Interventions/Outcomes Involving Teacher Leaders' Strategy of Designing and/or Providing Professional Development

Excerpted from Bliss, T., Fahrney, C., & Steffy, B. (1995). ***Secondary department chair roles: Ambiguity and change in systemic reform.*** **Lexington, KY: Institute on Education Reform. (ERIC Document Reproduction Service No. ED410 649).**

What appears to be prolonged neglect of the department chair role in professional development is mirrored in formal research. "Departments are emerging as one fundamental part of the organization of schools which researchers have disregarded" (Johnson, 1990). Despite the momentum of restructuring efforts, the research on discipline area departments in the American high school is still scant with very little attention given to the role of department chairs (Siskin, 1994). The prominent descriptions we do have of departments were developed for another purpose, such as describing good teachers or exemplary high schools, as in The Best Teacher in America (Matthews, 1988) and The Good High School (Lightfoot, 1985).

While the role of the department chair remains largely unattended, this role is unique in its official inclusion of both teaching and administrative responsibilities. The potential of this position is largely untapped and, in the context of systemic reform, unknown, thus creating a definite gap I the transition to more inclusive and facilitative leadership at the school site.

Any appearance of newly emerging leadership roles of secondary chairs in a reform context would shed light on policy and training issues associated with high school restructuring. Will chairs have central roles in restructured schools, given the strong emphasis on collegial planning and interdisciplinary teaching (Task Force on High School Restructuring, 1993; Sizer, T., 1992) or is the position destined to become obsolete given its traditional lack of attention?

What are the noteworthy aspects of the roles of department chairpersons involved in implementing both mandatory and voluntary reform initiatives in Kentucky? In the present study, we undertook a two part investigation in order to determine how secondary department chairs are currently functioning in reform efforts and how teachers feel department chairs could function more effectively. We surveyed a representative sample of department chairs concerning general roles and responsibilities. Additionally, teachers within selected departments were surveyed for their perceptions of three areas: actual and desired responsibilities of department chairs, degree of involvement in innovation, and collegiality within departments.

Excerpted from Burch, P., & Spillane, J.P. (2003). Elementary school leadership strategies and subject matter: Reforming mathematics and literacy instruction. *Elementary School Journal,* 103(5), 519-535.

In order to explore interactions between leadership and subject matter, we studied patterns in how administrators and curriculum coordinators across eight elementary schools in a large urban school district identified expertise for improving mathematics and literacy instruction. In particular we looked for patterns in leaders' emphases on internal expertise such as the practical insights of fellow faculty relative to external expertise such as university-designed staff development. Leaders not only enacted subject-matter views through their reform strategies, they also reported that their leadership strategies affected these views. Based on this evidence, we argue that leadership practice and leaders' subject-matter views have a reciprocal relation. What leaders do to improve instruction depends in part on their views of the subject matter. Nevertheless, leaders' views of teachers' subject-area needs also emerge through their leadership practice.

Excerpted from Coggins, C.T., Stoddard, P., & Cutler, E. (2003). *Improving instructional capacity through field-based reform coaches*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

This paper describes a new capacity-building role designed to promote tighter connections between the macro aspects of instructional leadership and more micro-level classroom practices. Positions for "reform coaches" have been developed in a number of schools and districts in the Bay Area School Reform Collaborative (BASRC), a foundation-funded non-profit school reform organization that provides grants and professional development support to schools and districts in the San Francisco Bay Area. Here, we examine the reform coach role, the functions it provides to the system, and its potential as a capacity-building strategy.

Because the coach role is focused on *capacity*-building, it is important to clarify how we define this term at the outset. Building capacity in a school refers to the development of skills and knowledge in both individuals and in the organization as a whole. It often involves creating new structures and roles to broaden participation. Building capacity for changed practice is a critical, through often under-specified, aspect of instructional leadership. It involves:

- Building capacity for instructional leadership at the school level
- Managing knowledge resources by, for example, connecting teachers to relevant academic research or organizing student data into a format that is accessible to teachers
- Direct coaching of teachers on topics related to their practice, such as literacy or differentiated instruction
- Building capacity for instructional support amongst teachers to support their peers

These functions are based both on our observations of the actual enactment of the role by the coach, as well as our interpretation of the roles they play that are distinct from other actors in their schools.

Excerpted from Even, R. (1999). Integrating academic and practical knowledge in a teacher leaders' development program. *Educational Studies in Mathematics*, 38(1-3), 235-252.

This article examines an attempt to make research in mathematics education meaningful for practitioners – teacher leaders and inservice teacher educators. It centers on making research more accessible to them, And on introducing ways in which research can be made relevant to them, as practitioners, even if it does not provide them with rules for action. This study is part of a more comprehensive study situated in the context of the *Manor Program*. The Manor Program aims to develop a professional group of teacher leaders and inservice teacher educators whose role is to promote teacher learning about mathematics teaching. Some of the program activities emphasize and build on the practical expertise of the participants. Others introduce an academic perspective. In the following section I give a brief overview of the Manor Program, elaborating its academic component which is the focus of this article (for a comprehensive description of the multi-facets of the Manor Program, see Even, in press).

Program Facets
The program emphasizes the following:

- The development of understanding about current views of mathematics teaching and learning.
- The development of leadership and mentoring knowledge and skills, and work methods with teachers.
- The creation of a professional reference group.

The program centers on cognitive, curricular, technological, and social aspects of teaching different mathematical topics; it examines critical educational issues; it enhances mathematical knowledge; it emphasizes the development of leadership skills and methods for working with teachers; it encourages discussion of practical difficulties and dilemmas; and it focuses on initiating change in school mathematics teaching and learning.

Operation of the program
In this article, I focus on the first group of teacher leaders and inservice teacher educators who started the program in the 1993-94 academic years. The program extended over three years in an effort to allow sufficient time for the participants to learn, experience and experiment with topics and ideas encountered. Further, there was a need for development and growth in the participants' conceptions, beliefs, and dispositions about eh nature of mathematics learning and teaching and about teaching teachers (Even, 1994). Such changes require time to become established.

