AN ABSTRACT OF THE THESIS OF

Sandra Henderson for the degree of Doctor of Philosophy in Science Education presented on July 19, 2001. Title: Partnerships between Secondary/Elementary Science Teachers and Laboratory-Based Scientists: Delineating Best Practices

Abstract Approved:

Redacted for privacy

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Given the high probability of national and federal research laboratories continuing to sponsor science education partnerships between their staff and classroom science teachers and the dearth of research in this area, this study set out to delineate best practices associated with such partnerships for the purpose of increasing the effectiveness of future partnerships. This investigation critically examined two science education partnerships at selected federal research laboratories over the course of summer workshops and the subsequent academic year. Sources of data included interviews, workshop observations, electronic mail communication, written program evaluations, and casual conversation.

A unique feature of this research was the inclusion of all representative groups including program administrators, laboratory scientists, and the participating classroom teachers. By capturing the perspectives of all participant groups, this research was able to present a complete portrayal of science education partnerships at two national research laboratories. The longitudinal nature of this investigation allowed for all

components of each program (e.g. planning, organization, implementation, evaluation, and follow-up) to be included in the research.

The determination of best practices in science education partnerships provided the framework for this research which clearly showed the underlying importance of the need for all participants to understand the goals and what is expected of them before the program gets underway. To be achievable, individual and programmatic expectations must be in alignment with the overall goals of a program. To be attainable, the goals must be understood by all and provide a framework for the expectations. Without a clear and shared vision of a programs direction, goals and expectations are not likely to be fulfilled. The common thread for each of these components is communication and its importance during all stages of a program cannot be overstated.

Additional findings suggest a variety of areas that should be considered important in science education partnerships. Insight into effective classroom transfer, the role of lead teachers, the role of scientists and science content, and program evaluation was developed as a result of this study.

Partnerships between Secondary/Elementary Science Teachers and Laboratory-Based Scientists: Delineating Best Practices

By

Sandra Henderson

A THESIS

Submitted to

Oregon State University

In partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed: July 19, 2001

Commencement: June 2002

Doctor of Philosophy thesis of Sandra Henderson presented on July 19, 2001

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any ready upon request.

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Sandra Henderson, Author

ACKNOWLEDGEMENTS

It is a wonderful sensation to be writing the acknowledgements page because that means the thesis has been completed! And it could not have been completed without the support, encouragement, and guidance of so many.

First, I would like to thank Norm Lederman for many years of support and guidance. Norm provided a challenging learning environment and consistently encouraged me to reach for a higher standard. I am indebted to him for sharing his wisdom and insights in the field of science education. Norm simultaneously provided specific direction as well as the freedom to explore ideas of my own. It is my intent to become a science educator whose actions reflect well on Norm.

My doctoral committee has my sincere appreciation for staying the course with me. Margaret L. Niess, George King, and Jodi Engel were all instrumental in helping me understand what I had to learn and in providing the right mix of instruction and friendship. I am also very grateful that Kathleen Heath was appointed as my graduate council representative.

Many people passed through the Department of Science Education during my tenure, and they have all contributed to my education and this thesis in some way. I would like to thank all the past and present graduate students for many useful discussion and general camaraderie. I would especially like to thank Kathy Howell, for countless bits of advice and friendship over many years.

This thesis could never have been written without the cooperation of the many teachers, scientists, and program administrators who gave so generously of

their time. I would especially like to thank the key informants in this study - several became good friends. For their ongoing support and encouragement, I would like to thank my former friends and colleagues at the U.S. Environmental Protection Agency laboratory in Corvallis and my current friends and colleagues at the National Center for Atmospheric Research in Boulder.

My husband, Tony Selle, never gave up on me and remained steadfast in his belief that I would finish. I appreciate his patience, encouragement, support, and, of course, his proof-reading skills. Our children, Scott and Annie Henderson-Selle, were a source of inspiration. I wanted them to understand that no matter what happens in life, there are projects worth finishing, even if only for personal satisfaction. I hope it is a lesson they learned.

During the course of this research, I was diagnosed with cancer. I am indebted to the many doctors and health professionals who made it possible for me to be here today. During the past few years, I have met many cancer patients who have taught me strength and courage in the face of adversity. To those who have lost their battle, my heartfelt gratitude for allowing me to take part of your spirit with me on this journey. You will never be forgotten.

And finally, I must give thanks to 'Jimmy Dean,' my equine companion who never asked me how the dissertation was coming along. His gentle strength was a source of comfort and centering when life got hectic. But most of all, I want to thank Jimmy for teaching me that it is never too late to grow up to be a cowgirl!

Happy Trails

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To Tony, who made it all possible.

Partnerships between Secondary/Elementary Science Teachers and Laboratory-Based Scientists: Delineating Best Practices

CHAPTER I
THE PROBLEM

Introduction

With the publication of A Nation at Risk in 1983 by the National Commission on Excellence in Education, the educational system of this country found itself the target of intense criticism not unlike the criticism following the launching of Sputnik in 1957. The past two decades have witnessed efforts directed at wide-scale reformation of the nation's school system as all areas of education are being scrutinized. As part of the reformation effort, collaborations and partnerships between schools and outside entities are being encouraged (Bybee, 1997; Flick et al. 1996; Goodlad, 1988; Spector, et al., 1996; Tucker, 1991). In science education, scientists are being encouraged to establish linkages with educators as evidenced by this statement from the National Science Education Standards; "Scientists must take the time to become informed about what is expected in schools and then take active roles in support of policies to strengthen science education." (NRC, 1996, p. 238)

As part of the current pre-college science education reform efforts, there is increased encouragement for the scientific community to collaborate with schools and classroom science teachers. At the federal level, there is a concerted effort to marshal the scientific expertise of the national laboratories and include non-university based scientists in programs that focus on pre-college science and technology education. In the past decade alone, the federal government has spent hundreds of millions of dollars on programs that link national laboratory scientists

(e.g., Department of Energy, U.S. Environmental Protection Agency, National Aeronautic and Space Administration) with the education community (Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), 1992).

A review of the history of science education in this country, reveals that scientists have been a part of pre-college science education since the Committee of Ten in the late 1800s (Atkin & Atkin, 1989; DeBoer, 1991; Maeroff, 1983). In this case, the role of the scientists was advisory in that they suggested how science should fit into the curriculum with an emphasis on helping students make the transition from secondary schools to college. The Committee of Ten is credited with having a strong influence establishing science as a course of study in secondary schools.

From the turn of the century, until after World War II, scientists were largely uninvolved in science education (DeBoer, 1991). The end of the war brought about nationwide concern regarding the lack of scientists to lead the country as it faced new challenges in a changed world. The war had demonstrated the importance of science and technology in meeting military and national security needs. To address the shortages of scientists, a presidential advisory committee was formed to review, among other items, the status of school science. Although the main impetus at that time was to train scientists for the workforce (and bolster national security), there was also a stated concern about science being accessible and useful to all citizens. As with the Committee of Ten, the input of the scientists was mostly advisory.

Scientists took an active role in science education after the successful launching of Sputnik in 1957. At that time, the science education community and the nation at large were in a crisis mode in an attempt to "keep up" with the perceived technological and scientific superiority of the Soviets. The federal

government channeled millions of dollars into pre-college science education in the years following Sputnik. Federal research scientists teamed up with university science educators to develop "cutting edge" science curricula. These curricula were distributed in an almost paternalistic fashion to science teachers across the country. The science teachers were largely uninvolved in the process and in many cases were not prepared to teach the new curricula. Although there is disagreement as to the effectiveness of the post-Sputnik reform effort, many educators consider this era a failure particularly in terms of lasting change (DeBoer, 1991; Klopfer & Champagne, 1990; Maeroff, 1983; Podeschi & Hackbarth, 1986).

As is evidenced by this brief historic overview, scientists have been involved in prior pre-college science education reform efforts. A commonalty of the past efforts is that the scientists were deemed to be the "experts" in pre-college science education and knew how to "fix" the problems. There was a marked absence of collaboration and communication between scientists and classroom teachers. This trend has changed with today's active encouragement of scientists and teachers to work together in furthering science education. Although we may have more insight on what didn't work, what insight do we have on what does work? The current emphasis on partnerships and collaborations calls for the interaction of two very different cultures (i.e. laboratory scientists and classroom science teachers). In a research sense, these are uncharted waters.

For the purposes of this research, a distinction will be made between university-based scientists and laboratory-based scientists. University scientists are those whose primary employment situation is through a university or college setting with a focus on research and/or classroom teaching. Laboratory based scientists are those individuals whose primary employment situation is at a government-funded research institution and not directly linked to a university

setting or classroom. In making this distinction, it should be noted that the two groups do have some overlap as many university scientists receive funding through federal laboratories and many laboratory scientists collaborate or teach occasionally at universities and colleges. The focus of this research will be on the laboratory scientists and their role in science education programs at the pre-college level. Partnerships and collaborations refer to educational programs that have mission or goal statements that suggest shared responsibility, commitment, and support from diverse institutions for the purpose of improving educational practice. Pre-college science education is used as an umbrella term to include the teaching of science at the K-12 level in all science disciplines (e.g. biology, chemistry, physics) in a formal school setting. When used in this proposal, the term science education partnership refers to partnerships linking laboratory-based scientists and pre-college science teachers.

Statement of the Problem

In the words of Bruce M. Alberts, President of the National Academy of Sciences, "...I now view effective partnerships between scientists and pre-college science teachers.....as the only hope for lasting systemic change in pre-college science education and, therefore, as an important national priority for the United States" (Sussman, 1993, p. 2).

Dr. Alberts' message is clear, however, what are the effective partnerships that he is promoting? Although partnerships are receiving a great deal of attention in both the popular press and the technical literature, there is very little research-based information on what constitutes an effective partnership. Most of what is written about partnerships are little more than testimonials touting the success or effectiveness of such programs. There is a dearth of research in terms

of what constitutes effective practices between laboratory-based scientists and classroom teachers. What are the best practices in reference to today's partnerships between scientists and educators? How can we make certain that today's efforts are not roundly criticized as yesterday's failures because we did not know enough? To be certain that collaborative efforts are effective, it is necessary to critically and systematically investigate partnerships.

Herein lies a major shortcoming of science education partnership programs. There is little evidence that such partnerships have been the subject of any critical inquiry either for the purposes of research or evaluation. In most reports on science education partnerships, the attention to a critical and rigorous evaluation is lacking and often appears to be an afterthought. Lacking a critical investigation, it is impossible to determine what practices contribute to the apparent success of a program. The lack of evaluation comes at a critical juncture as many of the federal funding agencies are demanding accountability of what has been accomplished for the dollars spent on collaborations (FFCSET, 1992).

Although there is widespread agreement on the importance of evaluating partnerships, in reality, critical evaluations are often lacking. Clark (1988), in a review of educational partnerships, noted a dearth of attention to the documentation and evaluation of partnership activities. According to Vivian (1985), evaluations are critical in providing credibility when linking different institutions. "Because collaborative programs are often, unfortunately, seen as nontraditional - because they may not be regarded as central to the mission of either institutional partner- they have special needs to provide sound evidence of their results." (p. 88) Vivian's statement has direct application when linking national research laboratories and classroom science teachers. Partnerships between these two cultures must be able to provide sound evidence in support of their efforts.

The limited body of research on pre-college educational partnerships has focused mainly on partnerships between universities and schools. Although not as limited as the research on laboratory scientists and pre-college science teacher partnerships, critical inquiry of best practices found in school and university partnerships is also incomplete (Clark, 1988; Vivian, 1985). The literature on general educational partnerships can be used as a starting point to learn more about educational collaborations between two different cultures (e.g., pre-college teachers and university faculty; schools and university departments). It is important to note that using school/university partnerships as a surrogate for laboratory scientist/educator partnerships, is not a perfect exchange for a number of reasons. For example, university education departments have an established relationship with schools through the preparation of teachers. National laboratory scientists do not have such a clear reciprocal arrangement. The university environment is one that embraces academic freedom. The political implications of statements from national laboratories usually prevent individual scientists from speaking freely. The reward systems in universities and national laboratories are different. Therefore, caution should be used in making comparisons and extrapolating outcomes of school/university partnerships to scientist/educator partnerships. However, a review of school/university partnerships may prove instructive when seeking insight in how diverse cultures work together toward a common goal.

From the literature on general educational partnerships come lists of characteristics that are associated with effective partnerships (Atkin & Atkin, 1989; Dodge, 1993; Goodlad, 1988; Goodlad, 1993; Maeroff, 1983; Parkay, 1986; Reed, 1988; Seely, 1984). Generally, these characteristics seem to be based more on intuition than on research. Although research may suggest that some

of these characteristics are indeed important, without undertaking a rigorous evaluation, they remain best guesses rather than best practices. By giving evaluation only minimal attention, the opportunity to truly understand partnerships remains tenuous. Instead of being used as a powerful tool to assist those involved and provide insight on which practices are best (in meeting stated goals and objectives), evaluations seem to be limited to afterthoughts or glowing testimonials.

Sirotnik (1988) notes that school and university partnerships are not "controlled social experiments" that lend themselves to traditional study using "objective" research and evaluation methods. He suggests that such partnerships "..... are evolving social experiments by people in the context of their work, ideologies, and interests, struggling with alternative ideas and organizational arrangements and activities for promotion of collaboration between typically non collaborative institutions (p. 169)." Sirotnik argues that the traditional cannons of research and evaluation are inadequate bases for an inquiry methodology under these kinds of conditions and situations.

As previously stated, critical investigations of science education partnerships are seemingly non-existent. The few reported evaluations were based on the instruments and tools generally associated with quantitative research (e.g., questionnaires and Likert-type attitude scales). Sirotnik (1988) suggests this focus is inadequate when conducting inquiry in the multi-dimensional realm of partnerships. Peshkin (1993) notes that reliance on quantitative methods is inadequate when the research is concerned with clarifying and understanding the complexities associated with people, events, and situations.

Questionnaires and attitude scales that do not allow interaction are limited to a predetermined set of stimuli and cannot be altered in view of the responses

(Bogdan & Biklen, 1992; Vierra & Pollock, 1992), thereby limiting the responses only to the topics or questions asked. Generally, they represent a single snapshot in time and do not provide a view of the big picture. The intent here is not to suggest that traditional quantitative instruments such as questionnaires or surveys are not important tools for gathering data. Such instruments can be very useful in determining trends or general overview responses, but a key problem is that if the instruments are not founded on a research-based understanding of partnerships, how valid is the information they provide?

A primary concern in the reported studies is the seemingly unbalanced presentation. By relying only on data from "one-shot" instruments, the results will be limited to what was covered by these instruments. And by reporting only the glowing testimonials and anecdotes that represent all that is "good" with a program, the opportunity to learn from mistakes is lost (Punch, 1986).

There are several reasons reliance on "one-shot" instruments is detrimental to the understanding of science education partnerships. Individuals may say one thing in response to a questionnaire, but their actions may not be consistent with what they say. In many cases teachers in science education partnerships are paid a salary or stipend, receive travel allowances, and are given computers and other equipment for classroom use. Since they are "getting something," teachers may be reluctant to share criticisms on evaluation instruments. Therefore, the answers they provide may reflect what they think the questioner wants to hear. This may be especially true if the instruments are distributed without evidence of being treated confidentially or if the evaluation is administered by program management (i.e., those who control the resources). When the evaluation is conducted at the conclusion of the project, individuals may be influenced by the camaraderie and optimistic expectations. In such a situation, the data may reflect the upbeat mood of

the moment and not what will actually occur when the teacher returns to the relative isolation of the classroom. The lack of longitudinal studies has limited what is known about science education partnerships.

A search of the literature does not provide any examples of studies that collected data at all stages of the partnership (e.g., planning, implementation, dissemination) from all of the program participants (e.g., teachers, scientists, project administrators). Given the current lack of information on partnerships between laboratory-based scientists and classroom science teachers, there is the need for studies that generate hypotheses rather than test them. There is no evidence in the literature that in-depth qualitative research has been undertaken for the study of laboratory scientists and teachers working together.

The research is a grounded study that delineates best practices of partnerships between teachers and national laboratory scientists. A portion of the research was based on a critical evaluation of partnerships exhibiting varying degrees of success. A successful program is defined as one that meets its stated goals and objectives and best practices is viewed as those that appear to contribute to meeting the goals and objectives. Therefore, a central theme of this study is what practices of partnerships between teachers and scientists appear to be most effective in meeting program goals and objectives. It is important to determine how individual participants perceive the program goals and objectives. Are the teachers and scientists working toward the same outcomes? Do the teachers and scientists view themselves as equals working toward a common vision? What are their personal agendas (i.e., why are they involved in the partnership?). Are the scientists and teachers able to communicate with one another? Are the efforts of the partnerships transferred to the classroom?

Specifically, this research is a critical investigation of science education partnerships at selected federal research facilities in the Denver-Boulder metropolitan area. The study contributes to the determination of best practices found in laboratory-based partnerships. This investigation includes a review of science education partnerships and derives differences between effective and ineffective partnerships and determines what characteristics or practices contribute to the apparently successful programs.

Significance of the Study

Given the widespread encouragement of partnerships and collaboration, this research will reflect a salient issue in science education. On the surface, the concept of scientists and classroom teachers working together to advance pre-college science education has genuine merit. National research laboratories have tremendous resources, are generally at the forefront of cutting edge science, and employ some of the most creative minds in science and technology. Classroom science teachers have experience in working with students and knowing what will and won't work in a classroom. However, there are no clear guidelines on what constitutes the best practices of such collaborations. It is important to get beyond the unsubstantiated reports of success and learn more about the different cultures in the context of the partnership.

Many federal research laboratories are now mandated to participate in pre-college science and technology education. As science educators, we can work with those involved in federal education programs to help them meet stated goals and objectives and share our knowledge of what constitutes best practices. This research will determine what appear to be the best practices in selected science

education partnership projects at federal research facilities through the collection and analysis of empirical data.

It is anticipated that this research will provide templates of best practices that can be exported to similar laboratory-based projects elsewhere. In short, this research will significantly enhance the efforts of science education projects supported by government agencies. In addition, this research will add to the general body of knowledge on science education partnerships and provide a foundation for further inquiry by science educators.

