLC as Reported by Teachers in 1994 Follow-up Survey**

| Activity | Public School Teachers | % | Archdiocese School Teachers | % | Total | % |
|---|---|---|---|---|---|---|
| Offered one-on-one conusultation to other teachers | 13 | 100 | 13 | 92 | 26 | 96 |
| Inventoried my school's science materials | 7 | 53 | 11 | 78 | 18 | 66 |
| Purchased new science materials | 8 | 61 | 9 | 64 | 17 | 62 |
| Conducted Workshops | 9 | 69 | 8 | 57 | 17 | 62 |
| w/other primary grade teachers | 10 | 76 | 8 | 44 | 18 | 66 |
| w/teachers from across grades | 7 | 53 | 6 | 42 | 13 | 48 |
| w/parents | 4 | 30 | 0 | 0 | 4 | 14 |
| other | 4 | 30 | 3 | 21 | 7 | 25 |
| Integrated TLC effort with ongoing intiatives in the school or school district | 8 | 57 | 5 | 35 | 13 | 48 |
| Developed/implemented whole school science activity | 5 | 38 | 6 | 42 | 11 | 40 |
| Set up a resource room | 1 | 7 | 7 | 50 | 8 | 29 |
| Obtained funding or in-kind support for science efforts | 7 | 53 | 0 | 0 | 7 | 25 |
| Distributed a newsletter | 1 | 7 | 0 | 0 | 1 | 3 |
| Other | 2 | 15 | 5 | 35 | 7 | 25 |

**TABLE 6**
**Schoolwide Impact of TLC as Reported by Teachers in 1994 Follow-up Survey**

| Impact | Public School Teachers | % | Archdiocese School Teachers | % | Total | % |
|---|---|---|---|---|---|---|
| Students more enthusiastic about science | 9 | 69 | 12 | 85 | 21 | 77 |
| Atmosphere of acceptance about hands-on as approach to teaching science | 8 | 61 | 12 | 85 | 20 | 74 |
| More science materials available for teachers to use in their classrooms | 8 | 61 | 12 | 85 | 20 | 74 |
| Teachers are more comfortable with hands-on approaches to science | 8 | 61 | 12 | 85 | 20 | 74 |
| Science has become a higher priority in the school | 8 | 61 | 11 | 78 | 19 | 70 |
| Teachers are spending more time on science | 7 | 53 | 11 | 78 | 18 | 66 |
| Primary teachers using activities in "It's Elementary My Dear" | 9 | 69 | 8 | 57 | 17 | 62 |
| Other | 3 | 23 | 4 | 26 | 4 | 14 |
| *Statement that best characterizes the school* | | | | | | |
| Teachers resistant to hands-on approach | 0 | 0 | 0 | 0 | 0 | 0 |
| TLC stimulated teachers' interest in hands-on methods | 0 | 0 | 6 | 42 | 13 | 48 |
| Teachers using hands-on methods more frequently | 6 | 46 | 5 | 35 | 11 | 40 |
| Teachers more likely to use hands-on approaches than other approaches for science | 2 | 15 | 2 | 14 | 4 | 14 |