During each school year the participants met weekly for four hours with project staff and guest lecturers, either in whole-group sessions or in parallel teams. In addition, they conducted weekly two-hour professional development activities, some explicitly focused in initiating change in mathematics teaching and learning. As an overall assignment for the year, the participants prepared portfolios that documented their learning experiences. They received feedback on partial drafts several times throughout the year, both from project staff and from their peers.

Academic component

Part of the program was devoted to developing the value participants attached to inquiry into student learning of different topics in mathematics and into student and teacher conceptions and ways of thinking. We wanted the participants to look at mathematics learning "from the student point of view", to examine what might be the meaning of the widespread constructivist claim (supported by numerous cognitive studies) that students' ideas are not necessarily identical to the structure of the discipline nor to what was intended by instruction; that students construct and develop their own knowledge and ideas about the mathematics they learn.

This component of the program seemed a natural place for focusing on research, deepening the academic background of the participants in mathematics education (the participants received graduate credit for this advanced academic component), and encouraging integration of knowledge learned in academy with knowledge learned in practice. In contrast with the approach of the Cognitively Guided Instruction (CGI) – a founder project that focuses on changing teachers' beliefs and practices by helping teachers acquire research-based knowledge about students' thinking – we did not provide the Manor Program participants with explicit research-based models of children's thinking in specific mathematical topics. Research on student thinking at the level of junior- and senior-high school mathematics does not seem to support this existence of such models. Rather, similar to the Integrating Mathematics Assessment (Rhine, 1998) and the Mathematics Classroom Situations (Even and Markovits, 1993); Markovits and Even, in press) approaches, we focused on presenting the program participants with research-based key features of student and teacher thinking in different mathematical topics. Thus we aimed at challenging and expanding the participants' understanding of students' and teachers' ways of making sense of the subject matter and the instruction.

A large part of this component of the program included reading, presentations and discussions of research articles on students' and teachers' conceptions and ways of thinking in mathematics. Later, the participants were asked to choose one of the studies presented in the course, replicate it (or a variation of it) with students and with teachers, and then write a report describing the subjects' way of thinking and difficulties, comparing their results with the original study. This article examines the first group of the Manor Program participants' encounters with research, as a means for intellectual restructuring, and concentrates on an examination of the nature of these experiences.

Excerpted from Fancsali, C. (2004). *Teacher Leaders for Mathematics Success (TL=MS)*. *Final evaluation report*. New York, NY: Academy for Educational Development.

Teacher Leaders for Mathematics Success (TL=MS) is a five-year project designed to build the capacity of Bronx teachers and schools in supporting continued improvement in mathematics education for all students in a standard-based environment. The project, implemented by the Institute for Literacy Studies at Lehman College and funded by the National Science Foundation., seeks fundamental educational change by enhancing the understanding of mathematics content, standards-based curriculum, and performance standards, as well as student-learning strategies among teachers, principals, and other administrators.

The project facilitates discourse about and reflection on the relationships between content knowledge, pedagogy, student learning, and school change. Its goal is to create conditions for institutionalizing teacher leaders as agents for instructional reform in mathematics within schools and districts. It is founded on the notion that "effectiveness of mathematics teaching and learning is a function of teachers' knowledge and use of mathematical content, of teachers' attention to and work with students, and of students' engagement in and use of mathematical tasks" (National Research Council, 2001). Working with three cohorts of approximately 20 schools and 80 teacher and administrator participants each, the project is organized around three schools and 80 teachers and administrator participants each, the project is organized around three levels of activities across three years for each participating cohort.

Level one immerses participants in an intensive study of mathematics topics aligned with standards-based curricula implemented in the schools, and their relationship to performance standards and student learning. During this first year, all participants are asked to attend a 60-hour summer institute. Once the school year begins, participants attend monthly Saturday seminars (eight Saturdays for six hours each) and work with a teacher consultant on a biweekly basis. The teacher consultant provides a range of services, including meeting with, and conducting observations of, teachers, facilitating team meetings, coteaching classes, and assisting in lesson and project planning. The teacher consultants also provide support to school in lesson and project planning. The teacher consultants also provide support school administrators and the district by participating in meetings, facilitating discussions, and conducting workshops. Through this immersion, participants enhance their understanding of mathematical concepts as well as develop effective strategies to teach these concepts in the classroom.

In level two, during the second year, TL=MS focuses on curriculum and leadership development as well as the development of mathematics "leadership action plan" for the school. Participants continue to attend professional development sessions on Saturdays and after school, and teacher consultants continue to visit the school, although less frequently. During this second year, TL=MS participants also involve other teachers and administrators in their school in mathematics reform. In level three, the third and final year of each cohort's involvement, participants focus on implementing their school's leadership plan and sustaining school-based leadership.

To recruit schools and participants, TL=MS staff made presentations at pricnipals' conferences in each Bronx district to outline program objectives and clarify criteria for nominating schools and team members. Schools were encouraged to nominate teams tat included three teachers and team members. Schools were encouraged to nominate teams that included three teachers representing a mix of experienced and new teachers and a staff developer or administrator. Schools submitted applications to participate in the program to a steering committee comprised of district mathematics coordinators, district principals, the principal and co-investigators of the project, and Lehman College faculty. The committee selected schools for participation based on the following criteria: 1) school readiness, commitment to reform, and capacity; and 2) teacher, staff developer/administrator preparation and experience, in-service professional development related to nationally validated curriculum, and degree of exposure to standards-based curricula (Source: TL=MS project summary, Lehman College, undated). Participants received tuition-waved graduate credit or stipends for their involvement.

Excerpted from Fortner, R.W., & Boyd, S. (1995). *Infusing earth systems concepts throughout the curriculum*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.