CHAPTER II
REVIEW OF THE LITERATURE

Introduction

This study provides an in-depth examination of partnerships between science teachers and laboratory-based scientists. There is little research available that specifically addresses science education partnerships. Most of the reported studies were limited to descriptions of various projects in a non-research based format. Therefore, it was necessary to seek studies that serves as surrogates in the development of a foundational understanding of partnerships in science education.

One area that proved a useful starting point was the literature on the more established partnerships between universities and schools. Although not extensive, a review of school/university partnerships provided insight in how diverse cultures work together toward a common goal in educational reform.

Very few of the studies included in this literature review were undertaken as research. More common were those that attempted a critical investigation based on program evaluations. Therefore, this review will include studies that critically investigated partnerships from a research or evaluation perspective. Smith and Glass (1987) noted that evaluation and research can use similar methods even though the intended purposes are different. Evaluation is the process of assigning value to something based on evidence. In contrast, the same data analyzed within the context of research is intended to gain understanding and to "ostensibly, advance the frontiers of knowledge" (p. 33).

Using these criteria, two broad categories emerged from the literature: a) those that critically address the nature of partnerships between university

education departments and teachers or schools, and b) those that critically address the nature of partnerships between science teachers and scientists that have key associations or linkages outside of university education departments.

School and University Partnerships

The focus of this section is to review studies that provide a critical examination of the nature of school and university partnerships. Papers that simply announce a successful partnership without providing any details of how the determination was made are not included in this review. Also, papers and reports that offered only a description of their project without attempting to provide additional insight into the practical or theoretical nature of partnerships are not included.

The 1992 September-October issue of the *Journal of Teacher Education* focused on educational partnerships. The lead paper in the special partnership issue noted that little evidence of successful school/university collaborations could be found offering little criteria for effective comparisons (Smith, 1992). Case reports were the most common although few presented objective evidence of program effectiveness. In her paper, Smith described a review of award-winning partnership programs in an attempt to identify the salient features that make these programs exemplary. It should be noted that the winning of awards, while laudable, does not necessarily translate into representative or even good programs. Generally, there are many biases in picking winners.

The 38 programs she reviewed were all recipients of the Association of Teacher Educators (ATE) Distinguished Program in Teacher Education Awards (DPTE) from 1977-1989. To receive an DPTE award, a program must have met

several criteria including "...b) clearly stated goals directed at establishing identifiable teacher behaviors, c) an evaluation protocol that is appropriate, operational, and directly related to its goals, d) data to demonstrate that after program implementation, goals were achieved....." (p 244). Smith was interested in how these programs had fared over time. Because the programs she included in her study had already been implemented, she devised a program update that consisted of semi-structured telephone interviews using specific questions to guide the interviews. She did note that inferences and generalizations from the data were limited.

Smith clearly understood the need for effective evaluation, however, there is little mention of how the award winning programs met the stated goals. Longevity appears to be the criteria she used to establish success. She focused her discussion on characterizing the changes in the programs over time (e.g. new key personnel, expansions, contractions), looking for common themes of those still in operation. It should be noted that the focus of her paper was change over time and she covered that aspect sufficiently. However, program longevity by itself does not demonstrate that stated goals have been met.

Auger and Odell (1992) reported on a partnership between the University of New Mexico and the Albuquerque Public Schools that had been in existence for the past 25 years (this program was one of the award winners mentioned in Smith's review). The overall theme of the partnership focused on in-service teacher development. There were many different programs and projects under the umbrella agreement between the university and school district. The specific program that will be included in this review is the Teacher/Intern Exchange Program.

The Teacher/Intern Exchange Program is based on collaboration between veteran in-service teachers and university education department faculty for the

purpose of helping first-year teachers adjust to their new jobs. A clear statement of goals and objectives was not provided. Veteran teachers were assigned to the college of education where they assumed faculty roles as clinical supervisors to the first-year teachers. No details on the selection process were reported. The number of participants varied from year to year (from 7 - 26). The interns received half salary for the year. The veterans received full salary during their time as clinical supervisors and were relieved from classroom duty. Because the school district paid the beginning teachers half-salary, they could afford to continue providing the veteran teachers with full pay. Auger and Odell noted that many of the veteran teachers did not return to the classroom but went on to become principals or assume other district level positions. However, as this was never mentioned as a goal, it does not necessarily translate into a measure of success.

The authors noted that the effectiveness of the program had been demonstrated by testimony and program evaluation. The testimonies focused on the durability of the partnership (25 years), its many awards, the placement of individuals in the program upon completion, and the fact that many other schools have used it as a model. While this certainly sounds favorable, testimonials by themselves are not effective evaluations because many factors can influence the testimonials.

The authors reported that program evaluation centered on a collaborative framework where participants shared in specifying outcomes of an ongoing process that was documented and analyzed. They noted that this resulted in a less traditional program evaluation. The evaluation included the review of program correspondence, informal communication, feedback questionnaires, and interviews. However, the authors did not include any description of the questionnaires, who they were administered to, or how they were analyzed. There was no discussion of the

type of interviews, who conducted them, or the findings. The authors neglected to include examples of any program correspondence. The authors conclude by stating that "The testimonials and collaborative program evaluations demonstrate that the exchange of services model, which is the foundation for the collaboration programs, provides a means through which a college of education and a school district can productively work together to solve problems of mutual interest" (p. 267). The declaration of success would have been strengthened if the authors had provided specific examples and analyses from the feedback questionnaires, interviews, or portfolios.

Daly and Jassell (1985) described a collaborative program involving Stockton College and local schools. Thinking they had useful and innovative ideas for educational reform, the authors persuaded two school districts to let them "take-over" the in-service training days for the entire year. They began the collaboration with little input from the teachers. In feedback and evaluation from the teachers, they reported disaster. Although not rigorously evaluated, it was clear to them that their efforts had not been successful. They made considerable changes the next year based on the feedback from teachers and involved teachers in the decision-making process. The changes resulted in a summer institute and a conference in the spring that focused on content knowledge.

A Likert-type scale was used to evaluate the effectiveness of the institute and conference. The authors did not specifically report what was addressed on the instrument. On a 7 point scale, they reported a mean score for effectiveness of the institute was 6.3 and the conference was 6.0. They made it clear that these high scores do not necessarily translate into actual classroom instruction effectiveness. They also made it clear that high scores did not guarantee the success of the collaboration over time. The value in their report is that instead of abandoning the

project after the initial failure, they made inquires from within, changed the approach, and appear to have a realistic assessment of their program. Most notably, their revised approach actively solicited teacher input in the planning and decision-making process.

Joann Jacullo-Noto (1992) provided an in-depth assessment of the evaluative aspects of a partnership. This partnership involved faculty members from Dartmouth College's department of mathematics and computing, five urban school districts from several states, an educational consultant (the author), and a computer consultant. An institute was developed for in-service education with the purpose of linking computer learning to mathematics and science instruction in secondary schools.

The program was a 5-week summer institute that included 35 teachers each year. The goal of the institute was to familiarize teachers with computing, allowing them to transfer this knowledge to their students and thereby enhance the student's skills in using computers. The program had been in existence for eight years.

High school teachers were recruited from five U.S. urban areas (Atlanta, Chicago, Fort Worth, Boston, and Baltimore) and several rural schools in near proximity to Dartmouth College. There was no discussion of how the teachers were finally chosen for participation, nor was any information about the teachers reported (e.g. background, years teaching, familiarly with computers, gender, subject(s) taught).

Early evaluation focused on the program itself and consisted of observation by the consultants and questionnaires that were given to all participants. During the school year, classroom visits were made to randomly selected teachers from the program. After three years, the need for expanded assessment of the program was noted. As the program continued, teachers were randomly selected and interviewed

by telephone. The results of these interviews indicated that 14 teachers reported increased confidence and 12 indicated that they had expanded their professional work. The author did not provide specific details of the evaluation tools used in the telephone interviews.

After a few years, it was decided to further expand the evaluation process to determine if goals were being met. A faculty member with no link to the program and with expertise in measurement was brought in to develop and conduct a survey to evaluate teacher development. The survey instrument was based on data collected earlier although no description of the instrument was given. There was no mention as to the reliability or validity of the instrument. The survey sample consisted of 167 participants who had participated in the program from 1985-1991.

Survey results reported a marked impact on how teachers used computing in their classrooms and professional lives. From the survey 90% said participation had increased their confidence in teaching, 91% reported increased enthusiasm for teaching, 95% cited increased interest in curriculum reform using computers in the classroom, 96% reported increased interest in professional growth, 94% stated increased willingness to share ideas with other teachers, and 90% said they made a determined effort to encourage other teachers to use computers. In addition, 90% reported increased student interest in the use of computers, over 50% reported that student attendance had increased and classroom disruption had decreased, and 88% reported increased student participation.

The results appeared to meet the goals of the program, however, without a discussion of the validity and reliability of the survey instrument, it is difficult to determine how accurate the findings are. In addition, no attempt was made to provide baseline data prior to the administration of the survey as a basis of comparison. Still, this paper gave much more than cursory attention to the

evaluation process and does provide some useful direction in terms of data gathering methods.

Many of the collaborations reported in the literature focused on outcomes specific to classroom teachers. The rewards or benefits to the university partners were not always apparent. Bennett, Ishler, and O'Loughlin (1992) described the partnerships between the Bowling Green, Ohio public schools and the College of Education at Bowling Green State University that required reciprocal relationships between partners. A primary objective of all of the Bowling Green partnerships was to have faculty from the schools and university work in each other's classrooms. The individual Bowling Green partnerships fell under an umbrella program coordinated by the superintendent of Bowling Green Public Schools, the Dean of the College of Education, and the Director of Field Experiences. This group coordinated and facilitated partnership teams and projects. An advisory board oversaw prioritization of programs, allocation of resources, and assisted in evaluating the outcomes of the various projects. The advisory board was comprised of an equal number of college faculty and K-12 classroom teachers.

The overall goal of the Bowling Green partnerships focused on university faculty and classroom teachers working together in each other's classrooms to improve instruction, facilitate curriculum development and enhance faculty development. To be considered for inclusion in the Bowling Green partnership, proposals were submitted by teams of classroom teachers and university faculty. Reflecting the goals of the overall program, each proposal required collaborative teaching and curriculum development. The accepted proposals provided funding for substitute teachers for the K-12 partners. University faculty were given support and resources to adjust their workload to accommodate the collaboration. All

partners were expected to attend seminars and to work with the advisory board in partner program implementation and review.

The case study reported here focused on a collaborative exchange between an education psychology professor (one of the authors of the paper) and two elementary classroom teachers. No information was provided about the two elementary teachers (e.g. years taught, grade level, background) or how they became involved in the project. During the development and implementation stages of the partnership, the teachers and the university professor met weekly. It was decided that the elementary teachers would co-teach an undergraduate education psychology course and the professor would work in both elementary classes on a regular basis. It was not clear if the elementary teachers were the co-teachers or if they were co-teaching with the university professor (the latter is assumed). There was no discussion of how this exchange led to improved instruction, curriculum development, or faculty development.

For evaluative purposes, the partners kept journals and read and responded to student journals. It was not clear if the student journals were kept by the college students or the elementary students (the former is assumed). The authors reported gathering evaluative data from journals kept by the teachers, the professor, and the college students. Interviews were conducted with the participating partners, the school principal, and the superintendent. The authors did not report if the interviews were individual, group or some combination nor did they mention if the interviews were open or semi-structured. Based on the journals and interviews, the authors reported "strong evidence of the effectiveness" of this collaborative project. However, there was no report of the data, what topics the interviews included, selected examples of journal entries, etc.. The authors clearly stated the need for effective evaluation and cited the lack of such efforts. Although there was

ample evidence that the participants worked in each others' classrooms (the stated approach to achieve the program's goals), there was no evidence that such interaction actually did result in "improving instruction, facilitating curriculum development, and enhancing faculty development" (the stated program goals).

The authors concluded their paper by listing characteristics they suggest are central to effective partnerships (e.g. rewards, equals, support etc.). They went on to state that such "characteristics are clearly evident in the Bowling Green partnership" (p. 54). However, based solely on the information presented in this paper, it would be difficult to arrive at such a conclusion. This does not mean that the Bowling Green partnerships were not successful, simply that there is not enough objective information provided to make an unbiased assessment. Another failing of this paper is that the programs are discussed only in positive and successful terms. Even the best programs will have glitches to work out. And the real value to others interested in effective partnerships is in determining just how the glitches were dealt with.

In a departure from the usual school/university partnership where one (or both) of the partners instigate or originate the project, Teitel (1993) explored the state role in "jump-starting" collaboration between schools and universities. This case study provided a unique approach in that it described a third party as the motivator in a educational partnership. In this partnership, a state department of education (DOE) provided the push that linked six urban middle schools and four colleges and universities. The author reported on a qualitative research project undertaken for the purposes of assessing this case study.

This partnership had two stated goals: 1) to help in the restructuring of the middle schools as they changed from traditional junior high schools to middle schools, and 2) to develop or improve middle school teacher preparation at

universities. The middle schools involved in the partnership had anywhere from 0 - 3 years of restructuring experience and no experience with collaboration. Only one of the universities had a middle school preparation program and only one had been in an educational partnership before.

The DOE maintained a high profile throughout the course of the project. At the initial meeting, the administrators of all invited institutions participated and committed their institutions (and faculty) to the partnership. It was several months before the partners met each other. At that time, each institution brought a planning team to the meeting. At this meeting, partners were informed that there was a potential for three years of funding. During the planning year (1990-91), the partners jointly developed a course of action to achieve the overall goals of the program. Additional funding was dependent on the first year efforts.

To evaluate the partnerships for continued funding, the DOE collected data through observation and written exchanges between the participating partners (e.g. memos). Teitel reported that these sources were supplemented by semi-structured interviews with one or two key figures from each of the collaborating institutions and with the staff at the DOE. There were three rounds of interviews (December 1990, May 1991, and March 1992).

The final confidential interview was considered to be the last "gate" for funding. Teitel noted if the partners made it through this interview, they would have secured funding for the following two years. He reported that the partners all expressed enthusiasm and indicated they would continue the collaborative efforts with or without funding. Although this sounds encouraging, it is important to remember that this was the final "gate" to two years of funding. It would behoove all participants to be committed team players at this point and express enthusiasm. All of the partnerships received the additional two years of funding.

This paper was written at the end of the second year of the program. At that point, the author offered three questions to be addressed when determining if this partnership project has been successful in promoting meaningful collaboration. His answers to these questions form the crux of the evaluation for this case study. They are:

What actual changes have been made that can be attributed to participation in the project? What are the types of joint activities planned and implemented by the partners, and to what degree do they represent coordinated or collaborative activities? Actual changes that appeared to be linked to the partnership project varied among the different schools and universities. Examples ranged from the establishment of a new middle school certification program at one of the universities in collaboration with its school partner. Another university hired a middle school expert for its faculty. Another outcome of the project was a college course co-taught by middle school teachers and university faculty. To help in the restructuring, two of the partnerships developed team-based study groups to explore specific topics. Overall, there did appear to be some specific changes that were a direct result of the partnership program. Teitel reported the activities undertaken during the first two years of the project were largely cooperative. However, he suggested that most of what had been accomplished had yet to test the strength of the collaboration. Future planned activities included shared responsibility for the placement and supervision of student teachers and getting middle school teachers involved in the teaching of college classes. Teitel believed that these type of activities have more potential "sticky issues" and will require a greater commitment to the collaboration when implemented.

To what extent have the partnerships become institutionalized? Are they still dependent on personal contacts and relationships to sustain them? It did not

appear that the partnerships were very independent at the end of Year 2. Without the DOE to sustain the interaction, it was difficult to determine if further collaborative efforts would be undertaken or if the present ones would continue.

How much progress have they made to some preset ideal for a school/university partnership? What pace of change is reasonable? The DOE had hoped the partnerships would undertake activities such as "joint action research, joint professional development, collegial supervision of students teachers, swapping and co-teaching of college courses, peer coaching, portfolio assessment, and others" (p. 84). At the end of Year 2, it was clear that this ambitious list came up short. However, Teitel questioned if the expectations were realistic and the time allotted adequate.

The author appeared candid in his assessment of how the partnerships measured up against the three questions above. He did not dwell exclusively on the positive and the paper contained many quotes from partners complaining about the process or otherwise expressing frustration. There are several aspects of the third party role that merit further consideration, particularly if the current trend of government agency intervention in educational reform continues.

It is clear that many of the partners offered a fair amount of initial resistance and were not necessarily committed to the project. A large part of this recalcitrant behavior probably had its origins in the way the project was initiated. The decision to join the DOE program was made quickly and unilaterally by administrators (principals and deans). Staff involvement was kept to a minimum until it was time to meet their new partners in August, a particularly hectic time for those in the school system. Teitel reported that many of the partners were indifferent, unenthusiastic, and in one case, hostile. From his report, it seems that much of the first year planning activities involved smoothing the waters between

the partners and defining roles and expectations. Teitel stated that the DOE had unrealistic expectations and time-lines. This probably reflected the different philosophies, mission, and time-frames of government agencies and school systems.

Because the DOE played the role of organizer, facilitator, holder of the purse strings, and overall evaluator, these diverse roles often created conflict. For example, Teitel reported that one teacher did not feel she could be completely forthright with the DOE during the planning year when everyone was being evaluated for continued funding. By assuming conflicting roles, the DOE may have missed opportunities to be a more effective third-party. A positive side to having DOE involved as a third-party was the structure for conflict resolution between school/university partners. The DOE could (and did) step in and assume the role of the "heavy" allowing the partners to avoid disruptive conflict between themselves.

The case study would have been strengthened if more information about the individual partners involved and how they had been chosen had been included. Some problems may have been avoided or at least mitigated if confidential questionnaires had been administered to all of the "forced" partners asking what they hoped to gain, what they saw as potential problems, and how they felt about the partnership program. Finally, Teitel expressed concern regarding the longevity of the partnerships in a forced marriage. The real determination of an outside entity jump-starting a partnership will be after the DOE exits the picture and if the partnerships then continue.