In 1990 the National Science Foundation funded a three-year project entitled "Programs for Leadership in Earth Systems Education," with the acronym of PLESE. The principal program components were intensive three-week summer workshops designed to

- Provide teachers in grades 4-12 with up-to-date information on global change issues,
- Acquaint them with constructivist learning approaches so they could effectively help learners to acquire science knowledge,
- Equip teachers with integrated Earth systems activities they could use in their own teaching, and
- Help teachers develop skills to conduct their own workshops, thus extending the reach of the project to others in participants' local education environments.

Teachers were recruited in five-person teams to attend workshops with others from their region of the country. Teams were to consist of a teacher in each grade level – elementary, middle and high school – plus a college teacher and a school administrator from their area who could serve as facilitators for the teachers' follow-up work with the project. The three teachers participated together for three weeks in a workshop either at The Ohio State University (OSU) in Columbus, Ohio (for those in the Northeast, Southeast, and Great Lakes regions) or at the University of Northern Colorado (UNC) for those in the Pacific or Midcontinent regions (Table1). The administrators and college liaisons for those teams joined the teachers for a three-day period near the end of the workshop. Over the course of the project, fifty-eight teams with teachers representing 36 states participated in the summer workshops.

During the workshops, college faculty from the lead institutions, along with local teachers who had demonstrated leadership capability and interest in curriculum restructure, provided experiences focused on the workshop goals. For up-to-date science, each workshop had the services of three to four leading scientists who agreed to spend the same four days with participants as the teachers studied about the scientists' specialties. In cooperative learning sessions (jigsaw method) teacher groups first learned about the science topic through selected articles and a scientist, then taught the topic to teachers at their own grade level with the scientist in attendance. Over three days the teachers and scientists learned from each other. The scientist was able to see how teachers understood and planned to use the information, and the teachers came to trust the scientist as a person and their peers as teachers (Mayer, Fortner and Hoyt, submitted).

While science updates occupied most of the first week of the workshop, the work of the second week was also introduced at that time. Teachers from the same local team were to work together on development of a resource guide that would include exemplary ESE-type activities and reference materials designed to answer questions about an Earth system topic in relation to the framework of Understandings. The development of advance questions was critical to this effort. Those who believe in ESE as a model for curriculum structure are accustomed to thinking about classroom subject matter as being selected in answer to questions. If there is no question to be answered by an activity, why do it? To construct a good question, then, is to develop a curriculum design that has relevance.

In addition to giving substance to how ESE might integrate science in their classrooms, this exercise was designed to encourage articulation of subject matter across grade levels and build a team spirit by region. As in the science jigsaw, time was allotted to share resources within grade levels as well, so that all elementary teachers, for example, would become aware of exemplary materials on the range of Earth system topics being explored by all groups. Throughout this period, project staff integrated ideas for application of classroom computer technologies and demonstrated alternative assessment techniques useful in evaluating group learning.

The final week was spent in learning how to present a workshop to other teachers. While some participants were experienced in this, a large majority of teachers indicated that they never made a personal presentation to their peers before. Since the NSF funding included support for workshops to be conducted by the teachers in their home regions, it was important to assure that participants were prepared to accept that responsibility. With project staff oversight, groups of two or three teams worked together to design a three-hour workshop, which they presented to the other groups.

While completion of the resource guides and plans for peer teaching were in progress, the time came for the college and administrative liaisons to visit the workshop. After briefings on ESE philosophy and methods, liaisons joined their teachers to strategize about local efforts that could be accomplished by the group in the coming year. The liaisons were able to recommend audiences and conferences that would be appropriate to reach with ESE information and ideas, and in many cases liaisons became facilitators for the work of the teacher teams. Having representation of key support groups not only assisted the teachers, but also expanded ESE ideas into other colleges and served as program outreach for other teachers in the districts represented.

Other aspects of PLESE in addition to summer workshops included a quarterly newsletter, *PLESE Note*, which originated from the OSU project headquarters and included information from the teams, updates on science and new resources available to educators, calendar of opportunities, and articles of interest in curriculum restructure. At the end of the project the newsletter was reaching over 2200 readers. This activity of the project assured that participants and other interested people could be networked for sharing supportive information. An electronic bulletin board was also established, but even as the project came to an end the number of classroom teachers with access to electronic mail was very small.

As for leadership opportunities, the project was able to support key teachers who were restructuring their own curricula as a result of PLESE to attend national meetings and represent ESE for others. Teachers were supported to regional and national meetings of NSTA, the Geological Society of America, and Coalition for Earth Science Education.

During the final year of the project, teacher leaders from each of the five regional workshops were invited to a final workshop at the Colorado center. This “summit” followed the same general plan of the earlier workshops, but participants were charged with developing 1) a final set of exemplary activities and guidelines for others who would choose to infuse Earth systems concepts into their curricula, and 2) guidelines and suggestions for those interested in restructuring science education in entire schools and districts. The Resource Guide for earth Systems Education, entitled *Science is a Study of Earth*, was initiated through these efforts as a final product of PLESE that could become the beginning of curriculum restructure for teachers.

Excerpted from Frechtling, J., Katzenmeyer, C. (2001). Findings from the multi-agency study of teacher enhancement programs. In C.R. Nesbit, J.D. Wallace, D.K. Pugalee, A.S. Miller, & W. DiBiase (Eds.), *Developing teacher leaders: Professional development in science and mathematics.* Columbus, OH: ERIC Clearinghouse for Science, mathematics, and Environmental Education.

Working through DEWG, six agencies initiated a study of professional development programs: the Departments of Energy (DOE), Education (ED), and Health and Human Services (HHS), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Smithsonian Institution. The work was coordinated by NSF and carried out by three independent research firms—Westat, SRI International, and the National Center for Improving Science Education. In the long term, the evaluation and other efforts of the DEWG were designed to meet two basic goals:

- Identify those government-supported professional development programs in science, mathematics, and technology that are most effectively implementing and encouraging "best practice," and
- Assessing the extent to which these programs are contributing to the national effort to improve science.

More immediately, this evaluation was designed to document the teaching practices promoted in the selected professional development programs believed to represent best practice in science education at the time of study initiation. The study examined the impact of these programs on teachers and their teaching, assessed the extent to which dissemination took place, and determined participant satisfaction with the programs and their outcomes. In addition, the study tried to identify the contextual factors that affect a teacher's ability to apply new learning and use new approaches in the classroom setting. Based on an extensive review of the professional development literature available in 1994, best practice was defined in terms of four elements:

- An instructional approach that emphasizes hands-on/minds-on activities;
- A standards-based approach that aligns curriculum, instruction and assessment with local, state, or national standards or frameworks;
- Development activities that extend over time, including followup when participants return to their schools; and
- Direct involvement of participants in the scientific process.

Using these and other selection criteria, program officers from each of the six agencies nominated professional development programs they considered successful in delivering professional development in science teaching. Additional considerations governing selection were 1) stability; 2) inclusion of teachers who themselves were from populations traditionally underrepresented in science or who work with significant numbers of students from those underrepresented groups; and 3) inclusion of programs that were carried out within a systemic reform context.

Excerpted from Gillis, L., Glegg, L., Larkin, J., & Ojo, M. (1991). *The summative evaluation of the Science Quality Education Project (SQEP)* (Research Report No. 9-1990-91). Toronto: Ontario Educational Communications Authority. (ERIC Document Reproduction Service No. ED 328 453).

The goal of the Science Quality Education Project was to train teachers to make more effective use of television as a teaching tool and encourage greater use of TVOntario's science programming.

The project had two significant aspects. First, the SQEP experimented with a model of teacher in service training referred to as the trainer-of-trainers' model. It was hoped that this method of training would encourage more substantial change in teaching beliefs and practices than the "one-shot" workshops TVOntario had used in the past.

Secondly, the project was significant in that its implementation was guided by the educational change theory of MICHAEL Fullan (Dean of the Faculty of Education, University of Toronto). Fullan's (1982) theory has described the factors influencing the implementation of change in educational beliefs and practices. Key concepts from this theory were incorporated in the project planning.

The Science Quality Education Project was implemented at four curriculum levels (Primary, Junior, Intermediate, and Senior), each in a different board of education. The four school boards included: the Lincoln County Roman Catholic Separate School Board (Primary level), the Durham Board of Education 9Junior level), the Timmins Board of Education 9Intermediate level), and the Bruce County Board of Education (Senior level).

The SQEP was administered by four TVOntario project leaders, and each project leader was responsible for a school board. The TVOntario project leaders were each paired with the leader of a board and together the two planned and conducted the training for that board. Since each board administered its own training, the SQEP was frequently described as four separate projects (i.e., a Primary project, a Junior project, etc…).

During the first phase of the project, roughly spanning the time period from January 1987 to June 1988, the TVOntario project leaders worked closely with the boards to organize and begin the training sessions. In the second year, from September 1988 to June 1989, teachers practiced their training and initiated others. Both phases of the project have been documented by TVOntario's Evaluation and Project Research Branch (see Glegg, 1988, 1989).

Beginning in September 1989, the SQEP entered its third year. As planned, the boards assumed full ownership for their projects, while TVOntario limited its involvement to a consultative role. It was hoped that during this third year, teachers would continue to apply their training to their own teaching and at the same time, continue to affect change in others.

The Trainer-of-Trainers' Model

The trainer-of-trainers' model of in service teaching is a relatively new model for TVOntario, though it has been used elsewhere. TVOntario's first experience with this model was in the "Renfrew Quality Education Project" (Sharon, 1987).

In this model, the training is first concentrated on a small group of carefully selected teachers. After this "model" group is trained, they then become trainers for their colleagues. The colleagues then train others, such that the effects of training continue to ripple throughout the school board.

In the past, projects using this model have employed a variety of methods to extend the training beyond the original group. The "Renfrew Quality Education Project," for example, used what was called the "collegial approach," where the first group of trained teachers modeled their newly acquired skills for colleagues. The teachers in the SQEP used a variety of methods including: informal sharing with colleagues, workshops, and peer coaching as described by Joyce and Showers (1980).

To apply this model of training in the SQEP, a small group of teachers was selected in each of the four school boards. Within each of the boards, this small group – who were sometimes referred to as the model teachers 0 met on a regular basis during the first eighteen months of the project. These meetings typically occurred once every month or every two months.

The content of the training sessions varied somewhat from board to board but generally addressed many of the same topics. Teachers were taught the proper use of equipment and shown techniques for using videotape television more effectively in their teaching. These included: showing segments of programs, starting and stopping the tape for discussion, pausing, replaying, or turning the sound off to encourage more independent thinking. The aim of the techniques is to enhance students' interaction and involvement with the videotape presentation and thereby improve learning. The participants were also instructed on the importance of fostering in their students critical television viewing skills and a better appreciation of television's unique communication capabilities.

Another purpose of training was to familiarize teachers with TVOntario's science programming and show them ways in which the programs could be related to the curriculum and integrated with follow-up activities. In some sessions, teachers were encouraged to develop lesson plans incorporating videotape television with other curriculum-related activities in an integrated unit of study.

Teachers were also taught some of the basic principles of adult education, particularly with regard to giving workshops or making presentations. Some of the groups also experimented with "innovation Profiles" – a self-evaluation scheme developed by Ken Leithwood at the Ontario Institute for Studies in Education. Using this scheme, the groups created a profile of the skills of a successful television-using teacher; the skills were then organized along the continuum of increasing proficiency. The continuum provided a benchmark against which teachers could evaluate their progress infusing television more effectively.

The training in the Primary- and Junior-level projects differed in that greater emphasis was placed on using television in conjunction with a child-centred activity-based approach to science instruction. The Intermediate- and Senior-level projects experimented with computer conferencing.