As has been mentioned in almost every paper included in the review of partnerships between school and universities, one of the key concerns in school university partnership is the differences between the two institutions and how these differences affect the outcomes of collaborative efforts. Jones (1993) undertook the challenge of assessing the perceived differences between K-12 classroom

teachers and university faculty. His study included faculty at Weber State University (WSU) and various public schools in northern Utah. WSU faculty had been involved in several educational partnerships that included projects in specific disciplines, interdisciplinary projects, and the emergence of educational "centers" (e.g. Center for Science Education). At the time of this report, Jones noted 13 on-going partnership projects at WSU. Of the 13 partnership programs, 11 were between the faculties of arts and sciences and the public schools and included only a few faculty from the College of Education.

The primary goal of the WSU partnerships was the improvement of schools through more productive teacher in-service programs. As could be expected given the majority presence of faculty in the arts and sciences, the WSU partnerships emphasized content enhancement of in-service teachers. Jones noted the continual background problem of the hierarchical relationship between college professors and classroom teachers. He suggested that professors often look at teachers as former students in need of a "refresher course" and that K-12 teachers easily fall back into the role of student. In this operating mode, a true partnership would remain out of reach. As with many other papers on school/university partnerships, Jones compiled a list of organizational attributes which described effective collaborative programs. Jones went on to devise a quantitative approach to determine if these attributes are being attained. Specifically, he asked:

1. Are we developing new ways of interacting and thinking between the faculty at the university and the public school teachers?
2. Have we "shared" as the partnership language would suggest or are our relationships still based on a hierarchical system?
3. Are there differences in perception between the public school teachers and the university faculty on partnership relationships? (p. 6)

To assess these questions, 16 goal-like statements were developed that reflected the desired organizational attributes of partnerships. The statements were

organized so that respondents could report both their assessment of the relative importance of each statement to educational partnerships in general as well as the degree to which the statement had been achieved by the partnership in which they had participated.

The survey was sent to all faculty at WSU involved in partnerships and to those teachers in the public schools that had available addresses (it is assumed that the author was referring to those teachers still working in the region). The survey instrument was distributed to 101 participants -- 12 at the university and 89 in the public schools. The response rate was approximately 50% with 6 responses received from university faculty and 41 respondents from the public schools. The author made no reference to the relatively low response rate and how this would limit the usefulness of the findings in his study.

In an overall evaluation of partnerships between WSU and public school teachers, 76% of the respondents indicted the program they were involved in was "excellent," 20% rated their partnership as "good," and 4% indicated that their partnership was "OK." It is not clear if the instrument was administered in a confidential manner that would assure anonymity. A blind survey would have been preferred as the respondents may be less constrained in their answers if they don't believe responses will be traced back to them.

In order to assess the response-difference between the university faculty and the public school teacher, a two-tailed t-test was run on both the importance and the achievement responses to each question (32 t-tests total). Four items showed p-values of .05 or lower on the importance scale and two had p-values of .05 or lower on the achievement portion. The statistics suggested that the university faculty attach more importance to equal representation, consensus-building, and having rewards. Conversely, the public school faculty attached less

importance to having an equal voice in the partnership. Jones suggested that university faculty have strong feelings about academic freedom and assume they will have an active voice in partnerships. He went on to say that public school teachers are used to being directed, and therefore, are not as concerned with having an equal voice. Jones stated that unless classroom teachers take an active role in decision-making, university professors will dominate the partnership. He puts the onus for change on the classroom teacher by recommending that they change their behavior and "learn the skills and develop the attitudes involved in an independent organizational role" (p. 9). Interestingly, he did not suggest that the university professors needed to make any changes.

Surveys such as the one used in this study can be useful in determining if differences exist between the disparate groups and specifically, what differences are apparent. However, survey instruments can be very limiting as respondents only address what is directly asked. This evaluation project could have been strengthened with follow-up interviews to discern additional information. By understanding the different perspectives between the university professor and K-12 teachers, steps can be taken to make certain that neither group subverts the planning or implementation process.

Probably the most ambitious evaluative paper in this review is the study planned by Knight, Wiseman, and Smith (1992). They recognized the differences in school and university goals, outlooks, ideas, directions, constituents, etc.. They noted that schools tend to be action and activity oriented, whereas universities tend to be more reflective, leading to evaluation and research. They referred to this as the "reflectivity-activity dilemma." Does this dilemma make evaluation more difficult? In partnerships, it is important to find ways around the differences and

satisfy the needs of all participants. To resolve this apparent dilemma, the authors suggested comparison, analysis, and evaluation of programs to provide guidelines.

As in other papers, the authors acknowledged the lack of evaluative reports in the literature. They suggested that the partnership itself may create tensions that make evaluation difficult. If the university participants push for data collection as part of the evaluation process, the school participants may believe that "research," once again, is the only interest university staff have in partnerships. Traditional evaluations may undermine the spirit of trust and collegiality needed for collaboration. They suggested that perhaps, for this reason, partnerships have avoided or postponed systematic evaluation. However, they stated that to learn from experience, evaluations must be part of partnerships.

Their study included three collaborative models from three different universities in Texas. A longitudinal research and evaluation process was underway; it was divided into three phases with only Phase 1 complete. Phase 1 included the collection of information on the characteristics of each model, comparison of features and activities, and an investigation of how each model was initiated and implemented. Documentation of the first year of each partnership included minutes and videotapes from meetings, proposals, correspondence, journals and logs, positions papers and needs assessments. These were compiled into a history of activity for each model. To gain an understanding of the perceptions of the participants in each model, questions and interviews were used.

The second phase will include a survey developed from the findings of the interviews in Phase 1. The survey will be administered to all involved in the collaborations. In addition, group interviews at each site will be used to gather qualitative data. They did not discuss why group interviews were chosen. The final phase will focus on the results of the partnerships, with observation, interview and

survey techniques being used to document and evaluate the effects of the partnerships on the individual schools and universities. In all phases, formulation of the questions, data collection, and interpretation will be a collaborative effort.

This project represents an ambitious undertaking. As with most papers on educational partnerships, the authors' clearly stated the critical importance of evaluation. At the time of reporting, they were simply describing the process and some of the characteristics of each model. It is hoped that the authors will follow through on their evaluation plans and publish the actual results of their findings at the conclusion of this study. What is learned from their study could form the foundation for future evaluations of school/university partnerships.

Partnerships between Science Teachers and Scientists

The previous section focused on somewhat generic school and university partnerships without regard to content. This section will review partnerships that include scientists outside of education departments and focus on science content using "real-world" experiences. The outside scientists may be from another university department (e.g., physics, chemistry, biology), business and industry, or government agencies. In some cases, university science educators were actively involved in the partnership, however the central premise was having the teachers collaborate with scientists involved in physical or biological research. Papers that only describe their efforts and conclude success without any apparent attempt at a critical analysis will not be included in this review.

The most extensive discussion of programs linking teachers and scientists was found in a paper by Gottfried, Brown, Markovits, and Changar (1993). In this paper, the authors gave an overview of scientific work experience programs for

science teachers and then described in detail the program they are associated with; The St. Louis Research Internship Model. There is no discernible difference between what the authors referred to as "scientific work experience programs" and the more commonly used term "internships". Both are defined as programs where teachers work within business, industries, or universities in a variety of roles, for a specified period of time (generally during the summer), and under the direction of a science mentor. The authors distinguish between project internships (i.e., teachers perform a specific job for the collaborating institution) and research internships (i.e., teachers work with a scientist on a research project). The term "internship" will be used here to refer to either type of experience.

To provide an overview of internships, the authors solicited information from approximately 70 programs nationwide. They provided no detail of the instrument used (e.g., survey or questionnaire) or how the information was gathered (e.g., mail, phone conversation). Twenty-five program directors responded to their request for information giving a response rate of approximately 35%. Respondents were clearly a minority and may or may not be representative of all the programs included in the request for information. Another point that weakens the internship overview is that information was solicited only from program directors. It can be expected that program directors will have a very biased perspective of their programs especially when reporting to outsiders.

The authors synthesized the information provided by the 25 program directors and came up with commonalties in goals, evaluations, and findings. The synthesized goals suggest that internship programs seek to: (a) provide teachers with "real-world" science experiences; (b) increase the teachers' technical and scientific knowledge; (c) enhance teacher understanding of careers in science, (d)

enhance leadership skills; and (e) transfer the internship experience to the classroom thorough the development of curriculum materials.

All of the respondents reported that evaluation of the internships was accomplished using qualitative methods and included questionnaires, teacher interviews, and pre-to-post program teacher and student attitude questionnaires. No additional information on the instruments was provided. The synthesized findings included consistent references to increases in teacher feelings of self-confidence, self-esteem, and professionalism. Another consistently reported outcome was that teachers came to realize the importance of communication and problem-solving skills in scientific endeavors and now teach in a manner that emphasizes those skills. The synthesized findings conclude that teachers leave the internships with increased content knowledge and a better understanding of careers in science and technology.

The overview information was presented as documentation of the collective success of the science teacher intern programs reviewed by the authors. However, details are sketchy and success is concluded without sound evidence. This overview only serves to reinforce the need to be skeptical when reading reports of such programs especially when the information is provided by program directors and is not subject to critical review. It would have been useful if examples of the evaluative instruments had been included.

The remainder of this paper focused on an in-depth discussion of the St. Louis Research Internship Model. The St. Louis Model, in existence since 1987, is comprised of four separate internships in the St. Louis, Missouri area that are "philosophically and structurally similar." The internships are coordinated by the Mathematics and Science Education Center (MSEC), a nonprofit professional development organization for St. Louis area mathematics and science teachers, and

faculty at the University of Missouri-St. Louis (UMSL). The authors were associated with one or more of the internships. Approximately 15 science teachers (grades 7 - 12) participate each year. There is no mention of the selection criteria. Science mentors come from a variety of institutions including McDonnell Douglas Corp., U.S Food and Drug Administration, the American Association of Immunologists (AIA), and local universities. It is assumed that the teachers receive stipends for their involvement, although this is not explicitly stated. Teachers work 40 hour weeks for 6 to 8 weeks in the summer. The authors noted the mentors chosen to work with teachers "have actively sought involvement in the program." It would have been useful to know more about the mentors. Graduate credit was available to all teachers in the St. Louis internship program at an area university.

The St. Louis internship model had three components; an internship experience, a curriculum project, and professional leadership opportunities. The goals were to:

1. Provide teachers with experiences in science, mathematics, and technology in an industrial/university research environment;
2. Offer opportunities for teachers to interact with professionals from industry and academia in the fields of science, mathematics and technology;
3. Assist teachers in translating what they learn during the internship experiences into curriculum materials for use in the classroom;
4. Encourage teacher to integrate a science-technology-society perspective with their math and science curricula;
5. Reinforce the advantages of viewing curriculum development as an ongoing process that thrives on deliberation with colleagues; and
6. Support teachers in their professional development, encouraging them to share their experiences with colleagues to inspire them to pursue such professional development activities (pp. 269-70).

Of the three program components, very little attention was given to a description of the actual intern experiences. Teachers are guided though the curriculum

development process by a university science educator. Reflecting the different intern experiences and science content areas, the teachers developed their own activities, but met weekly for critique and review. After the curriculum had been used successfully in classrooms, they were printed and distributed by the MSEC. As part of their professional development, teachers were expected to lead in-service workshops in their schools based on their internship experiences. In addition, some of the supporting institutions provided funds for teachers to share their internship experiences at local, regional, and national meetings.

For planning purposes, the program leaders were interested in what teachers expected to get out of their internship experience. This information was gleaned through the application process as well as through questionnaires and interviews. The authors note that by trying to understand more about teacher expectations, they acquired insight into their "interests, strengths, weaknesses, and openness to change." This explicit interest in teacher expectations was unique to the St. Louis model. There was no indication if similar information was solicited from program mentors.

The St. Louis internship programs relied on questionnaires and interviews as the primary methods of evaluation to determine if the program goals had been met. In further describing the evaluation, the authors narrowed the discussion and focused on one of the four intern programs - The Science Teachers as Research Scientists (STARS). The STARS program directors were interested in determining the value of the internship as perceived by the teachers and mentors. Data was collected for two years. On the last day of the STARS program, a questionnaire using a Likert-type scale (1 (low) to 5 (high)) was administered to teachers. Teachers were asked to assess statements relating to research, science content, curriculum development, pedagogy, and science as careers. All of the mean responses were

above the mid point and ranged from 3.3 (ability to perform process skills) to 4.0 (knowledge of teaching strategies and ability to design appropriate activities for classroom). Two weeks after the program ended, mentors were asked to respond to statements regarding teacher participation and understanding of research and of having teachers in the laboratory. The responses were also favorable and ranged from 3.6 to 4.5 A third questionnaire was administered to the teachers six months after the summer program to evaluate the impact of the internship program on teaching. The responses ranged from 3.3 to 4.1. From these attitudinal measures, the program leaders claimed success. However, Likert-type scales do not provide conclusive evidence that the goals were achieved. Of interest here is the fact that the program directors included mentors in the evaluation.

The STARS teachers were also asked to complete questionnaires based on program goals and objectives. No additional information regarding these instruments was provided. The teachers were interviewed using questions similar to those on the questionnaire, but in a more open-ended fashion that allowed the evaluator an opportunity to probe specific areas. Teachers were interviewed prior to the summer program and after they returned to their classroom. The data from the questionnaires and interviews were analyzed and determined to be consistent. There is no indication of mentors being asked to complete questionnaires or take part in interviews.

Teachers in the STARS program were observed in their classrooms on two separate occasions prior to and after the internship experience (total of 4 observations). An analysis of field notes revealed no observable differences in the teaching strategies of teachers after participation in research internships. To further investigate changes in teaching strategies, and understanding of scientific processes, two established instruments were used: The Science Classroom Activity

Checklist and the Test of Integrated Process Skills. Both of these instruments were administered pre and post intern experience. The differences between the pre and post for both instruments showed no significant statistical differences.

The authors concluded that as a result of the information provided by the St. Louis internship evaluation and the 25 program directors of similar internships, teachers participating in such program made substantial gains in the affective domain. Less clear are gains made in science content knowledge and processes. Also, there was no conclusive evidence that the teachers were able to effectively transfer their intern experiences to the classroom. The authors did recognize that the different internship experiences involve different science disciplines and activities and therefore, the teachers did not share the same experience. They concluded that the use of a generic instrument may not be an appropriate measure. Regarding changes in teaching practice, teacher perceptions of change do not match any measurable change. The authors suggested this disparity may be because .... "(a) the methods we are using are not detecting changes that exist, or (b) that observable, measurable changes not taking place". The authors ended by noting,

> ....despite the paucity of 'hard' data regarding the effectiveness of research internships, we are convinced that research internships specifically and scientific work experience program in general provide an outstanding model of teacher development. We infer from our data that research interns increase teachers sense of professionalism, empowering them as change agents at a variety of levels. We also infer that by engaging in the scientific enterprise, teachers gain an understanding of the nature of the scientific processes and infuse these understanding into the professional lives in way we have yet to measure (p. 285-86).

This paper represented the most in-depth examination that could be found on programs that bring scientists and classroom teachers together. The authors included information from mentors as well as teachers and they did collect data before and after the intern experience in an effort to determine the impact on

teaching practices. However, there are several aspects of this report that needed further consideration. It was never made clear who conducted the interviews and administered the questionnaires. If it was a person associated with program management, the respondents may not have been completely forthright in their answers. Also, if the teachers were getting paid and receiving equipment, they may be less inclined to appear critical of the program. Also, it would have been very useful to have the authors document the practices or activities that appear to contribute to the successful outcomes.

Gilmer and Davis (1994) described another program that highlights science teacher participation in "real" research. This was one of the few projects that reported their findings using a research model (i.e. methods, data collection and analysis). Although never stated as a research question, the focus of the research was to determine how teachers' experiences in scientific research would affect their beliefs and practices.

Science Feat (Science for Early Adolescence Teachers) is a program coordinated through the Department of Chemistry and the Department of Curriculum and Instruction at Florida State University (FSU). The project was coordinated by a biochemist and a science educator. Sixty-six middle grade (5-9) science teachers were involved in scientific research projects. The teachers were from northern Florida and southern Georgia. There was no mention of how the teaches were chosen to participate, their educational backgrounds, years of experience, age, gender, etc..

Teachers in the Science FEAT program were involved for three summers and two academic years. Participants had the option of earning a masters degree or a special certification degree in science education. Although not explicitly stated, it appeared that the teachers involved were all students enrolled at FSU. It was not clear if they enrolled because of Science FEAT or if by enrolling at FSU they were

automatic participants in Science FEAT. Unique is that Science FEAT claimed to provide both the course work and research experiences in both science and science education. The specific goals and objectives of Science FEAT were not reported.

During the first summer, the teachers were enrolled in coursework that would be of use in their classrooms and would "develop a foundation for the rest of the program." The courses covered data analysis and interpretation, Science-Technology-Society, curriculum theory and development, and the teaching and learning of science. No additional information from the first summer or following school year was provided.

During the second summer, the teachers participated in research projects with scientists. Five of the teachers worked individually with scientists, the remaining 61 worked in groups of two to eleven teachers. Most of the scientists in the project were faculty from FSU (e.g. biology, physics, meteorology, etc.) and two-thirds of the teachers worked with them. The remaining 21 teachers worked with scientists from a variety of government and non-government research organizations (e.g. Apalachicola National Esturaine Research, the Nature Conservancy, National High Magnetic Field Laboratory).

The authors reported the detailed process undertaken in finding the appropriate placement for 66 teachers. They noted that both the perspectives of the teachers and the scientists had to be considered. Each teacher received a list of possible sites and activities (81 combinations total) and were asked to prioritize seven placement choices. From the lists of teacher preferences, the research scientists were provided with an information package introducing each of the potential participants. Using feedback from the researchers, final placements were made. It is not clear how the scientists were chosen to participate. Of the 66 teachers, the authors noted that only two were unhappy with their research

placement, however, no additional information was provided. Of potential interest here, is that the teachers had a say in their placement and their backgrounds and abilities were considered. The placement decisions were not made unilaterally by program directors and the research scientists.

The majority of the teachers spent half-days in their research assignments. An exception was two small groups of teachers who spent the entire work-week living at a marine research laboratory. In addition to the research experience, the teachers met weekly with the program coordinators and the other teachers. The point of these weekly meetings was to share their research experiences with others. No additional information regarding the weekly meetings was provided. It is not clear if the teachers were also taking classes during this second summer.