Excerpted from Lewthwaite, B. (2006). Constraints and contributors to becoming a science teacher-leader. *Science Education,* 90(2), 331-347.

This inquiry examines the personal attribute and environmental factors that contribute to and impede science teacher-leader development. Using a narrative approach, the inquiry focuses on the experiences of three teachers in three different New Zealand primary schools (Years 1-6) as they develop their capabilities as science teacher-leaders during sustained school-wide science delivery improvement projects. Bronfenbrenner's bio-ecological model and Rutter's views on resiliency are used as a foundation for interpreting the science teacher-leader development process. Teachers identify a variety of personal attribute and environmental factors and the interplay between these factors as a risk and supportive factors contributing to and impeding their development as science teacher-leaders. Teachers also identify that their development is influenced by several proximal processes that are context and time dependent.

Excerpted from Manno, C.M., & Firestone, W. (2006). ***Content is the subject: How teacher leaders with different subject knowledge interact with teachers.*** **Unpublished manuscript submitted for publication.**

This study focused on eight teacher leaders who participated in a professional development program for teacher leaders—the Teacher Leader Institute—presented by the New Jersey math Science Partnership (NJ MSP). The NJ MSP was a consortium of two universities and 11 school districts working together to improve student achievement in mathematics and science through a variety of means. One strategy was to strengthen leadership for change, in part by helping districts to identify and prepare teacher leaders to support other changes being supported by the MSP. TLIs were held in the summers of 2003 and 2004 with follow-up activities during the year and the following summers. Districts sent cohorts of teacher leaders to develop a vision for improved math and science instruction, improve their content knowledge, and learn how to work with their peers.

A two-person team observed the 2003 TLI for two days and interviewed 18 participants. These observations were repeated during the 2004 TLI. More important, a sample of eight teacher leaders was identified to follow during the upcoming academic year to learn about a variety of issues, including how their content knowledge influenced their work as teacher leaders. Here we briefly describe the sample, methods of data collection, and data analysis strategies.

Sample
A purposive sample was selected among participants in the 2004 TLI to obtain variation on two dimensions. The most important was content expertise. A *content expert* was defined to have a minimum of an undergraduate major in the teacher leader's content area and teaching certification in that area. A non-content expert was defined to be a teacher leader without a major and certification in the content area, either mathematics or science.

Excerpted from Miller, A.S., Wallace, J.D., DiBiase, W.J., & Nesbit, C.R. (1999). ***Pebbles in the ocean or fountains of change? New insights on professional development: Examining the links—Professional development, teacher leaders, and school change*****. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Boston, MA.**

This study provides a holistic analysis (Patton, 1990, p. 49) of a long term, large scale science and mathematics professional development project which was conducted by the Mathematics and Science Education Network (MSEN) of the University of North Carolina (Franklin, 1993) from 1990-1993. The project, which was funded by a three year grant from the U.S. Department of Education, Dwight D. Eisenhower mathematics and Science Education Programs, Fund for the Improvement and Reform of Schools and Teaching (FIRST), was composed of 15 two year professional development programs held at 8 university sites over a 3 year period (one university site did not participate in the first year of the project). Each university site recruited schools to participate with priority given to the schools which met one or more of the following criteria: minority population greater than the North Carolina average of 33%, a high percentage of students in the federal lunch program, or location in a small town (less than 5,000) or rural area. Of the 183 participating schools, 21% met all three criteria, 56% met two criteria, and 20$ met one of the criteria (Franklin, 1993, p.5). The schools were recruited in a variety of ways by each university sites, with approximately 12 schools participating in each of the 15 professional development programs. There were 88 schools that participated in the first year of the project and 95 schools during the second year. The majority (55%) of the schools had a student enrollment in the medium range of 250-500 students (p.5). There were 45 schools (25%) with a minority population of less than 15%, 41 schools with a minority population of 15-33%, 47 schools with a minority population of 34-50%, 36 schools with a minority range of 51-75%, and 14 schools with greater than 75% minority population.

There were 354 lead teachers who began the project and demographic data was available for 349 (Franklin, 1993). Most of the lead teachers were female (94%) and 80% of the lead teachers were white, 17% African-American, and 3% other. The educational level included 67% with a Bachelor's degree, 31% with a Master's degree and 2% other. Sixty-one percent of the lead teachers taught in grades 3-6, with 33% in grades K-2, and 6% in other grades or areas. The average length of experience for the lead teachers was 11 years with a range of one to 30 years. Most teachers had majored in elementary or intermediate education in college with only 8% majoring in either mathematics or science. The lead teachers and the other teachers in their schools were similar with respect to gender, ethnicity, and educational level. One difference between the two groups was that other teachers included 46% who taught in grades K-2.

This project was designed to help improve science and mathematics teaching in North Carolina elementary schools. The overall project plan included site-based planning based on needs assessments, professional development that was responsive to the needs of the lead teachers at that site and reflected national standards, involvement of the lead teachers and principals in the change process, and "fostering collegiality through peer teaching"

(Franklin, 1993, p.2). Additionally, the project was designed to be long term, include follow-up activities, provide support to lead teachers and schools, and to encourage the development of groups of teachers who could help each other in the change process, and be responsive to the instructional level of the participating teachers.

Each participating school was represented by a team comprised of two teachers and their building principal. The lead teachers from each participating school conducted a Needs Assessment in science or mathematics or both with the teaching staff and the principal of that school. This Needs Assessment (Franklin, 1990) was based on the National Science Teachers Association Self Assessment (Voss, 1987) and rated items on importance and achievement. The Needs Assessment data for each participating school was used by that school to identify perceived strengths and weaknesses in order to develop a School Improvement Plan (SIP). The SIPs were used by each program coordinator to plan a unique professional development program that was responsive to the needs of the 12 schools in that program.

The professional development programs varied from 110 to 141 contact hours, with incomplete data on one program. Project guidelines suggested that a leadership component be included in the professional development program, that principals be involved in the development and implementation of school improvement plans, and that lead teachers would work with other teachers at their school to share activities, strategies, and equipment. Participating teachers attended three academic year sessions (about 10 contact hours), an intensive (approximately 75 contact hour) Summer Institute, about six follow-up sessions during the second academic year (10 contact hours), and a 25 contact hour Summer Workshop the final summer. While principal support and participation was a project requirement, actual support and participation varied. Lead teachers developed a variety of ways in which to share with their peer teachers; sharing strategies ranged from one-on-one contact to formal workshop presentation to the entire school faculty.

Moore, J.L. (1992). The role of the science co-ordinator in primary schools. A survey of headteachers' views. *School Organisation*, 12(1), 7-15.

Following the introduction of the National Curriculum it may be expected that the role of curriculum specialist has been further enhanced as school are called upon to deliver new sets of content and meet new standards. The co-ordinators' role may be especially significant in science, a core subject of the National Curriculum and one in which many primary schoolteachers have traditionally felt under-qualified.

Training in a subject specialism such as science is now an established part of primary courses of ITT. Subject specialism modules are regarded by some as basic training for assuming the role of co-ordinator. Pre-service training needs to be extended through suitable programmes of In-service Education and Training (IN-SET). Regardless of how they are trained, co-ordinators have to apply their skills in the context of their own school. The Headteacher plays a key part in determining this context and in deciding the role of the co-ordinator. To be effective change-agents science co-ordinators need resources, time and the moral support and encouragement of their Headteachers to carry out clearly defined duties.

Because Headteachers determine both the context and purposes of the coordinators' work, it seemed worthwhile to try to discover their views about science co-ordination. The study was guided by a wish to discover Headteachers' views per se rather than to determine whether or not they were congruent with a particular model of co-ordination or a chosen set of recommendations.

Method

In a pilot survey to be reported elsewhere 20 Headteachers of one local education authority (LEA) were interviewed and asked to describe the role of the science coordinator. If they were not mentioned spontaneously, direct questions were asked about the co-ordinator's role in curriculum development, their responsibility for resources, and the ways in which he or she helped colleagues with science teaching. The pilot survey confirmed that there was a range of Headteachers' views on the work of science coordinators and that a wider survey would be worthwhile.

A questionnaire was drawn up from the pilot survey interviews. Small revisions were made after consultations with two primary Headteachers. The questionnaire which was limited to a single folded A3 sheet, contained four parts. The first asked for a statement of the co-ordinator's role, work in developing the science curriculum and responsibility for resources. The second part asked the Headteacher to indicate on a list the ways in which they wished the co-ordinator to support colleagues in their science teaching. The third part asked about sources of help and information for co-ordinators and the skills needed for the role. The final section asked for the Headteachers' views on the responsibility the co-ordinator should have for deciding on resources, teaching methods and teaching activities.

Excerpted from Russell, A.A. (1990). *The dissemination of doing chemistry. Final evaluation.* Washington, D.C.: American Chemical Society. (ERIC Document Reproduction Service No. ED 359 039).

Between January 28, 1989 and January 30, 1990, Professor David Brooks and one of four different high school teachers who had been involved in the production of the Doing Chemistry materials conducted 19 workshops for 206 high school teachers who would become Doing Chemistry lead teachers (Table 1). The workshops were held in 18 different states and at the ChemEd conference in Kingston, Canada. The lead teachers came from 46 states, the District of Columbia and Puerto Rico. In addition 28 observers attended the workshops. Each lead teacher who was trained in a workshop was given the Doing Chemistry videodiscs, a set of Macintosh Hypercard program stacks, and the 620 pages of written materials. As trained lead teachers, they were expected to use the Doing Chemistry materials to train other teachers to use more laboratory activities in their classrooms.

Excerpted from Slater, T.F., Coltharp, H., & Scott, S.A. (1998). A telecommunications project to empower Kansas elementary/middle level teachers as change agents for integrating science and mathematics education. *School Science & Mathematics*, 98(2), 61-66.

Lead Teacher Empowerment

Using a guiding principle that permanent change comes from classroom teachers, 24 in-service teachers participated in 100 hours of workshops during the summer of 1995. The workshops emphasized using hands-on manipulatives for science and mathematics to bring about positive attitude changes toward using constructivist pedagogy. The topics for the workshops were selected by polling the participants as to what topics they perceived to be most needed by all inservice teachers in Kansas. An abbreviated list of selected topics can be found in the appendix. This cadre of teacher-participants became the project's lead teachers. The workshop was led by the authors and two regionally recognized master teachers. Additionally, the workshop included two day-long field trips to enhance collegiality.

Following the initial summer leadership workshops, the lead teachers ordered a total of $20,000 in hands-on manipulatives and science equipment to determine "what works" in their classrooms. Lead teachers met after school twice each month during the school year via video-teleconferencing links to share ideas, results, and frustrations.

Teacher-led Workshops

During the summer of 1996, 13 summer workshops were delivered to 235 in-service teachers using the master teacher or key teacher method (Carpenter, Smith, Astwood, Wideman, & Ryan, 1993; Ross, 1990). The lead teachers created four distinct 1996 summer workshops: manipulative-based mathematics; scientific inquiry; integrated science/math; and advanced integrated science/math. The workshops adopted a consistent theme of "Teachers Teaching Teachers: What Works for Integrated Math and Science Instruction" and covered the topics listed in the appendix. The workshops were conducted by teams of two to six lead teachers daily. Lead teachers purchased an additional $10,000 in instructional materials to conduct the workshops. Each workshop was designed for 16 contact hours and one graduate semester credit (except for Integrated Science/Math, which was designed for 32 contact hours and two graduate semester hour credits). Advertisement and scheduling of the workshops was accomplished by the authors through school district visits, school building posters, and direct mailings.