Although not clearly stated, the point of this research was to see if teachers beliefs and practices changed as a result of a real-word science experience. The data collection and analysis was of a qualitative nature. Data sources included materials teachers submitted from courses in the first summer, videos of teaching from the year prior to the research summer, written evaluations, data collected from "Science Day" at each of their schools, research notebooks, audio or videotapes of research meetings, written reports including electronic mail, field notes from observations at research sites, and the final research reports as part of the poster presentation. Preliminary categories that emerged from the data included changes in the teacher's views of science, changes in how teachers conceptualized scientists, and changes in the teachers' views of their role in teaching science. The information reported from each of these categories is anecdotal and in a positive light. Gilmer and Davis note the analysis is incomplete.

Gilmer and Davis did not report actual changes the teachers made in teaching although they did address the plans teachers were making to change their teaching.

The authors indicated that more data was being collected and that no data from the classroom had been collected or analyzed. However, this did not discourage them from stating that the impact of this program was "profound." They did pose useful follow-up questions and suggested that they will continue to collect evidence from the next academic year. It was not clear what Science Feat intends to accomplish during the third summer. A category that they did not address but that may be insightful is the different sizes of teacher groups. The groups ranged from one to 11 teachers. How were the experiences of the teachers in a one on one relationship different than those who worked in small and medium sized groups?

Anderson (1993) also reported on a program that linked research scientists and science teachers. Based on the belief that research scientists could contribute to the improvement of pre-college science education, Project SCI-LINK was developed to determine what roles scientists could play in the enhancement of inservice teacher education. The staff of Project SCI-LINK was headed by a research scientist and a science educator at North Carolina State University (NCSU). For three summers (1991, 1992, 1993), Project SCI-LINK organized institutes and workshops where research scientists and classroom science teachers were brought together to enhance teacher knowledge on topics in environmental science (e.g. air quality, water quality, global climate change). The two-week institutes included teachers from North Carolina and Minnesota. Classroom teachers had no part in the planning stages of this program.

The goals of Project SCI-LINK are clearly stated:

1. Provide experiences for teachers that result in a better understanding of scientific research and recent findings.
2. Assist teachers in developing skills, classroom strategies, and instructional materials needed by them to include recent advances in science in their teaching.
3. Develop the leadership abilities of teachers so they become more effective teachers of their peers.

4. Explore a way of having scientists and teachers work together (p. 45).

In the first year of Project SCI-LINK (1991), the North Carolina institute included 36 science teachers (grades 6-12), 27 from North Carolina and 9 from Minnesota. The Minnesota Institute included 27 science teachers from Minnesota schools and 10 from North Carolina. Three of the teachers attended both institutes. An application process was used to select teachers for participation in Project SCI-LINK, however the only criteria reported was that the teachers had to be full-time, certified science teachers. No information on the teachers was included (e.g. years taught, subject(s) taught, age, gender, background, etc.). It is interesting to note that each of the scientists involved in Project SCI-LINK was mentioned by name, position, institutional affiliation, and in some cases, a short discussion of their expertise and illustrious careers. The disparity in information between the scientists and classroom teachers suggests that the scientists were held in higher esteem.

For reporting purposes, the author focused on the 1991 summer institute in North Carolina. Anderson stated, " ....the program can be described in terms of two major components: (a) contributions of the research scientists and (b) what was done to help participants translate new knowledge into forms to be used in their classrooms" (p. 45). Both of these components suggest a "working on" rather than a "working with" approach to teacher enhancement.

Anderson's was the only paper that gave more than cursory attention to the logistical details of lodging and meals. He suggested that careful logistical planning can help to facilitate a groups' *esprit de corps*. Stipends were provided to all teachers involved and those who were from out of town were housed near the NCSU campus. The participants ate lunch and dinner as a group, further encouraging a

team atmosphere. Anderson also reported that several outside trips and social events were undertaken by institute participants. It should be noted that, here again, the partnership between the scientists and teachers is not in evidence. From Anderson 's description, it is only the teachers who ate together and participated in outside activities. There is no mention of the scientists or Project SCI-LINK staff being a part of these group activities.

The institute took the form of presentations by the scientists to the teachers. In addition, the teachers were taken on field trips to various research field sites and laboratories. It is not clear if the field trips were interactive or if the teachers were passive observers. The expected output at the end of the institute was completed classroom instructional activities. Final editing would be done by Project SCI-LINK staff. The author noted that many teachers have limited experience in writing instructional activities and developing experiments and, at times, this was a very frustrating part of the program.

Anderson reported that evaluation was an on-going process during the two weeks the institute was in session. Both formal and informal methods were used to evaluate Project SCI-LINK. Informal evaluation included regular discussion and feedback from the institute participants and the author reports that changes were made based on this information. It is not clear if the research scientists participated in these discussions or if participation was limited to the teachers and Project SCI-LINK staff. A faculty member from the NCSU Center for Research in Mathematics and Science Education designed and administered an evaluation instrument. The author did not address the validity or reliability of the instrument. The evaluation took the form of a questionnaire that was given on the first and last days of the institute. The first day questionnaire asked teachers to write about air quality, draw a picture of a scientist at work, rate the importance of environmental

topics, and share the teaching strategies they used. The last day evaluation asked participants to rate various aspects of the program and make suggestions for future institutes.

Anderson reported that the evaluation results were generally favorable and useful information was gathered that suggested changes for improving future institutes. He noted that while the evaluation provided some useful information, future evaluations would need to be expanded. A faculty member from the University of Minnesota College of Education designed a telephone follow-up evaluation for both 1991 summer institutes (North Carolina and Minnesota). The survey was undertaken by NCSU staff. Details of the survey were not described. Out of the 70 teachers who participated in the 1991 institutes, 67 were contacted for the follow-up survey. The results of the telephone survey indicate:

1. All (100%) of the teachers had used an institute activity in their classroom; 69% indicated they had used more than one activity.
2. Sixty-eight percent of the teachers indicated that at least 50% of the information in the activities was new to them.
3. Ninety-four percent of the teachers shared ideas gleaned from the institute with others; 88 % shared resource material, and 75 % shared institute activities.
4. Forty percent reported that other teachers in their school were now involved in activates similar to those addressed in the institute.

The institutes that were held during the summers of 1992 and 1993 followed the same format as the one in 1993 (i.e. scientists made presentations, teachers developed classroom activities). An outside evaluator was brought in to continue the evaluation of the institute teacher participants, but also to develop procedures and instruments that would be administered to the participating scientists. However, no additional information on the procedures, instruments, or results were reported.

One of the Project SCI-LINK goals was to develop the leadership abilities of teachers. It was reported that a number of teachers had since given presentations at international, national, regional, and state conferences. However, without knowing if this was typical behavior for these teachers, it is difficult to credit the participation in the institute with this accomplishment. Once again, without knowing anything about the teachers or their backgrounds, it is difficult to know what changes can be attributed to Project SCI-LINK. Anderson noted that the Project SCI-LINK evaluation is still underway.

Kreuzer, Woodworth, and Kreuzer (1995) reported on another partnership between teachers and research scientists. Although the goals were never stated explicitly in this paper, the implied goals were to expose students (through their teachers) to "real world" science and research. Much of this paper was devoted to a description of the research project itself (DNA and biotechnology). For the purposes of this review, only that portion of the paper associated with the partnership process and outcomes will be addressed.

Citing the limitations of "cook-book" laboratories, this project was designed by scientists at a university research laboratory (Duke University Medical Center) to allow students to carry out real experiments that would contribute to larger, on-going experiments at Duke University. The students would share the results of their research at a conference designed to replicate scientific and professional meetings. The Duke University scientists worked with staff from the North Carolina Biotechnology Center's (NCBC) education program. The NCBC education program was based on summer workshops on topics in molecular biology where teachers are brought in to learn basic science concepts and laboratory techniques. After participating in the summer workshops, teachers were eligible to borrow equipment from NCBC for use in their classrooms. The criteria for the described

research partnership was that it build on the established NCBC workshop and equipment program and that experimental techniques and data analysis would be feasible for a high school setting.

A select group of past NCBC workshop graduates received information on the new project. The authors did not mention the criteria associated with being considered in the select group nor did they mention how many teachers were targeted. From the select group, ten teachers volunteered to participate in a content-oriented summer workshop in 1992 composed of lectures and supporting laboratory activities (content focus was on DNA mapping). It is not clear how many scientists were involved, however, it did appear that the format was in a traditional college science course where the professor lectures and the students participate in laboratory activities that relate to the lecture material.

During the following school year as the teachers implemented the research activities in their classroom, one of the scientists visited each classroom to talk about how the classroom research activity fit into the bigger research project at Duke University. The authors noted that the scientists provided "technical and moral support" throughout the classroom activities. There were technical difficulties associated with the students conducting the experiments and in most cases, the experiment had to be returned to the nearby university to "get it right." The authors noted that nearly all of the students who worked on the project put in additional time. However, no further description of the students or classes was provided. It was not clear if this was select groups of students or if entire classes participated.

In the spring of 1993, teachers and students attended a "research conference" at Duke University. Nine teachers out of 10 attended; seven brought students with them. It was not clear if the teachers accompanied by students

brought all of their classes or just a select few. The authors noted the various degrees of students "getting it" and they attributed differences to the understanding of the respective teachers. The authors seemed to have a preconception of the importance of doing it right and getting the right answers. With this apparent emphasis, it was not clear how the teachers and students were exposed to real world research where uncertainty prevails.

During the summer of 1993, nine of ten participating teachers returned for a second year. Again, the format was lectures accompanied by laboratories. The workshop focused on a review of the previous year with some additional topics included. The authors suggested that the second year was better in that the teachers were able to ask more "targeted questions" of the scientists. The authors described in some detail each of the new content areas and the scientists who led the that portion of the workshop. Each scientist is described with his name, professional title (Dr.) and affiliated institution. No information about the teachers was provided. Of interest here is the apparent disparity in status between the partners.

Six teachers and their students attended the 1994 research conference. At the end of a 1994 conference, teachers and students were asked to respond to questionnaire. The authors noted that the student questionnaire focused on issues of interest in science, science knowledge, the scientific process, and self-concepts. The actual instrument was not included. From the student responses, the authors note that over 80% of the students indicated an increased interest in science as a result of the research project and that over 70% stated an increased confidence in their ability to do science. One hundred percent of the students said they enjoyed doing real experiments. The students now viewed scientists as "real people." The teachers' evaluation was reported but, unlike the students, no description of what was covered on the questionnaire was provided. Overall, the authors reported that

the teachers were enthusiastic about the collaboration as a teaching tool. All teachers were reported to have cited personal growth.

The authors were very pleased with the success of their program and urged other scientists to follow their model. They noted that teachers had changed their views of science and scientists as a result of working in the partnership. Teachers now considered scientists to be "normal" people. The teachers also had a better understanding of science. However, the authors did not mention how the scientists viewed classroom science education and science teachers as a result of being in the partnership. Given that in this project, each classroom was visited by a scientist, it seems they may have changed their views on pre-college science education and it would have been interesting and insightful if they had shared their perspectives.

The literature review will conclude with a brief discussion of a recent book entitled, *Science education partnerships: Manual for scientists and K-12 teachers.* This 1993 book is edited by Art Sussman, a biochemist currently serving as director of the Far West Regional Consortium for Science and Mathematics Education. Given the topic, it would seem that this manual would be a welcome guide in the current proliferation of science education partnerships, however, it only serves to underscore the need for critical examination and research on partnerships between scientists and classroom science teachers.

The book was divided into sections that addressed teacher centered activities, student centered activities, evaluation and resources, and the "big picture." It was written as a "how to" manual for anyone with an interest in partnerships between scientists and teachers. The partnerships and experiences included are primarily recounts of programs in the San Francisco Bay area in California. There are no classroom science teachers among the 33 authors. From a perusal of the brief author biographies, only one had a direct link to a k-12 school (a former principal

now curriculum developer). All of the authors were scientists, educational program directors, school district administrators, or university professors. Some of these individuals may have been classroom science teachers at one point in their careers.

In this 244 page manual, there was not a single citation or footnote referencing other works. It was an entirely self-generated book, written from the perspective of scientists and program directors. It was clear that many of the contributors were aware of the failings of the post-Sputnik science education reform efforts as they plainly cited the need for teacher involvement. However, in practice, little evidence of real input from the classroom teachers could be found.

In several cases, the tone towards the teachers was patronizing. For example, Bruce Alberts, President of the National Academy of Sciences, suggested finding the best teachers possible and have them be part of the partnership executive committee. He goes on to note that meetings should be held in a "nice room" and to "provide some food" as teachers are not used to being "treated well" and will really appreciate the efforts. Treating people well is certainly desirable, but if this treatment is only of a superficial nature, the teachers are not likely to feel they are equal partners.

A consistent theme in this book was the need for systemic reform in education. Scientists in partnership programs are viewed as having lead roles in reform efforts. However, is it realistic to assume that individuals not in the system and with no apparent understanding of the whole system, can be effective change agents? Sussman notes that as a result of working with teachers and the educational system, he had grown in his understanding of the needs of educators. He did not elaborate or provide any insight to suggest how he had changed nor did he suggest any specific activities or practices that contributed to his changed views. As the book's

editor, Sussman's philosophies on education were apparent throughout. He contrasted his views of what the educational systems should look like (he refers to this as "Ameristroika") with the current system or the "Status Quo."

Most of the chapters were based on the experiences and opinions of the various authors and provide anecdotal information on successful partnership programs. Some of the suggestions and recommendations of steps to take in partnerships may be useful and may contribute to effective practices in science education partnerships. The real value in Sussman's book was the sharp reminder that more in-depth understanding of partnerships are needed before prescriptions for success can be written.

Discussion and Conclusion

Although critical reviews of educational partnerships are a rarity, the existence of such partnerships is widely documented in the popular press and the technical literature. From the literature review, it is clear that there is a diversity of programs that consider themselves to be partnerships. The partnerships examined in this review included teacher institutes (e.g. Daly & Jassell, 1985; Jacullo-Noto, 1992;), workshops (e.g., Anderson, 1993; Kreuzer et al., 1994), internships, (e.g., Gilmer & Davis, 1995; Gottfried, et al., 1993) and collaborative exchanges (e.g., Auger & Odell, 1992; Benett et al., 1992) Some of the programs had only a few participants (e.g., Benett et al., 1992; Kreuzer et al., 1994), whereas other included many individuals (e.g., Auger & Odell, 1992; Gilmer & Davis, 1995). Content areas varied as did individual program goals and objectives. Given the variety of types of educational partnerships, a common view

of what they should look like is not necessarily desirable, however insight into what works is.

Although there is not a clearly accepted definition of what educational partnerships are, there is widespread agreement that true partnerships will involve a high level of joint goal setting, decision making, and institutional commitment (Atkin & Atkin, 1989; Clark, 1988; Lasley, Matcynski, & Williams, 1992). As the concept of partnerships is popularized, it is tempting to label any interaction between different institutions as partnerships. Teitel (1993) stated that,

> Real partnerships are those that can lead to substantial school and university change. Yet the words partnership or collaboration are used to apply to a wide range of ventures" (p. 81). Accompanying usage of the term "partnership" for naming such networks is, in my judgment, unfortunate. Further, and more important, the goals frequently set for such arrangements, implying significant change and even institutional renewal, are unrealistic, portending failure and erroneously discrediting the use of partnerships as a change strategy (p. 13).

Lasley, Matczynski, and William (1992) make a distinction between truly collaborative programs and non-collaborative programs. They note that in true collaboratives, the power is shared and goals are set by consensus. In non-collaboratives, the participants have unequal power, and goals are pursued in a way that maximizes the gratification of individual needs and diminishes the effectiveness of the collective effort. They further suggest that only those partnerships that are truly collaborative have any chance to have a lasting impact on education. The purpose of this discussion is not to split definitional hairs, but rather, to determine functional realities.

What works in successful partnership programs? Those who believe that partnerships are worthwhile endeavors have suggested traits that are considered to be imperative for effective educational partnerships. The following is a

compilation of traits believed to be important (Atkin & Atkin, 1989; Dodge, 1993; Goodlad, 1988; Goodlad, 1993; Maeroff, 1983; Parkay, 1986; Reed, 1988; Seely, 1984).

1. Partners should be true equals and have representative voices in all phases of collaborative projects. Key players must be included in the early stages to encourage ownership of the project.
2. The expected outcomes of the partnership should be specific and realistic. Goals should not include broad claims of general, sweeping educational reform.
3. The needs and beliefs of all involved (both individually and institutionally) in the collaborative effort should be stated up front.
4. Collaborative inquiry should be an integral part of the partnership program.
5. It is important to have the support from the top-level of each institution (e.g. school administrator s, college deans).
6. The reward system must provide benefits for all.
7. The partnership should be flexible enough to accommodate changes and make adjustments where necessary.

While the above list is not based in research, it does provide a common sense view of what may be associated with a successful partnership. For many reasons, it is unlikely that all of the attributes listed above will be found in any one partnership. The above list is reflective of the experiences considered in school and university partnerships. The effective practices for partnerships between scientists and teachers may not resemble those associated with school and university partnerships.

The literature on school and university partnerships appears to be more mature than the literature on science education partnerships. Caution must be used in making comparisons and extrapolating outcomes of school and university partnerships to science education partnerships. Although relationships between schools and universities may have some generic dilemmas, there are also some strong commonalties that can provide a solid foundation for partnerships. Although they may have a different perspective, schools and universities are intimately

linked in educational reform. Indeed, strength can be found in differences, particularly when each partner benefits from the success of the other. The remainder of this discussion will focus on several themes that emerged from the papers that specifically addressed science education partnerships.

Most of the science education partnerships in this review note the need for reform in science education and suggest that their program brought about or would bring about key changes in the teaching and learning of science (Anderson, 1993; Kreuzer, 1994; Sussman, 1993). There is a certain tension between the ideal and what one can accomplish in reality. Scientists are seen as saviors in science education reform efforts. There is a real belief that if scientists are involved, teachers will have enhanced understanding of science content and research and will also be more effective science teachers. While few would dispute that scientists, as a group, have in-depth content knowledge, it would be a stretch to assume they know how to transfer that knowledge to a pre-college classroom.