As shown in the appendix, the lead teachers decided to provide workshop participants with a wide variety of activities through numerous examples. The general format was for lead teachers to lead the workshop participants through a 40-minute activity. Afterwards, the lead teachers would facilitate a 20-minute discussion among the workshop participants about how to best integrate the activities into local curricula and provide copies and descriptions of three to four supporting activities as examples. This process would be repeated four to six times each day.

For example, the manipulative-based mathematics workshop began with an introduction to geoboards and a challenge to make a variety of geometrical shapes with given constraints (e.g., create 10 polygons with an area of 3 square units). Then lead teachers asked workshop participants to create and share other tasks for students. Finally, the lead teachers would model "lesson debriefing" by providing a possible list of activities for students that workshop participants might like to try in their own classrooms. This discussion always included questions about what cross-curricular connections could be drawn from each activity and strategies to make the activity more integrated between science and mathematics. This general model was used for each of the topics shown in the appendix.

Excerpted from Spillane, J.P., Diamond, J.B., Walker, L.J., Halverson, R., & Jita, L. (2001). Urban school leadership for elementary science instruction: Identifying and activating resources in an undervalued school subject. *Journal of Research in science Teaching*, 38(8), 918-940.

Our central aim is to analyze the resources for leading innovation in urban elementary schools in order to understand how resources are identified and activated in the cause of science education. More specifically, we examine how school leaders bring resources together to enhance science instruction when other subjects, by virtue of tradition and formal policy, command the bulk of the resources. We begin by outlining the theoretical frame for our research and describe our study of leadership for instruction in 13 Chicago elementary (K ± 8) schools. We then consider how the subject matters when it comes to resources for leading instruction in urban elementary schools by comparing resources for leadership in mathematics, science, and literacy in these schools. After describing the between-school variation in the resources for leading science education, we analyze a case of one urban elementary school that successfully identified and activated resources for leading change in science education.

Theoretical Underpinnings

We frame the research reported here using a distributed perspective on school leadership. We also draw on theoretical work about the nature of resources for human action and the activation of these resources in particular contexts. By leadership we mean the guiding and directing of instructional innovation in schools. We define school leadership as the identification, acquisition, allocation, coordination, and use of the human, social, and material resources necessary to establish the conditions for the possibility of instructional innovation. ``Innovation is the generation, acceptance, and implementation of new ideas, processes, products, or services. . . .[I]t can involve creative use as well as original invention" (Kanter, 1983; p. 20). Leadership involves mobilizing school personnel and clients to notice, face, and take on the task of changing instruction as well as identifying and activating the resources needed to support this process.

Our study is premised on a distributed notion of leadership (Spillane, Halverson, & Diamond, 1999, 2001). Consistent with previous work that critiques the focus on positional leaders (Barnard, 1968; Heenan & Bennis, 1999; Heller & Firestone, 1995; Katz & Kahn, 1966; Lipmam-Blumen, 1996; Ogawa & Bossert, 1995), we see school leadership as distributed among formal and informal leaders. Leadership is an organizational quality (Ogawa & Bossert, 1995; Pitner, 1986; Pounder, Ogawa, & Adams, 1995) that reaches beyond the work of individual positional leaders. Hence, any investigation of the resources for leading innovation in science education has to consider more than positional leaders. Our distributed perspective, however, goes beyond considering a division of labor for leadership functions to argue that the thinking and practice of leadership is stretched over school leaders and the material and symbolic artifacts in the environment. Appropriating several concepts from work in distributed cognition and activity theory (Cole & Engestrom, 1989; Hutchins, 1995b; Lave & Wenger, 1991; Leont'ev, 1981; Pea, 1993; Resnick, 1991), we argue that the social, material, and symbolic situation is an integral and constituting component of leadership practice. Leadership practice emerges in and through the interaction of leaders, followers, and situation in the execution of leadership tasks.

If a distributed perspective on leadership is assumed, then what constitutes the resources necessary for school leadership is a central issue. Much of the literature on relations between school resources and student outcomes focuses on conventional resources that are easily measured—expenditures, teachers' educational levels, physical materials, and the like (Cohen, Raudenbush, & Ball, 1999). We use three categories of resources for leadership, which correspond to the economic concepts of physical capital (i.e., financial resources as deployed in time, etc.) and human capital and to the sociological concept of social capital.

Physical resources include money and other material assets. The time and staffing that school leaders have available to spend on reforming instruction do not constitute a form of capital because according to Webster's Third New International Dictionary, capital is the ``accumulated assets, resources, sources of strength, or advantages utilized to aid in accomplishing an end or furthering a pursuit." However, time and staffing do represent an allocation of the financial resources, a method of using or expending continuing revenue rather of accumulating capital. Therefore, we view them as material or financial resources (Spillane &Thompson, 1998).

Human resources include individual knowledge, skills and expertise that might become a part of the stock of resources available in an organization. ``Just as physical capital is created by changes in materials to form tools that facilitate production, human capital is created by changes in persons that bring about skills and capabilities that make them able to act in new ways" (Coleman, 1988, p. S101). For example, the knowledge and skills of school leaders represent a form of human capital that may be productive in transforming science education.

Social capital concerns the relations among individuals in a group or organization and results from the prevalence among individuals of such norms as trust and collaboration as well as a sense of obligation. ``Social capital . . . comes about through changes in the relations among persons that facilitate action. . . ." (Coleman, 1988, p. 98). Social capital facilitates productive activity just as physical capital and human capital do. It ``inheres in the structure of relations between actors and among actors" (Coleman, 1988, p. 98). For example, ``a group within which there is extensive trustworthiness and extensive trust is able to accomplish much more than a comparable group without that trustworthiness and trust" (Coleman, 1988, pp. S101± S102). Moreover, social capital can facilitate the transfer of information among people, thus increasing the individual and collective knowledge of organizational members. Social capital can also refer to information and resources that are inherent in social relationships that extend beyond the particular organization. For example, the social networks of school leaders might provide them with access to useful information or resources with which to enhance a school's instructional program, resources that would not have been accessible to the school absent these relationships.

Excerpted from Venville, E.M., & Jones, M.G. (1998). Gardens or graveyards: Science education reform and school culture. *Journal of Research in science Teaching,* 35(7), 757-775.

This project was initiated by the Education Department of Western Australia in the afterwash of the MSE report, *Profiles of Student Achievement in Science in Western Australian Government Schools* (Education Department of Western Australia, 1994a). Under pressure to respond to the disappointing MSE results, the Western Australian Minister for Education announced the Science Project, a four-year initiative to improve the status and priority of science, provide curriculum materials and support professional development for teachers (Education Department of Western Australia, 1994a). The Science Project was managed by the office of the Superintendent (Science) and advised by a cross-sectoral committee including representatives from the Catholic Education Office, the independent sector, universities, the Science Teachers Association of Western Australia (STAWA) and the Scitech Discovery Centre. The overall goals of the Science Project were to:

1. provide all schools with access to exemplary curriculum materials;
2. establish an effective, whole school curriculum in primary schools;
3. establish science teaching methodology in primary and secondary schools consistent with identified best practice;
4. provide access for teachers to update their knowledge of science and its role in society; and
5. establish networks of curriculum leaders to provide ongoing support for teachers. (Education Department of Western Australia, 1995)

Several concurrent primary school projects were conducted under the umbrella of the Science Project. These included a joint project with STAWA to support *Primary Investigations* training, the Twelve Schools Project, an evaluation of primary science curriculum materials, and teacher access to science content upgrade courses. The major effort, however, was directed to the Primary Science Teacher-Leader Project which was steered by a committee of representatives from the Education Department, three Western Australian universities and the Scitech Discovery Centre. The project commenced in 1995 with 29 teacher-leaders, one from each of the geographically organised education districts in Western Australia. In 1996, a second teacher-leader was selected from each district. Where the 1995 leader did not continue for the second year, the district was offered two positions for the 1996 project. In each year several leaders were based in district offices while others were school-based. Five additional leaders were included in the 1996 project, each with specific expertise in one of the following areas: early childhood education, English as a second language, education support, Aboriginal education, and isolated and distant education.

In the initial year, the 29 teacher-leaders were involved in ten days training focusing on aspects of planning, teaching and assessment of primary science, identification of best practice, science content, examination of teaching resources and support materials, and ways of providing support for other teachers at the school and district level. The second year of the project involved the ongoing training of the 1995 primary teacher-leaders and the training of the new primary teacher-leaders for 1996, a total of 65 participants in all. The 1995 teacher-leaders participated in a total of four days training in their second year and the 1996 teacher-leaders participated in a total of nine days training. The training was provided by a broad spectrum of science educators from three local universities, Scitech Discovery Centre, STAWA, the Education Department and industry. The purpose of the training for 1995 leaders in 1996 was to provide ongoing training in science content, teaching pedagogies, the use of outcomes statements and train-the-trainer skills to deliver professional development within their districts. The program aimed to provide training in:

1. effective implementation of whole school programs to suit the needs of individual schools;
2. best practice in the teaching and learning of science in primary schools;
3. the use of outcomes to monitor student achievement in science;
4. effective strategies to support primary school teachers in primary science; and
5. the integration of teaching and learning of science with other learning areas.

At the district level, primary teacher-leaders were asked to work with their district offices to plan and implement a science support program for local teachers. These local support programs were funded by the project, each district receiving A$5,000 in 1995 and between AS 12,000 and A$16,000 in 1996. The fourteen metropolitan districts each were made up of approximately 30 primary schools and the fifteen rural districts approximately 25 schools with primary-aged students. The rural districts generally consisted of a central town with one or more primary schools and several other primary schools in centres ranging from 20kin to several hundred kilometres away. The teacher-leaders were required to submit a proposal for their local support program, including a budget, to the Superintendent (Science) for approval. The funding was used to pay for a variety of activities as will be discussed in the case studies later in the results section of this paper.

Excerpted from Wallace, J.D., Nesbit, C.R., & Miller, A.S. (1999). Six leadership models for professional development in science and mathematics. *Journal of Science Teacher Education.* 10(4), 247-268.

The project on which this study is based was conducted by the University of North Carolina's Mathematics and Science Education Network (MSEN) and funded by a three year-grant from the U.S. Department of Education's Fund for the Improvement and Reform of Schools and Teaching (FIRST). The FIRST project was developed to improve elementary school science and mathematics in North Carolina by supporting teams of two lead teachers and their principals from 180 schools across the state.

To bring about this improvement, the teams of lead teachers made an assessment (Franklin, 1990) of the strengths and weaknesses of their schools' science or mathematics programs. Each team then developed a School Improvement Plan (SIP) designed specifically to meet their school's needs. Based on these School Improvement Plans, Program Coordinators at each university site planned a unique two-year professional development program for lead teachers that was designed to help each school carry out its plan.

The project was conducted at seven sites during years one and two and eight sites during years two and three—thus a total of 15 separate programs were provided. Seven programs focused on science, six on mathematics, and two on both subjects. The professional development programs included:

1. Orientation and Planning Presessions—Lead teachers and their principals learned about the project, completed a science and/or mathematics needs assessment, and each team analyzed their school's results. At most sites, these preliminary sessions also included some "visioning" activities; that is, teachers and principals were shown what an ideal elementary mathematics or science program might look like according to current national standards. Finally, lead teachers used needs assessment data and input from their faculty to develop a School Improvement Plan.

2. Summer Institute—Lead teachers at each site attended a three-week Summer Institute (approximately 75 hours) designed to help them implement their School Improvement Plans.

3. Academic Year Follow-up Sessions—During the year, teams at each site met approximately six times to receive additional training and to discuss successes, problems, and strategies.

4. Summer Workshop—A final one-week workshop (approximately 25 hours) provided additional professional development activities and future planning for the project's lead teachers.