The evidence of success was generally based on the results of attitudinal measures and anecdotal reports (Gilmer & Davis, 1995; Gottfried et al., 1993; Kreuzer et al., 1994). From these measures, it seems clear that the teachers are happy and enthusiastic. None of the studies were able to provide evidence of any changes being made in the classroom. There were no reported examples of differences in teaching strategies or how students derived any benefits from their teachers' involvement in the partnerships. This may reflect use of the wrong measures. Because each science education partnership has unique characteristics, goals, personalities, and politics, it is unlikely that standard evaluations will be of any value. The methodologies in the studies were very poor and the reports were incomplete. In actuality, these programs may be more effective than the reports suggest.

From the general tone of the science education papers, there is a perception of unequal status among the scientists and teachers. Little information was provided regarding the teachers; they almost seemed to be an amorphous mass. In contrast, the scientists were described in more detail and often background, institutional affiliation, and professional titles were provided (Anderson, 1993; Kreuzer et al., 1994; Sussman, 1993).

A critical shortcoming was the lack of attention given to an in-depth look at the partnership interaction. What does it mean for a teacher to participate in "real world" research? What does a day in a partnership look like? The establishment of best practices will require a full understanding of the interactions between teachers and scientists.

Little insight as to the effectiveness of partnerships between scientists and teachers could be gleaned from this review. The timing for increased understanding of science educational partnerships is optimal as the partnership approach to educational reform appears to be gaining momentum. If the trend towards collaborations continues, the competitive process of funding will eventually establish the need to demonstrate effective practices.

CHAPTER III
DESIGN AND METHOD

Introduction

The intent of this research is to provide a basis for improving future partnerships between laboratory scientists and classroom science teachers. The review of the literature revealed a paucity of research on partnerships between laboratory scientists and pre-college science teachers. While discussions of such partnerships can be found in the literature, most are limited to programmatic descriptions and conclude success without a critical examination of all participants or outcomes within the context of the partnership. Prior to suggesting changes or improvements, it is necessary to understand the culture of science education partnerships (i.e., what they are and what they do). No research could be found that provided a longitudinal study of all aspects of the partnerships (i.e., planning, organizing, implementing, evaluating) including representation from all participants (i.e., scientists, administrators, teachers, and associated university staff). The different participant groups include individuals with different backgrounds, experience, perceptions, and expectations of pre-college science education, each of whom contributes to the overall culture of the partnership. If only portions of the culture are studied, the reported information will be unbalanced and incomplete.

This research provides a rich descriptive foundation to better understand the characteristics that form the culture of science education partnerships and how individuals within this culture respond over a period of time. This study includes the experience of teachers, scientists, and program management within the context

of a science education partnership over the course of a summer session and the following academic year.

Participation in science education and outreach activities is mandatory for many federal and national laboratories resulting in stakeholders representing a variety of interests and perspectives. The stakeholders for any collaboration between laboratory scientists and classroom science teachers are similar and include: The U.S. Government (both a patron and user of science and science education); Federal Agencies (they provide funds and oversee the research laboratories from which the pool of scientific and technical staff is drawn); Science Education Programs within the agencies (develops, disseminates, and evaluates programs to improve science and technology education); Scientists (work with teachers, develop activities for science education, and are representatives of their agencies); School Districts (seek help to improve education of their faculty); Schools (send teachers for instruction, host instruction after hours and provide feedback); Teachers (work with scientists, learn state-of-the-art research, train other teachers through workshops, implement new curriculum into classroom instruction and provide feedback); Students (will be exposed to "real world" science and technology based on their teachers' experiences at federal laboratories); Parents and Community; and Science Educators (benefit from increased understanding of the science education partnership culture).

Methods

According to Bogdan and Biklen, qualitative research questions "are formulated to investigate topics in all their complexity, in context (p. 2)." It is important to note that science education partnerships are not cast from a directed

script, but rather are loosely evolving, complex entities involving individual from diverse cultures. Sirotnik (1988) describes educational partnerships as "on-going social experiments." Therefore, events and situations arose that were not anticipated ahead of time. Qualitative methods allowed the researcher to be open to new themes and questions as they arose.

As qualitative research, this study was not based on specific questions or hypotheses to test. Initially, the research questions were very broad to encompass all aspects of science education partnerships. The questions sought information that brought about a better understanding of what happens when scientists and teachers work together. This in-depth and accurate knowledge allowed a new perspective on the situation to emerge. With the contribution of this broadened perspective, this research provides a basis for subsequent research focused on improvement in science education partnerships.

A distinguishing characteristic of qualitative research is the emphasis on "grounded theory" where theories are developed from the data and not established a priori. Erickson (1986) believes that it is the emphasis on interpretation that forms the basis of qualitative research methods. Merriam (1989) suggests that the complexity of human interactions are highly subjective phenomena in need of interpreting rather than measuring. Emphasizing interpretation and the development of grounded theory, this research included participation in a field setting, careful recording of what occurred in the setting, and analytic reflection of the recorded data.

Borrowing from the ethnographic tradition, the research attempted to understand the unique culture of science education partnerships. A hallmark of ethnography is "thick description." To accomplish this level of description it was necessary to observe the culture differently, or what Erickson (1986) calls

"making the familiar strange." He maintains that the usual happenings in life are "largely invisible," in part, due to their familiarity. It was the responsibility of the researcher to go beyond superficial descriptions and view a situation or event while taking nothing for granted.

In keeping with the central tenet of the ethnographic tradition, the researcher assumed the role of a participant observer. Glesne and Peshkin (1992) suggest that the basic premise of participant observation is to "understand the research setting, its participants and their behavior" (p.42). LeCompte and Preissle (1993) note that participant observation allows the researcher to gain insights and develop relationships that would not be possible through alternative methods. The participant-observation continuum spans the range from full observer to full participant. In this study, the researcher functioned primarily as an observer, but will sought opportunities that allowed participation when the situation arose. Glesne and Peshkin (1992) note that a paradox develops when the researcher becomes more of a participant and less of an observer. They note, "The more you function as a member of the everyday world of the researched the more you risk losing the eye of the uninvolved outsider; yet, the more you participate, the greater your opportunity to learn (p. 40)." An ongoing challenge to the researcher was finding a comfort level that allowed her to remain detached enough and still gather useful information.

The longitudinal nature of the research and the amount of time the researcher spent in the field strengthened the internal validity of the findings. Borg and Gall (1989) suggest that the amount of time spent in observation improves the chances of obtaining a valid rendition of the phenomena being studied. They believe that more time in direct observation will decrease the likelihood of subjects "faking it" or "putting on an act for the benefit of the observer" (p. 392). Merriam

(1988) notes that the qualitative researcher is not seeking a universal truth, but is interested how each individual perceives the events, situations and interactions. Bogdan and Biklen (1992) state that qualitative research is interested in multiple, not single realities. Following these suggestions, this study used several strategies to strengthen internal validity including triangulation, long-term study, and member checks (Bogdan & Biklen, 1992; LeCompte & Preissle, 1993; Merriam, 1988). The use of multiple data collection methods (interviews, observation, and written reports) contributed to the trustworthiness of the data (Glesne & Peshkin, 1992). Data collected in one form was used to check the accuracy of data collected using different methods. Participants were asked for their perception of an event or situation, individually and in small groups.

The long-term nature of the study, with large blocks of time in the field and follow-up visits will add to the reliability of the data. To make certain the data collected is accurate from the viewpoint of the participants, the researcher occasionally asked a participant to review specified portions of the data. In striving for an accurate understanding of science education partnerships, this research was guided by qualitative methods that allowed for the collection of data that reflected the realities as perceived by all participants and captured the holistic nature of how laboratory based scientists and classroom science teachers work together.

Site and Participant Selection

At the time this study was initiated, there were 12 federal research facilities in a large metropolitan area along the Front Range of the Rocky Mountains that had the potential to be included in the study. Because the nature of the research required frequent interaction and involvement by the researcher, this geographic area was well suited for its convenience to the researcher's residence. In addition,

the metropolitan area is the western regional center for many federal agencies and national laboratories (Appendix A), and therefore afforded the researcher access to the types of facilities targeted for inclusion in this study.

Identification of potential research sites began during the spring of 1996. At that time, letters were sent to the heads of education programs at all the federal facilities with research laboratories in the metropolitan area (Appendix B). The researcher followed each letter with a phone call. In all but four cases, the education program coordinator expressed interest in the study but noted that due to budgetary constraints, he/she would not be funding in-service teacher programs during the summer of 1996. In December of 1995, the United States Congress had "shut down" the federal government, effectively closing all federal facilities for a period of about three weeks. When the government restarted operations in early January, there was a great deal of budgetary and internal turmoil that put many federal programs and staff in limbo. This resulted in unforeseen consequences for the availability of accessible or appropriate research sites. Federal agencies were strapped for funding and many were operating on a restricted budget. As a result, there were a limited number of federal facilities in the metropolitan area planning pre-college science education programs for the summer of 1996.

Administrators of pre-college science education programs at the four federal facilities agreed to personal meetings to further discuss the proposed study. The researcher met with education program personnel at all four sites. Two met the criteria for inclusion in the study, i.e., they involved local teachers and scientists, were scheduled to begin during the summer of 1996, and were willing to participate. The two programs in the study were sponsoring science education programs that involved collaborations between research laboratories and local K-12 schools. Hereafter they will be referred to as Program A and Program B.

To understand the culture of science teacher partnerships in their entirety, it was necessary to gain the perspective of representatives from each constituent group (i.e. teachers, scientists, program administrators). Both programs presented themselves as having middle school science teachers as the targeted audience. Therefore, as soon as possible, this research identified a middle school science teacher from each program to be key informants. Program administrators were considered to be key informants as was the mentor scientist in Program B who worked with the key informant Program B teacher. The program administrators had a selection strategy for choosing teachers and scientists to participate in the 1996 summer session from a list of potential candidates. Because the researcher did not have any control or input as to who participated, the scientist and teacher selection criteria used in each program are considered to be part of the program design and thus presented as research data in Chapter 4. All participants in the study were asked to sign an Informed Consent Form (Appendix C).

Initial contact with the program administrators informed the researcher that both programs, although targeted to middle school science teacher, had also accepted elementary and high school teachers as participants. To get a full view of all grade levels, elementary and high school teacher were recruited to participate in the research as secondary informants. Scientists not directly working with key informant teachers were also included in the study and considered to be secondary informants.

The nature of the research presented the opportunity for all persons participating in the two programs to participate in the research through informal interviews or conversations that arose naturally as the researcher was a part of the setting. The researcher (and the research) were introduced the first day of both programs. It was made clear at this time that the researcher would be making

observations during all aspects of the programs. This introduction served as a tool for recruiting key and secondary informants. All others in the program were encouraged to talk to the researcher with their comments being held in strict confidence.

As a participant observer, the researcher's presence was expected to change the behavior of the research participants in ways that could not be predetermined. By acknowledging this "observer effect," the researcher sought to understand her effect on participants and interpreted the data in that context.

Data Collection and Analysis

A central tenet in the data collection and analysis of the qualitative researcher is that he/she does not seek documentation to prove or disprove hypotheses prior to the initiation of the research. As the research progressed an understanding of participant perspective evolved and from this understanding, theories developed. Bogdan and Biklen (1992) refer to theory development from the "bottom up" as grounded theory.

It is clear from the literature on qualitative research that data collection and analysis are not separate events in a linear progression, but rather, occur in some combination and simultaneously throughout a study (Bogdan & Biklen, 1992; Erickson, 1992; Glesne & Peshkin, 1992; LeCompte & Preissle, 1993; Merriam, 1989;Peshkin, 1993). This is particularly apparent in the constant comparative design method where the researcher is concerned with multiple data sources (Hutchinson, 1986). Utilizing this method of theory development, the researcher "hit the ground running" with data collection, coding, and analysis occurring simultaneously from the outset. Early in the research, the data were scrutinized

for potential categories. Additional data collection served to add to the initial categories or begin new ones. As relationships were discovered, hypotheses were developed which guided further data collection, coding and analysis.

Data collection occurred during the implementation of the 1996 summer programs and the following academic year (1996-97). Data collection sites were the natural environments of the science education partnerships. Most events and situations of interest occurred either in participating program offices and laboratories or in the classrooms of the teachers involved in the programs. Off-site events included additional meetings and field trips. Data were also collected in unplanned situations including social venues.

The use of a variety of methods for data collection was useful in providing differing perspectives while attempting to capture the complexity and context of the situation. Each of the data collection methods is described below. Data consisted of daily observations in workshop and laboratory settings, interviews (semi-structured and informal) with key and secondary informants, written reports and journals, e-mail communications, and written program evaluations.

Interviews

All key and secondary informants in the research study were asked to participate in 30 minute interviews at least twice. Key informants were interviewed up to as many as four times.

Key teacher informants were asked to participate in four, 30 minute interviews scheduled at different times during various phases of the partnership. Other key and secondary informants were less frequently interviewed. To make certain the information was recorded accurately, all of the interviews were audio-taped and transcribed.

Initial interviews with the key administrator informants were conducted during the planning phase for each program. Initial key teacher and scientist informant interviews took place as soon as possible after the summer partnership began. The researcher waited until her presence was accepted and the participants appeared to be comfortable interacting with her. The researcher identified a neutral, comfortable environment to conduct the interviews.

The interviews were semi-structured to make certain that specific topic areas were discussed but at the same time, allowed for open-ended input from the participants. Care was taken not to orchestrate the interviews too much to allow participants to share whatever topic or issues they consider to be of interest. This was particularly important when it appeared that the informants had something they wanted to share.

At the first interviews, questions were of a general nature and included topics such as: (1) personal background and prior experience in partnerships (if any); (2) personal motivation for involvement; (3) expectations (i.e., what did they want out of this partnership; (4) their role and how they viewed it; (5) how they viewed the role of the other partners (i.e., how the teachers view the scientists' role and how the scientists view the teachers' role); (6) their understanding of program goals and objectives; (7) how they felt about the partnership; and (8) in general, how did they view pre-college science education? Subsequent interviews with key informants followed up on statements made during prior interviews and addressed any emerging topics deemed important to the research.

During the 1996-97 school year, the key teacher informant interviews focused on how they were transferring their partnership experience to the classroom. Did teachers feel they have changed what they taught as a result of

participation in the partnership? Did they feel they had changed how they taught as a result of participation in the partnership? Did the partnership meet their personal expectations? Did they stay in touch with the scientists they met during the summer program?

Written Reports and Journals

The teacher participants were asked to share their lesson plans (as they pertained to the topics associated with the partnerships) during the first semester of the 1996-97 school year. In addition, any written teaching materials or curricula developed through the program was considered as potential data.

At the beginning of the summer programs, it was suggested that the teachers keep a journal for reflection, general note-keeping, or as a laboratory notebook. Journal-keeping was made only as a suggestion and not as a requirement. At the end of the study, those key and secondary teacher informants who had been observed to be keeping journals, were be asked if they are willing to share the contents with the researcher. To avoid bias in their reporting, participants were not informed of this request until the end of the study.

Observation

Events were observed in the course of this research including regular workday happenings (at the laboratories and in the schools) and additional events that were of interest (social interactions and off-site situations. When possible, field notes were taken at all of these events.

The primary goal of observation was to record phenomena relevant to the topic and current questions. Observation was used to determine if what people said they did (from interviews and written reports) was consistent with what they were observed to do. Observation allowed insight as to the roles individuals take on in the

partnership and to see if there are differences in status between the teachers and the scientists. Of interest to the researcher was how the partnerships transpire and what form they take. Field notes were transcribed and transferred to a computer file within two days of collection.

Electronic Mail Communication

E-mail was used extensively to communicate between the researcher and the research subjects. The participating scientists and program administrators all had regular and unobstructed access to email and this proved to be an effective tool for communication with the researcher. The teachers in the study did not all have access to email, but for those who did, it was used for communication during the summer and the follow-up school year. All email messages (and the researcher's responses) were saved electronically and printed as hard copies.

Program Evaluations

The programs in this study asked for participant feedback on various aspects of the program. When available, the researcher requested copies of participant responses to questions from evaluation or feedback forms.

The Researcher

The researcher kept a personal journal during the entire study logging information on all aspects of the study. Glesne and Peshkin (1992) noted that the log would become a "personal methods book that contains the insights that result from the interaction of reading, reflecting, and doing research" (p. xii).

The researcher was the key data collection instrument, and therefore, it is useful to acknowledge her background and experience, particularly as it applies to a

federal laboratory setting. By recognizing personal information, sources of potential bias or distortion were made clear.

At the time of data collection, the researcher had spent 10 years working at a national research laboratory in a medium sized college town immediately adjacent to a state land grant university. The researcher worked on a variety of environmental research projects (wetlands, ecological regionalization, biodiversity, and global climate change) first as support staff and eventually in positions of project leadership. Of particular interest to this proposal was her work on the Environmental Education Program which focused on curriculum development and the establishment of partnerships between scientists and teachers. The Environmental Education Program was initiated, developed and directed by the researcher. Potential bias was that she had "done it" and may have had thoughts on how such projects should look. Her views were also influenced by the literature review and discussions with faculty members.

Her experience in the national laboratory setting was two-sided. On one side, she was familiar with the national laboratory setting, the government system, the scientists, general bureaucracy, etc. This allowed a certain level of comfort and understanding. On the other side, her familiarity with the setting may have caused her to overlook useful information that an outsider would notice. The researcher, although having worked with teachers for several years for extended periods, had never been a classroom teacher and, therefore, was limited in her understanding of the classroom environment.

Data Analysis

Glesne and Peshkin (1992) describe the process of data analysis as "working with the data, you create explanations, pose hypotheses, develop theories,

and link your story to other stories. To do so, you must categorize, synthesize, search for patterns, and interpret the data you have collected" (p. 127). As previously noted, in qualitative research partial data analysis takes place during all stages of the research. This approach provides a foundation in the development of grounded theory. Hutchinson (1986) describes this method as being circular and one that requires a continual process of data collection, coding and analysis. Bogdan and Biklen (1992) suggest that "design decisions are made throughout the study - at the end as well as the beginning. Although the most intensive period of data analysis usually occurs in the later stages, data analysis is an ongoing part of the research" (p. 59).

Early data analysis helped to focus and shape the research study (Bogdan & Biklen, 1992; Glesne & Peshkin, 1992; Hutchinson, 1986). As is typical in qualitative studies, this research yielded huge amounts of data, therefore, it was critical to find a way to organize the data to make sense of it all. To facilitate the organization of the data, Glesne and Peshkin (1992) suggest early data analysis that includes developing analytic files and applying rudimentary coding schemes.

Analytic files were developed to help manage the data. A primary incentive to do so was simply a housekeeping concern (i.e., what to do with the volumes of paper). A file was made for each program participant who was included in the research. The files were color-coded to distinguish which of the two partnerships the individual was associated with and to which constituent group the individual belonged (e.g., teacher, scientist, administrator). Initial information included the participant's name, who his/her teacher or scientist partner was, and laboratory address and phone number. All written documentation pertaining to each individual (i.e., transcribed interviews, surveys, questionnaires, e-mail correspondence) was placed in his/her file.

To facilitate the emergence of patterns and early categories, additional analytic files were developed. These included files that were devoted to interview topics, events, development of teaching materials, etc.. For example, the interview topic files included responses to questions designed to explore teacher and scientist expectations, motivations, understanding of goals and objectives, role in the partnership, feelings about the partnership, and linkages between the partnership and classroom teaching. Program administrators were asked questions regarding project background, expectations, logistics, and how, in general they thought the program was progressing at different times during the summer. Files were also developed for events such as planning meetings and social functions. The event files were very broad and included everything from who attended, what topics were covered, group dynamics, written agendas (if any), and description of the meeting rooms. Files were developed to include lesson plans, teaching materials, and program evaluations.

In many cases, the data fit more than one file. In this case, photocopies were made and the data were cross-filed. When photocopies were necessary, they were clearly marked to indicate the cross reference. To track all of the filed data, wall size charts and matrices were used in addition to the spreadsheet.

The categories were refined as the analysis progressed. Sorting the data into files was the first step in the rudimentary coding scheme. Bogdan and Biklen (1992) note that developing a list of coding categories after data collection is a crucial step in data analysis. As the analysis progressed, the codes multiplied. The data were searched for similarities and patterns and words or phrases were developed to represent emerging topics. The emerging topics were used for coding categories. As the categories emerged from the data, they were searched for patterns or relationships. Emerging categories were compared with all other

categories to make certain that they were mutually exclusive and covered all variations in the data (Hutchinson, 1986). By using the constant comparative method, categories continually underwent changes through refinement, modification, and elimination. Comparisons were made within and between the partnerships included in the study. Comparisons were made within each partnership to provide information about the nature of the individual partnerships and their functions. By using two partnerships for comparison, varying degrees of success became evident. Comparisons between the partnerships were key in the delineation of best practices.

Theories generated from the data were examined within the context of instances that provided support or refuted the construct on which the theory was based. Theories were developed and scrutinized using sequential sampling methods that included theoretical sampling, negative-case selection, and discrepant-case selection. Initially, data were searched for similarities that guided subsequent data collection. As the study progressed, data were chosen to highlight differences. The recognition of differences aided the delineation of categories and assisted in theory generation. The data were searched to identify instances that refuted or contradicted the developing theories. Discrepant cases, or those that "just didn't fit," were also identified as they were important in noting the limits of the developing theory. Through careful data collection and analysis, this research developed grounded theory that accurately reflected the data and provided useful knowledge in the understanding of the best practices in partnerships between classroom science teachers and laboratory scientists.

CHAPTER IV
ANALYSIS OF THE DATA

Introduction

While data analysis evolved concurrently with data collection, the researcher was a part of the setting and experience of the research participants. Because analysis must follow from a clear understanding of the data, presentation of the data is separated from data analysis.

The Research Setting

Two federal facilities in the greater metropolitan area of a large urban center along the Front Range of the Rocky Mountains provided the setting for this study. Both federal facilities were sponsoring science education programs that met the criteria for inclusion in the study, i.e., they involved local teachers and scientists, were scheduled to begin during the summer of 1996, and were willing to participate. The two programs in the study were sponsoring science education programs that involved collaborations between research laboratories and local K-12 schools. Hereafter they will be referred to as Program A and Program B. An overview of both programs is found in Appendix D.

Preliminary conversations with the program administrators gave some insight into the intent of the programs. Both programs intended to conduct three-week summer workshops for approximately 25 middle school science teachers focusing on enhancing science education and aligning classroom science instruction and assessment with the newly adopted state and district science standards. Both programs intended to conduct five or six additional days for follow-up contact and

instruction during the subsequent academic year. Both programs had a stated intention of having scientists as key participants and allowing teachers ample opportunities to interact and work with the scientists for the purpose of enhancing the teachers' science content knowledge and enthusiasm for teaching science. Both programs were geared toward middle school science teachers and expected between 25 and 30 teachers to participate.

The Participants

To fully understand the culture of the collaborations, it was necessary to identify representatives from three distinct population groups, i.e. administrators, teachers, and scientists from each program as informants.

The first individuals contacted in each program were the directors. They provided the necessary approval to conduct the research and the names of other key individuals. In both programs, all administrators agreed to participate in the research. They also provided useful background information regarding the intent and direction of the collaborations.

The researcher intended to identify a middle school science teacher to serve as a key informant in each of the programs. Once the teachers were identified, the scientists they interacted with would be recruited for participation in the research. The selection of teachers and scientists was based, in part, on how their situation reflected the stated intent of the program. The selection process will be discussed more fully later in this chapter.

The Table below lists the total number of participants in each program and provides the names of the key informants in each population group (i.e., administrators, teachers, and scientists).

Table. Participants in each program have been listed by population group. The key informants in the study are listed by name.

Participants and Key Informants	
Program A	Program B
Total Number of Participants - 34	Total Number of Participants - 42
Administrators (5) Donna Phil	Administrators (3) Beth Kim Jim
Teachers (28) Debra – middle school Thomas – high school Maria – elementary school	Teachers (24) Cathy – middle school Smitty – high school Patty – elementary school
Scientists (5) Mel Emily Steve	Scientists (11) Jennifer Robert George

Contact with the Researcher

The research design included observation of the summer programs and interviews with key informants representing administrators, teachers and scientists before, during, and after the summer program. Although much of the data collection was through direct observations, when appropriate, the researcher looked for opportunities to participate in workshop activities. When invited to join small groups or participate in an activity or discussion or join a lunch group, the researcher did so to further interpersonal relationships with the subjects and to get a fuller view of the programs.

This chapter examines each program separately and concludes with discussion and comparison of key features from both programs that emerged from the research. Aspects of the research deemed important have become sections

within the discussion of each program. Each section begins with a summative paragraph, followed by a richer description, and then a short discussion summarizing key points from that section. After a short overview, the sections address planning meetings, recruitment of teachers and scientists, expectations from administrators, program implementation examined week by week, post summer follow-up meetings, teacher/scientist contact during the school year, classroom impacts and teacher reflections, and scientist reflections.

Program A

Overview

Program A involved a partnership between a single school district and scientists at a research laboratory about 30 miles away, hereafter referred to as Lab A. Lab A was part of a large federal agency with many research facilities throughout the nation. The primary research of Lab A focused on the atmospheric and solar sciences. Lab A was located in a relatively affluent, liberal community with a major research university. The partnering school district was a large urban district with a significant minority population and hereafter is referred to as City Public Schools (CPS). A summer workshop was the featured event in Program A.

The directors for Program A were Phil, a scientist affiliated with Laboratory A and, Donna, an educator affiliated with CPS. Phil and Donna were in charge of the overall planning and organization of the workshop.

Phil, a Ph.D. physicist, had recently retired as the deputy director of Lab A and was working as a volunteer to coordinate K-12 science education projects involving Lab A scientists. Phil did not have any professional background or formal experience in K-12 education but had been working on collaborations with CPS for several years. He shared his view of the upcoming workshop.

> For the past few summers, we have put on teacher enhancement programs for teachers to get them more interested in science. For the past couple of years we have been working with CPS. The first week the teachers will stay in (city) and work on science and mathematics exercises with the standards and assessments. During week two, they will be at Lab A for content instruction in the earth sciences and one day of technology. They are all required to put together a hands-on science or math project that their students can use in the classrooms.....in August, they will come back for one more week and make presentations ....and get feedback from the other teachers. All the projects will be made available to all the teachers so they will get a nice packet of plans for classroom use based on the science standards.

Donna was a retired elementary school principal from CPS. She was working part time as the coordinator of the science and mathematics educational professional development programs at CPS. She had spent her entire teaching career with CPS starting as an elementary teacher and moving to administration during the latter part of her career. Donna had an Ed.D. in curriculum and instruction. She had been asked to come out of retirement to help CPS implement their new science standards. Donna shared her goals for Program A.

> We need help to get standards implemented in CPS. The teachers need to understand how to work with the standards in their classroom. We are trying to change the way children are taught and how teachers measure what children have learned. The entire education institution needs to understand that they have to do things differently. And that is the point of this workshop...to help teachers feel comfortable with the standards in their classroom.

Donna explained that Program A had three associate directors. Julie, Cheri, and Amy would be in charge of much of the actual workshop facilitation. All three of these women were former CPS classroom teachers now holding administrative positions with the district. Julie was the district science curriculum coordinator. Cheri and Amy were assigned to projects involving the adoption and implementation of the new district standards.

Both Phil and Donna were retired from their primary careers and focused on this project as a part time effort. Phil was the initial and primary contact and relatively accessible. Personal meetings with Donna began after the program's onset and were infrequent as arranging contact with Donna proved to be difficult.

Early on, Phil suggested contact be made with Mel, a scientist at Lab A. Mel was a notable exception to most of the scientists in the study as she assumed a leadership role in Program A. Mel was instrumental in planning the science content portion of the workshop and in recruiting additional scientists from Lab A to participate in the workshop. Mel, a Ph.D. physical chemist, was working as an atmospheric scientist at Lab A. Before going to graduate school, she had spent several months as a substitute high school science teacher. She had been at Lab A for 3 years and stated a very strong interest in K-12 education.

> I want to work with teachers. There is a really huge gap between scientists and the public. And teachers are part of that public. For the workshop, we only have a week to really concentrate on the science. And that is not a lot of time. It is always amazing to me the level at which scientists try to speak and how little comprehension they have of what people actually know.....most scientists don't have an understanding of their audience. I need to make sure the other scientists realize they will be working with middle school teachers and be ready for that audience. The workshop will be a good opportunity for us to show teachers real science and maybe help them figure out how to use it in their classroom.....I don't want this to be another example where scientists just get up to teachers and talk for hours as the experts. We don't need any more programs with the 'sage on the stage.'

Program A had held a similar teacher enhancement workshop the previous summer. Eleven teachers who had participated in the previous summer workshop returned for a second year. For the purposes of this study, it was decided new teachers would be preferred as subjects as they would not have to separate their experiences from the previous year. Program A did not have a teacher participant list far enough in advance for the researcher to solicit volunteers for the study,

therefore, the researcher had initial contact with the teachers on the first day of the workshop. Although middle school science teachers were identified as key informants, teachers from elementary and high school were also observed and interviewed to develop a fuller understanding of the programs from a multi-grade perspective.

Planning Meetings

From the earliest stages, Program A had significant communication problems between the program directors. In examining communications between these individuals, it became clear that they did not share similar philosophies or expectations regarding Program A or similar views of what teacher enhancement programs should look like. Nor did they share compatible views of the roles of the scientists and teachers in the program thereby making planning problematic. In the planning stages, teachers were involved in a peripheral context -- present, but not quite central to the actual planning. The differences between the program directors emerged almost immediately during the planning process.

The planning for the workshop began well in advance of the researcher's introduction to the program. Significant amounts of effort had been undertaken by the program directors prior to the more public, input gathering meetings that the researcher was invited to attend in the spring. Program A held a series of planning meeting during the spring of 1996. The planning meetings included individuals representing all aspects of the collaboration – classroom teachers, scientists, program administrators, district curriculum specialists, and others key to the summer workshop. The purpose of the early meetings was to get input to shape/form/improve the workshop. Attending these meetings provided the

opportunity to observe some of the key participants and to get a better understanding of the workshop.

Program A's first public planning meeting was held in mid-April. This initial meeting was attended by several CPS teachers, and the Program A Directors and Associate Directors. None of the teachers in attendance had participated in Program A the previous year or intended to participate in the upcoming workshop at Lab A. They had very little knowledge of the program. There were no handouts or agendas distributed. Phil gave a brief overview of what the summer would entail in terms of the focus on science, pedagogy, and science standards. Phil asked if any of the teachers would volunteer to work with scientists to help set up the content sessions. Although none of the teachers in attendance volunteered, Donna said they would get some teachers to help the scientists prepare for the summer workshop.

Donna spent most of the meeting addressing the more generic policies and politics of CPS professional development programs and the new district focus on standards. Little meeting time was devoted to summer workshop planning.

The classroom teachers in attendance complained about the last minute nature of the meeting and how they needed more advance notice to be able to attend such planning meetings. One teacher told the researcher, "This is so typical. It's as if somebody decided at the last minute that teachers should be part of this meeting, but the reality is that we are always an afterthought. It is such a waste of time."

Phil scheduled another planning meeting several weeks later. In preparation for the meeting, he sent e-mails to Lab A scientists and the following email to Donna to encourage the participation of CPS teachers as she served as the gatekeeper to the teachers. He specifically asked her to send this out to other teachers.

> Dear Science Teachers: (Donna, please pass on to the other teachers that do not have e-mail, thanks)

> We would like the teachers to bring specific ideas that they have for hands-on activities that have been successful in their classrooms.
>
> We really need your input into how to present the information to fellow teachers so they can utilize the information and materials in their classroom. Teachers are the best people to give us this input.

Even with the direct request for participation from teachers, no CPS classroom teachers attended this meeting nor did Donna. Attending the meeting were Mel and three other scientists from Lab A, Jane, a middle school science teacher from a nearby school district, Amy, Phil, and the researcher.

The meeting was held at Lab A. With the workshop only a month away, the focus of this meeting was to determine the role of the scientists and decide the best way to share the content information with the teachers. Earth science would be the content focus.

Phil gave a brief overview of the project and the discussion turned to how to best present the earth science content to the teachers. The discussion quickly became somewhat philosophical as they debated if it was better to present the content material in a traditional lecture format or a hands-on exploratory format. Phil mentioned that students like a "hands-on" approach in their classroom instead of having teachers lecture. However, he strongly favored having the participating scientists present material to the teachers in a lecture format.

In previous summers, Jane had participated in similar collaborations with scientists and made it clear that being given intensive science content lectures by scientists was not an effective way to get teachers more familiar with the content. She said teachers needed time to put things together and they liked to be able to brainstorm ideas of how to transfer new content knowledge to the classroom. She felt it was unreasonable to expect teachers to spend days being lectured to and then

expect them to turn around and be able to "give good presentations to our students and also, by the way, to have come up with effective and enjoyable hands-on activities for them as well." Jane stressed that she usually found the talks interesting and informative, but in many cases the "scientists do not know their audience and assume they are talking to other scientists and not 6th grade teachers who don't have Ph.D.s' in science."

The general discussion that followed supported a hands-on activity approach to teaching the content. Phil appeared frustrated with the focus on activities and exploration. After a couple of minutes of discussion, Phil broke in and stated that "the teachers needed more basic science content." Phil went on to express "that lectures were an effective way to impart information to large groups of people." To be successful, the workshop would have to have teachers coming away with increased content knowledge. He also noted that the hands-on activities needed to be more structured and not open-ended.

Jane noted that the problem with having the scientists lecture to the teachers was that it was a demonstration of poor modeling. Her statement was met with murmurs of support from several of the meeting participants.

There was not any apparent resolution to this discussion. Mel made several attempts to recognize Phil's desire for more content and to recognize the teacher's need to have the material presented in a way that would enable them to effectively transfer it to the classroom. Phil wanted a strong content focus delivered via lecture format and he believed that the scientists needed to take the lead in running the workshop. Phil later shared his thoughts regarding the state of pre-college science education with the researcher. He strongly believed that K-12 science education was in very poor shape and would benefit from the infusion of scientists in shaping the content and delivery. He said there was a need for,

> ....more of the science side rather than the education side because the education is run by the educational departments and because of that, the science components are not as strong as they should be. There needs to be more science and less education experts.

Phil expressed frustration with the workshop planning process and "the lack of focus on the science."

The workshop content was divided into two main topic areas, the earth and the atmosphere. Mel and her colleagues would take the lead in the atmospheric sciences. Two other scientists in attendance, Steve and Emily, offered to lead presentations on geology and geomorphology.

A final planning meeting was held at Lab A at the end of May. Only one classroom teacher (Laura) was present and she was not from CPS. Amy and Julie from CPS were there along with Mel and two of her Lab A colleagues (Annette and Carol). Bill, a Lab A scientist who had developed a web-site for science teachers was at the meeting as he would be leading the computer training day at Lab A. Steve and Emily were not at this meeting.

Mel was the facilitator for this meeting. She explained that she, Annette and Carol had been working on their atmospheric science presentations and would like feedback from those present. She stated that she was disappointed with the lack of CPS classroom teachers present. She asked Julie how many teachers would be participating in Program A and what grades and subjects they taught. Julie informed her they had 30 teachers signed up -18 elementary, 6 middle, and 6 high school teachers. The teachers taught a variety of subjects including pre-kindergarten, special education, language arts, social studies, mathematics, and science. The vast majority of the teachers taught grades 2 – 5. Mel was concerned about trying to create an experience that met the needs of all the teachers and wondered aloud how to handle an audience with more than 50% elementary teachers

when she and her colleagues had been targeting their presentation and activities towards middle school science teachers. Mel expressed some concern on being able to make the experience meaningful for all teachers given the wide range of grades and subjects taught. Phil noted that even with the wide range of grades and subjects, "teachers are pretty adept at modifying up or down." Mel noted that she was not certain that the atmospheric science presented would be of much use to the lower grade elementary teachers or the language arts and social studies teachers.

The atmospheric science content of the summer workshop presented by Mel and her colleagues would focus on climate change and atmospheric chemistry with an emphasis on stratospheric ozone depletion. Handouts of the planned content were shared. The general response from all, but especially the educators was that it was a very ambitious undertaking given the limited time. The scientists thought it could be done but the educators remained skeptical.

The meeting continued with activities being set up and tested. It was decided that the activities would be set up in a "smorgasbord" fashion allowing teachers to go from activity to activity. Amy noted that allowing the teachers some freedom to choose might lessen the concerns with the disparity in grade levels and subjects. The activities were well received by both the scientists and the educators. Mel, Annette, and Carol would continue to fine-tune their presentation to make it broader than originally planned to accommodate the diverse needs of the audience. With the exception of Phil, it was generally recognized that content could not drive the workshop.

The researcher met with Mel to further explore the differences between her and Phil and their vision of the workshop. Mel expressed frustration with the planning process. She and Phil had worked together the previous year on a similar workshop and she hoped to improve on what they had learned from that workshop.

Earlier in the spring, Mel had initiated an email exchange with Phil to share her concerns and suggest areas of improvement in a number of areas. One item of concern was continuity. Mel believed that,

> Last year we found that the teachers were tired and confused by the time they came to us. They had been exposed to too many different topics, too quickly. ....we need to organize the entire two weeks around a central theme.....Ask teachers in which specific subject areas/topics they need to improve their skills and content knowledge. Design a workshop that addresses those needs.

Phil did not share her concern on this topic. He replied:

> The summer workshop is organized around a common theme – standards based education. In addition to the science content, they were also given math content, pedagogy, and assessment presentations.
>
> Also, most teachers really don't know which specific subject areas and topics that need improved content knowledge. All of them indicate that they are relatively weak in most science areas because of their lack of proper science training, of hands-on science pedagogy, and in the other subject areas being presented – that's why they are taking the summer sessions.

Mel had also communicated her concern regarding mixed grade levels to Phil in their email exchange.

> We simply don't have time and resources to develop and present activities that will be appropriate and satisfying for such a varied group (last year's group ranged from pre-K to high school teachers in many subject areas).

For the upcoming workshop, she suggested that the group be limited to teachers of similar grade levels and subjects taught. She also asked that they be told in advance exactly who they could expect and how many teachers would be present.

Phil did not share Mel's concern. He noted:

> The teachers have stated they really like the multi-grade level approach in the science presentations. Since all elementary and middle school science teachers teach the same subjects, the science presentation content is applicable to almost all teachers and they are

> responsible for preparing the appropriate level for their particular class. The number of hands-on activities known to teachers is so limited, you will see the same hands-on activities in the elementary, secondary, and sometimes even the high schools. This limitation is an additional problem we, as scientists, must address.

Finally, Mel noted that she did not feel they had been given adequate feedback from teachers the previous year.

> We have no idea whether any of last year's attendees ever used any of what we presented. Also, I would have liked to see some follow-up to find out whether teachers had been able to use the new materials and activities in their classrooms.

Phil replied,

> I believe you were given a set of the evaluations from the teachers indicating that they were extremely happy with the content and intend to use the activities in their course work. I'm sure that if you had requested classroom impact feedback from the teachers after they returned to their classroom, you would have received some.

When asked if a change of workshop location for the second week was possible so that the teachers would not have to drive as far, Phil stated that they "are already imposing enough on the scientists" and that the second week would be held at Lab A.

Mel ended her email in a supportive manner suggesting further conversation to find a workable solution. Despite her concerns, Mel made it clear to the researcher that she was committed to the summer workshop and planned to devote a significant amount of time to organizing the content portion. Mel regularly solicited input from teachers and scientists as how to best organize the science content. She evolved as the *de facto* leader for the Lab A scientists' involvement in the workshop. She stayed in communication with individuals representing the various user groups, teachers, administrators, scientists, and the researcher during the planning stages of the workshop.

Summary of Program A Planning Meetings

By the end of the third planning meeting, it was clear that there were significant communication gaps between Donna, Phil, and Mel and it did not appear that they shared a common vision for the program. At times they seemed at odds with each other and this appeared to place the overall effectiveness of the workshop in jeopardy. Phil was the only one who attended all three planning meetings. Donna attended the meeting held at CPS and Mel attended both meetings at Lab A. There was little evidence that Mel and Donna communicated with each other directly. Phil did communicate with both Donna and Mel but was not effective at relaying information between them.

In examining communications it became clear that these key players did not have similar philosophies or expectations regarding the program. In fact, they did not even seem to have similar views of what teacher enhancement programs should look like or what the role of scientists should be in scientist/teacher interactions. Phil viewed the scientists as being the leaders and having the answers. Mel was more concerned in helping teachers get the best opportunity for staff development that was possible. And Donna was primarily concerned with CPS policy and standards implementation.

In observing Phil and Mel at the planning meetings, it appeared that they had differing philosophies and visions. Phil's responses to Mel's emails came across as defensive in nature. He did not offer solutions and dismissed her concerns. The same concerns she had in the emails were evident during the planning meetings. The issues had not been resolved.

The classroom teacher turn out at the meetings was minimal during the workshop planning. At the initial planning meeting at CPS, there were several classroom teachers in attendance, however they only had limited knowledge with

Program A. There were several CPS teachers who had participated the previous year and planned on coming back for the second summer. These individuals could have provided insightful suggestions for improvement and planning based on their experience the previous summer. For the planning meetings at Lab A, no CPS teachers attended although Phil had sent an email to Donna explicitly asking that teachers be encouraged to attend. Both planning meetings at Lab A were scheduled for later in the afternoon to make it easier for CPS teachers to attend. With only a few weeks before the workshop was scheduled to begin, Program A was disorganized and without a commonly held vision by its leaders.

Recruiting Teachers and Scientists

Program A accepted any individuals who wanted to participate. There was no formal selection process for either teachers or scientists. Program A had 24 teachers, 6 scientists, and 5 administrators involved. Although the focus audience was middle school science teachers, the vast majority of the teachers in Program A did not teach middle school or teach science. Accepting anyone who wanted to participate impacted the overall potential effectiveness of Program A.

The recruitment of teachers and scientists for participation in Program A was concurrent with the program planning. According to Donna, the teachers originally intended to be recruited for Program A's summer workshop were from specifically targeted schools in CPS that served a relatively high proportion of at-risk students. Even though specific schools were targeted, Program A accepted other teachers who showed interest. Donna explained that the information was communicated to the school principals and it was their job to get the information to the teachers who might be interested. If a teacher was interested he/she called Donna's office and registered. There were no formal application forms or

interviews. The teachers were notified by phone of their acceptance to Program A. Teachers were still being notified of their acceptance the week prior to the summer workshop. The last minute nature made the recruitment take on a slightly desperate edge. According to Donna, no teachers were turned down and they could have taken up to six more teachers.

Phil had the responsibility for getting the Lab A scientists involved. He contacted Mel, whom he had worked with previously, and met with her to discuss the new CPS district science standards. Between them, they picked out three or four standards that would be appropriate for Lab A scientists to address. From there, Phil contacted a Lab A division head and asked him to "put the word out." The scientists who responded were those present at the first planning meeting at Lab A. Mel recruited additional scientists from her department to help with her presentation.

Summary of Program A Recruitment

The teacher recruitment and selection process was disorganized and lacked any specified criteria. The stated intention of Program A was to focus on middle school science teacher enhancement and professional development. The vast majority of the teachers participating in Program A were not middle school teachers or science teachers. By simply informing selected principals of the opportunity and leaving it up to them to get the word out to teachers on their staff, Donna missed a chance to have a group of teachers who could better appreciate and use the content of the summer workshop. Also, the schools targeted for inclusion (i.e. at risk) were mostly elementary schools. From the start, the effectiveness of Program A was compromised by recruiting and accepting teachers who did not fit the profile of the program's targeted audience. Phil and Mel thought the program was for middle

school teachers and began their initial planning on that basis. Concern was raised at one of the planning meetings when it became clear that the majority of participants were elementary teachers. In an interview with Donna after the planning meeting, the researcher was informed that teachers were being accepted up to the last minute and no one was turned away. Donna did not have any flyers or brochures available to advertise Program A. Depending only on principals to inform teachers of Program A was a mistake.

Phil did take the time to talk with Mel to review the standards and select topics that the Lab A scientists had expertise in and could address. Once the topic areas were decided, Phil and Mel approached a department head who had staff with the specified content area expertise. Using email within Lab A was a good means of communication. In addition, Mel personally recruited individuals in her department to assist in her presentation. The overall scientist recruitment for participation in Program A was fairly effective. Scientists volunteered because they wanted to participate in Program A.

Administrator Expectations

From the planning meetings, it was clear that the program's administrators did not share a common vision for Program A or for teacher enhancement efforts in general. This became clear when, in private meetings, each was asked for their expectations. While not necessarily counter or out of sync with the overall program goals, each of the stated expectations did reflect each individual's own background. Of concern was the lack of communication regarding the differences in expectations.

Prior to the start of the summer program, the researcher asked Phil, Donna, and Mel what they each expected from the workshop. Specifically, they were

asked what they would like to see as a result of the workshop for them to feel it had been successful.

Donna's response reflected her hope that the teachers be better prepared to use the standards in the classroom which was a fundamental principle of the workshop.

> Basically, I want to see them get more science content. But I really want to see the change in attitude about the standards and how they can use them in their classroom. Not "what can I throw out for my students, but how can I be a facilitator or resource for my students." And if I can see that change happening, I will be absolutely elated.... and the other things that I am hoping is that the way they assess and how adept at how they become without being overwhelmed themselves, that's what I feel is important and what I would like to see them come out from the summer workshop.

Reflecting his generally high standards, Phil had lofty goals for the workshop. Even though the workshop did not have an emphasis on policy, Phil wanted teachers to make the link from scientific research to policymaking decisions on topics such as climate change and stratospheric ozone depletion and be able to convey that link to their students.

> I am afraid my expectations are a little higher than the results are going to be. I would hope that the 25 teachers would come up here and get enthusiastic about science and teaching science back in their classrooms and also have some insight into how science fits together with policymaking. I hope teachers will learn more about the science and understand that there are political and social ramifications of implementing scientific decisions and I hope that teachers will learn what the scientific methodology is. Decisions are harder and harder to make and we have to learn how to make more reasonable decisions. And teaching the scientific method will help teachers with that process.

Mel's expectations centered, in part, on personal growth as an instructor. She also hoped the teachers would become more confident in teaching the concepts covered during the workshop.

> I would want to feel that I had gone a little bit of a step beyond what I have done before with teachers. At least that I had made some progress in my own teaching style. Something had changed. And having the teachers having enough information that they understand the concepts and they can go off and work with their classes. Just having the teachers have a different way of thinking, just having their awareness open and having them understand that they are perfectly capable of teaching this stuff. So it is not so much transmitting huge amounts of information, just having them have some basic understanding of some of the stuff.

Summary of Administrator Expectations

The directors were open and happy to share their overview of what they hoped to have come out of the workshop for them to have considered it a successful endeavor. They shared their expectations with the researcher, but apparently, never with each other. It was not that any of their goals were out of line with the overall direction of the program, the problem was that they did not communicate with each other and they each envisioned different outcomes. For example, Phil wanted increased science content to be the focus. A problem was that most of the teachers were not science teachers. Donna wanted teachers to feel comfortable implementing standards. While Mel and Phil understood that and had a cursory knowledge of what that entailed, their expectations reflected their background as scientists. Mel was the only one of the three who expressed personal goals as well as goals for the teachers. For her, she hoped to improve her teaching skills. For the teachers, she hoped they would broaden the way they taught and feel comfortable embracing new ideas and new ways of presenting information to their students. Her statements were general and not limited to science content. All three had expectations that, at face value, did not compromise the integrity of the program. However, without each being fully aware of their intentions and expectations, a fully successful outcome for Program A was compromised.

Program A Implementation

Program A ran for two weeks early in the summer and then re-convened later in the summer for a final week. Six follow-up meetings were scheduled during the following academic year.

Week One

Overall, the first week of Program A was fraught with an overall lack of communication between participants and administrators; it was disorganized, and leadership was not well defined. The goals, objectives, and expected outcomes of Program A were never clearly stated. Only one of the 24 teacher participants fit the targeted audience. Initial observations clearly revealed that the teachers had not been brought into the discussion of standards implementation early on and that they were initially resistant. Although standard implementation was the unifying theme, much of the time was spent in busy work. Overall, the first week did not have many strong points.

The first week was held at a college campus in the downtown metropolitan area. The welcoming/introductory session was held in a large auditorium with several hundred CPS teachers as there were other workshops getting underway in addition to Program A.

Comments overheard from teachers indicated that some had only received confirmation of their participation the previous Friday. One teacher noted CPS's administration was generally incompetent and that she was always shocked whenever anything actually got done. The other teachers agreed with her.

Donna arrived 15 minutes late and gave a short welcoming address. She introduced Kent, a retiring CPS history teacher who gave the keynote address to "set the stage" for the new standards implementation.

Kent's talk was engaging and entertaining. He pointed out that standards are the "new rage right now." His talk was filled with humor and personal anecdotes. The teachers were laughing. They broke out in spontaneous applause when he suggested standards were the work of those "in the ivory tower and not those in the trenches." Kent said he was glad he was retiring and did not have to deal with yet another "new reform to education" and wished those in the audience that had no choice the best of luck. Overall, his message was one of wariness for the new standards. Kent was a gifted public speaker and the teachers enjoyed his talk as evidenced by the standing ovation he received.

Donna seemed a little bit flustered after Kent's talk but stated that "history teachers are eloquent and use such nice flowering terms." She gave a brief re-cap of Kent's talk but did not address his many stated concerns regarding standards being another "shot in the dark."

When a teacher asked for the overall objectives of the workshops, Donna said they would be available at the start of the afternoon sessions when the groups split up into separate programs. Donna introduced Madge, a CPS administrator who told the teachers that they were there to come up with an individual plan to implement standards-based education in CPS. Madge gave an uninspiring overview of standards using dry and boring overheads. The teachers appeared disengaged as they read unrelated materials, fidgeted, talked to each other, and shuffled through papers. Madge ended her talk by listing the reasons for standards-based education:

- Required by law
- Focus on not covering content, but student learning
- Student equity
- More efficient use of tax dollars
- Responsibility of the teachers, student, school board, etc.

Many of the teachers expressed concern about having to implement standards. The response from the Madge was, "It's the law." Teachers shared frustration about being asked to buy into yet another reform program. One noted, "It is hard to put energy into this new thing when change is inevitable because this new approach will not last long either." Again, Madge's response was "It's the law."

As the morning ended, the teachers were frustrated and Donna and Madge were defensive. On the way out, one of the teachers noted that the morning was a waste of time, but "oh well, I am getting paid to be here so I guess I don't really care what they do."

In the afternoon, Program A teachers met in a small, crowded classroom where they would be for most of the remaining sessions. Donna welcomed the teachers and acknowledged the tensions of the morning. She said that many of the teachers were "new" to standards, however, they had no choice as all CPS schools would implement standards by 1997. One of the teachers asked if there was a schedule or agenda for the Program A workshop. Donna said they would be passed out the next day.

There were 24 teachers in the workshop with the majority coming from elementary schools. Several of the teachers taught mathematics, language arts, social studies, and special education. There were also several high school teachers but only one who taught science. There was only one middle school science teacher participating in Program A. Out of the 24 teachers, there were only two who could be classified as classroom science teachers.

Donna talked about the responsibility each of the teachers had in becoming "master" teachers and how they were expected to be "change agents" in their buildings in the adoption and implementation of standards. From the responses, this

was new information to many of the teachers. A number of the teachers told Donna that they were not prepared to assume such a role. Donna assured them they would all feel comfortable as master teachers by the end of the workshop.

The remainder of the afternoon was spent in small groups where teachers were asked to use assorted materials (e.g. string, washers, rulers, tape, tacks, rubber bands, plastic pieces, etc.) to develop classroom science activities using the materials on the table. The teachers shared their "activities" with the other groups.

The researcher approached Debra, the only middle school science teacher who was new to Program A, to inform her of the research study and to see if she was interested in participating. She agreed.

In the initial interview with Debra, she clearly stated that her main reasons for participating were college credit and the pay. Debra had been a middle school science teacher with CPS for about 20 years. After the first 5 years, she left teaching for several years. She left due to,

> .....burnout. I wanted to do something else. I left the state and did other things for a couple of years. But when I wanted to come back here, teaching was the easiest way for me to find a job. I substituted at CPS for a year...and then got my old job back. This time around I have been teaching for 15 years for a total of about 20 years. I get to retire in about 6 years.

Debra did not have high expectations from her participation in the summer workshop. She had specific reasons for spending part of her summer in 'class.'

> College credit. And the pay. Really, I don't know exactly what things we are going to be doing with the scientists at Lab A. So it is hard to say right now. I don't have any great expectations. But the money and credit will be nice.

When asked if she had any motivations for participating in addition to the pay and college credit, she laughed and said she would not be there without the pay and

credit. She needed the credit to move up in the pay scale at CPS. She did allow that she had other reasons for attending the workshop.

> Since state standards are going to be required, I just want to know what is going on. Just to stay informed. Stay up to date with what is happening with science and CPS.

Although Donna was there the next day, the associate directors, Julie, Amy, and Cheri were in charge of running the workshop. Schedules for the workshop were passed out along with an attendance sheet. In order to get paid, each day the teachers were expected to sign the attendance sheet. Julie asked the teachers to keep a journal of their experiences and to "monitor personal growth." Blank paper was passed out and the teachers were shown how to fashion a notebook from a stack of blank paper that involved tearing and folding. The result was a marginal looking notebook. The teachers were not shy in noting how tacky the notebooks looked.

The focus of the day was on math activities. Cheri was a former math teacher and she led the activities. Working in small groups, the teachers did a number of very simple exercises. While engaged, the teachers were not particularly challenged. One teacher said that it was a reasonably good review, but the time could have been better and more interestingly spent. The afternoon was spent discussing math standards. Several teachers noted that they still were not sure where the program was going. Debra was candid and straightforward. She did not have high expectations or a clear understanding of what they were going to do. At the end of the second day, she noted, "so far, it's been pretty much a waste of time."

On the third morning of the workshop, at the prompting of the teachers, Program A's goals and objectives were discussed with no written handout provided for the teachers. Julie gave an overview of what they hoped to accomplish during the workshop. She explained that they should be preparing lesson plans aligned with

the standards and based on the new content they would be learning. Each teacher would be expected to give a presentation during the last week of the workshop later in the summer. A handout explaining the presentation requirements was distributed. The presentations would be peer evaluated and each teacher should be prepared to have copies of their activity for distribution to the other Program A teachers.

The teachers were asked to start working on the lesson plans that would form the foundation for their presentations later in the summer. On the board was a list that Mel had provided to inform the teachers of the science content topics to be covered at Laboratory A the following week. The teachers were asked to come up with a standards based lesson plan on one of the topics. The teachers who did not teach science immediately responded that there was no sense in doing a lesson plan for a subject they did not teach. The leaders conferred and told the teachers to do a lesson plan on whatever topic they wanted to just as long as they focused on standards and assessment. There were many text and resource books available for the teachers to use, although most of these were science based.

Debra was happy with the topic list because it included weather-related items and that was one of the major units she taught. But she was frustrated by not having access to her own resources to formulate the lesson plan.

Before the teachers left for the day, a packet of information from Mel was distributed. She had put together the next week's schedule and expectations as well as some background reading to make the teacher's limited time at Lab A more effective. In the packet, the teachers were asked to gather some simple data to bring with them to Lab A for further discussion. Copies of classroom activities linked to standards were also included.

On the fourth day of the workshop, the topic focus was on assessments. The teachers were instructed to use their lesson plan from the previous day and develop rubrics and assessments. Cheri gave a brief overview of assessments. The teachers sorted themselves into small groups and worked on rubrics. By the fourth day, Program A's overall disorganization and lack of clear focus was obvious. Teachers left the classroom for long periods of time. The absentee rate was high with at least three teachers absent each day. There was no clear accountability. The attendance sheet was not monitored and the researcher observed teachers "signing in" for absent colleagues. When the teachers were working in small groups, Julie, Cheri, and Amy did not try to interact with them. They stayed at the front of the room and talked to each other. Donna came by periodically but did not assume an active role.

By this time, two additional teachers had agreed to participate in the research study - Maria, an attentive and energetic 5th grade teacher and Thomas, the only high school science teacher participating. Maria had been teaching elementary school for eight years. She team taught a bi-lingual class at an elementary school in CPS with a high Hispanic population. Maria was not comfortable teaching science and turned most of it over to her team teacher. Maria had signed up for the workshop at the last minute at the urging of her team teacher.

> I couldn't tell you what I expect because I didn't know what I was getting into. A friend from school asked me if I wanted to go to this science thing and I knew I could use some science so I signed up. Science is so hard for me. So I don't really have any expectations. But I did think we would be getting more science. Maybe next week at Lab A.

Thomas received his degree in chemistry from a prestigious university in England. A native of that country, he had been teaching in the United States for 30 years and had no immediate plans for retirement. He was well known to the teachers in Program A and was well liked. Thomas referred to himself as a chemist rather

than as a chemistry teacher. Having attended many similar programs, he noted he liked to keep his expectations realistic.

> Venues such as this one designed for having teachers learn more science and simultaneously embrace a new pedagogical focus, in this case standards, generally promise much more than they can deliver. The intents are always admirable, but there is simply too much to cover. I expect to learn more about the standards which will be required for the upcoming academic year. I don't expect to learn much in the way of science content. Maybe get some exposure to current research, but I don't anticipate learning a great deal. The elementary school teachers may learn much more in the limited time we have.

The last day of the first week the workshop was held at City High School, a CPS high school with a new state-of-the-art computer lab. George, a CPS computer instructor was the teacher in charge of the day's computer instruction. He was not sure what they were supposed to be doing and asked Donna what she wanted him to do. She told him the teachers were supposed to set up a home page. Because of the disparity in computer abilities among the teachers, George suggested they take some time to learn some Internet basics. He would teach them some tricks in surfing the web and bookmarking useful sites. In the afternoon, they could work on homepages. Donna had forgotten to ask the teachers to bring diskettes. The teachers were turned loose on the computers. George walked around the room trying to help those who were really stuck. There was a lot of time for exploring the web and the teachers seemed to enjoy that.

At the end of the day, Debra said she was looking forward to working the scientists at Lab A the following week. Debra shared her thoughts on the workshop to date.

> I am the only middle school science teacher here and it hasn't been geared to me specifically as much as they said it would be. I think communication could be a little more direct. They did provide us, a couple of days ago, with the calendar for this workshop but I still haven't understood exactly what is happening and where it is

> happening. So I think there is a slight communication problem, however, the women involved seem to know what is going on, but I think a better job could have been done at communicating to us.

Summary of Week One

At the end of the first week of Program A, there was a lot of frustration and lack of direction at all levels. Beginning on day one, it was clear that the teachers were not brought into the discussion of standards early on and they were not happy.

Having Kent give the keynote address seemed to undermine the goal of having CPS teachers embrace the standards. Given Donna's reaction to Kent's talk, she may not have known what he was going to say. It does not seem likely Donna would have chosen his message to be delivered when the point of the CPS summer workshops was to help CPS teachers become more comfortable with the standards.

More than anything else, the researcher was struck by the disorganization and lack of communication in Program A. Although Donna was "in charge," after the first two days, she was not around often. She was almost always late when she did appear, thereby setting a poor example for the participants. There was not a clearly defined workshop leader. The goals and objectives were never stated or handed out although Julie did give an overview of the program. The focus on science did not live up to its advanced billing.

Given that Program A was supposed to be geared for middle school science teachers, there turned out to be huge disparity in the range and grade level of the teachers. This was a concern Mel had expressed during planning meetings regarding the effectiveness of the second week. Even with the unstructured application system, given that half of the targeted schools were elementary schools, Donna could have realized the teacher distribution would be skewed towards elementary teachers and conveyed that to Phil who could have informed Mel.

The accommodations for the teachers were substandard. The crowded classroom was not a good choice for a workshop. The teachers were confined to small groups of desks with little work space. Very few handouts had been distributed. The teachers were left floundering. No snacks or beverages were provided so the teachers frequently left to go elsewhere on campus for refreshments. They were often gone for up to 30 minutes at a time. This behavior was not discouraged.

At the end of the first week, the teachers had spent much of the time doing review and "busy work." There had been very little in the way of challenging content material presented. The teachers were still resisting the standards being forced on them. Many of the teachers went out of their way to let the researcher know what a waste of time the week turned out to be.

The workshop proceeded without the oversight of the directors. Phil had attended the first morning but had not come back. Donna made infrequent appearances at the workshop. The associate directors were trying, but they did not seem to have a complete vision of where the program was heading.

Week Two

The lack of clear leadership and accountability carried over into week two. By now, several of the teachers were not coming at all. The remaining regular teachers numbered about 18 and they had started to have a certain level of cohesion. The first group of scientists had organized talks with supporting classroom activities that obviously had a significant level of planning. The second group was not well organized and clearly did not put much advance time into the content presentation. A change occurred in several of those teachers who were interested in the science content now becoming actively engaged in all aspects of the second week.

The second week of Program A was held at Lab A to provide a more in-depth understanding of science by learning from Lab A scientists. The content focus was on the earth and the atmosphere with climate being the integrative theme. Mel and her colleagues Annette and Carol provided instruction in the atmospheric sciences while Steve and Emily were responsible for sessions on geology and geomorphology. The week included lectures, presentations, demonstrations, classroom activities, laboratory tours, computer training, and a field trip. This was the only opportunity in the three weeks for the teachers to interact with Lab A scientists.

A comfortable auditorium and several adjacent rooms in one of the more public buildings on the extensive Lab A complex had been reserved for the second week. This building was not the 'home' building of any of the Lab A scientists involved in Program A. The foyer of the building had many displays and interpretive information designed for a general audience. The teachers were appreciative of the space and openness of the building.

On the first day, all the scientists were present for introductions and an overview of what the week entailed. Of the 24 teachers in Program A, only 18 teachers were present. Steve informed the teachers that the field trip later in the week would involve a hike and that they should plan to dress comfortably, bring water, lunch, and sunscreen.

Mel, Annette, and Carol were in charge of the initial sessions. They intended to cover a basic introduction of the atmospheric sciences and would touch on topics such as the greenhouse effect, climate change, and stratospheric ozone depletion. Mel distributed copies of the overheads that would be used in presentations so that teachers could take additional notes.

Mel's presentation style was relaxed and easy-going. In one situation, as she was talking, she placed three bowls on the table, took out a cutting board, and began

chopping some bananas, oranges, apples, and avocado. She kept talking as she chopped. When she finished talking, she acknowledged her chopping activity as she placed the newly chopped fruit in one of the bowls. She told the teachers that she had not had much time to make her lunch. She had started chopping fruit the night before. With that, she pulled out a small bag of fruit and emptied it into one of the empty bowls. She pulled out another bag, emptied it in another bowl and explained that she had only been able to cut up a little more at home that morning as she had been rushed to get to Lab A and set up for the teachers. She hoped they did not mind her taking a few minutes to finish preparing the fruit for her lunch. She then looked at the contents in the three bowls and screwed up her face in disgust. Some of the fruit had turned brown, but not all of it. Some of the fruit from the night before was fine while some of the fruit chopped up earlier in the morning had turned brown. This was Mel's introduction to oxidization. The teachers were very attentive and obviously enjoyed her demonstration. She had them hooked. She encouraged teacher comments, questions, and input. She gave a brief presentation on some common scientific misconceptions and then asked the teachers for their thoughts. The teachers seemed to enjoy the exchange of ideas. Mel exhibited a comfortable and welcoming demeanor.

After Mel's session, Annette gave a presentation on the sun and energy as an introduction to climate topics. Annette used a traditional lecture style approach, and although she said at the outset the teachers should feel free to ask questions, she did not really encourage interaction. She was visibly nervous during her presentation and made little eye contact with the teachers. Her nervousness came through in her talk which was delivered in a pedantic manner with little involvement or interaction from the teachers.

Mel stepped in to support Annette in her talk. She was able to transition Annette's lecture style talk to a more open discussion while still imparting key content information and not pushing Annette out of the way. Mel was good at making clear, succinct points on complex topics. She carefully listened to all questions and answered carefully and thoughtfully stopping to draw on the expertise of other's in the room for her answers. Annette did relax somewhat, but never seemed entirely comfortable although it was clear she had an excellent understanding of the content material.

Recognizing they had a lot of content to cover and the importance of keeping the teachers engaged, Mel occasionally did something unexpected. At one point, she passed out a music sheet and led the group in a song about ecology and the food chain. The teachers seemed to enjoy this activity, especially the elementary teachers. It was not what they expected but everyone joined in and was laughing.

After the content presentations in the auditorium, Carol gave a brief description of the supporting activities. The teachers had the opportunity to try out a variety of classroom activities that had been set up in the adjoining rooms. The teachers were encouraged to try all of the activities and decide which ones might be useful to them in their classroom. Instructions and worksheets were provided. They could work alone or in groups. Mel, Annette, and Carol made themselves available to help out or simply engage in conversation. The elementary and middle school teachers were very engaged. The high school teachers did not appear to participate. Instead, they wandered around the building and talked to each other. The elementary teachers particularly seemed to enjoy the hands-on portion. Their enthusiasm was reflected in their comments such as "this is what we need," "hands-on activities rather than trying to learn from the book," "this is cool," and "I will use this with my students."

Thomas showed interest in much of the content presentation. However, he did not have much interest in the activities. He wandered though the room, looked at the activities and left. During the activity time, he was usually observed in the foyer talking with the high school math teacher who also showed little interest in the activities. Later, he said that the activities were not appropriate for his high school chemistry class and not very useful. But he did think it was great that the elementary teachers were enjoying them so much. He liked the idea of elementary students being more comfortable with lab activities, "so that by the time they get to high school, they are more prepared to be ready to work in a real laboratory setting."

Debra was engaged in the time at Lab A. During the presentations, she was frequently observed taking notes and interacting in discussions. She took several opportunities to have one-on-one conversations with Mel. As a science teacher, she did have more content knowledge than many of the elementary teachers and they looked to her for clarification. She liked being considered knowledgeable. Her demeanor while at Lab A was markedly different than it had been the previous week. She was comfortable in the lectures with the scientists and did not hold back from asking questions. She interacted more enthusiastically with others than she had the previous week. She later said that working with the scientists is what she had hoped they would do for the entire workshop.

Maria did take notes during the presentations but did not participate much in the discussions. She felt much of the talk was "over her head" even though she was quick to point out that Mel was doing a great job to keep it interesting and understandable. She felt she had so much to learn about science if she was going to be able to be a good science teacher. She immensely enjoyed the classroom activities and spent a good deal of time trying them out in a group with several other

elementary teachers. She did not spend any significant time in conversation with any of the Lab A scientists.

The sessions with Mel followed a consistent format. The teachers received content information interspersed with opportunities to further understand the content by taking part in hands-on activities. Overall, the teachers seemed to be involved in the presentations. They were part of the discussion, appeared to be listening, and most of them were taking notes. Many of the teachers interacted with Mel and the other scientists during the breaks and during the hands-on activity sessions. A resource table had been set up with hand-outs, booklets, brochures, posters, and some materials that teachers would take with them. The teachers were appreciative of Mel's effort.

Mel noted that the high school teachers did not seem as actively engaged in the activities. She said the separation in grade levels and subject matter made it difficult, especially given the limited time and resources, to make the experience meaningful for all.

Mel offered to visit the teachers in their classrooms if they wanted her to. She made sure everyone had information on how to contact her. She noted the need for scientists and teachers to work together to have kids be more comfortable with science. Debra asked her if she would be willing to come down to CPS. Mel said if anyone asked her, she would come. She also said she was available as a resource if they had science questions. Even if it was not in her area of expertise, she could probably find someone at Lab A who could answer most questions relating to science. A number of the teachers indicated that they would like for her to visit their classrooms and meet their students. Debra pointed out that Mel would be an excellent role model for middle school students.

> I thought Mel did a great job. She would be a great role model for some of my 7th grade girls. I really think it would be neat for them to see a young, attractive, vibrant female who's a scientist and well educated.

As a final workshop activity, Mel had arranged for a balloon launching equipped with monitoring instruments to detect ozone. It was scheduled for later in the day and she gave directions on how to get to the nearby field where the launch would take place. She was disappointed when only six of the teachers stayed for the launch. The teachers who did stay were able to help in the preparation and actual launching of the balloon. After the balloon was launched, the teachers went to a computer room to watch the incoming data as the balloon went through the troposphere and into the stratosphere. The teachers who did stay stayed for quite a while and asked the scientists and technicians many questions. Debra was fascinated with the entire process and said she had thought about leaving when so many of the others did but was really glad she had stayed.

The next day, when asked why they had not stayed for the launching, some of the teachers seemed embarrassed. One of the teachers noted she had to drive all the way from the city to Lab A and that she did not want to get caught up in rush hour traffic. The hours at Lab A had already been adjusted to take the 30 minute drive into account (i.e., the teachers arrived 30 minutes later and left 30 minutes earlier than they had the previous week). The teachers who stayed for the launch let the others know that they missed a unique opportunity.

Steve and Emily led the next sessions on geology and geomorphology. They shared information in a more traditional lecture format using overheads that, in general, were too technical for the audience. They had several handouts for the teachers. They were not able to facilitate the level of interaction with the teachers that Mel had done in previous sessions. The information may have been too advanced

for many of the teachers and few were taking notes during the presentations. After the talks, the teachers accompanied Emily to the roof of the building where they had a clear view of the Rocky Mountains. Emily used the mountains as a focal point in her discussion of geologic formation. It was an interesting and thoughtful talk, but only a few teachers were engaged. Others walked to different parts of the roof and began side conversations.

In the afternoon session, Emily and Steve had the materials for an extensive and complex activity which they admitted they had not yet tried. The teachers were teamed up and given materials and encouraged to follow the instructions and proceed with the activity. Initially, there was a lot of confusion as the teachers figured out what they were suppose to be doing. Steve and Emily were only of marginal help in setting up the activity. The activity took much longer than anticipated and only one team was able to get the experiment to work properly. Emily and Steve were slightly frustrated but the teachers were very encouraging. Thomas told them that this happened a lot when doing experiments with students in a classroom.

After the activity, Phil had arranged for the teachers to have a tour of Lab A because it was an interesting facility and had many public information displays throughout. The teachers were instructed to meet in the lobby of one of the buildings. Debra was the only teacher who showed up and it was clear she was there because of the relationship she had developed with the researcher. Due to the lack of interest, the tour was cancelled. Phil was upset with what he viewed as the teacher's "lack of responsibility and professionalism."

> I think it was pretty rude of the teachers. It bothers me that these workshops are set up for teachers to come and take a look if they want to and then leave and there is no reinforcement to make sure they stay there. In a regular college course, and remember, the teachers can get college credit for this (workshop), you are responsible to be there and you have to do the work. But in these summer sessions it is

> not always the case because the teachers are not held accountable and I think that is a big problem.

On the morning of the field trip, only 12 of the 24 Program A teachers appeared. Travelling by bus allowed Emily and Steve to give a narrative of the rock formations along the way. Steve made a point to try and connect the geology with the atmospheric science content the teachers had received from Mel. The hike was a rigorous one and about half of the teachers were not in good enough physical shape to undertake the hike comfortably. As a result, the group was not able to stay together. The scientists went ahead with those who could keep up and those straggling behind got little in the way of information from the scientists. Several of the teachers had to stop and wait to rejoin the group on the return.

Only six teachers attended the final day of the workshop held at a computer facility at Lab A. Debra, Thomas, and Maria all attended. Those who did attend found the day to be useful and informative. They were able to spend time on fast computers exploring a website that had been developed at Lab A by teachers for teachers. The website had science and math activities that had been rated by teachers for classroom use and that were linked to the state standards. After being given an overview, the teachers were able to explore the site and print whatever they thought might be useful in their classrooms. The computer session ended early in the afternoon and the teachers left.

When later asked about teacher accountability and attendance, Donna did not have a good answer. She mentioned that the field trip was "too much" for some of the more out of shape teachers and that some of the teachers were not interested in the science content so she had reassigned them to another workshop. Phil knew nothing of this decision. By the end of the week, he was disgusted with the lack of

accountability on the part of so many of the teachers. He noted that the scientists had taken a lot of time and resources to making the week good.

At Mel's request, the teachers were asked to provide Donna with written feedback on their time at Lab A that would be shared with the Lab A scientists. They were encouraged to share their perspectives on three areas from their Lab A experience – the best part, the most useful part, and the least useful part. Ten teachers provided a written evaluation. The comments were positive with over half of the teachers reporting no 'least useful part' as they had 'enjoyed it all.' None of the teachers provided more than half a page of written feedback and several supplied only a few sentences. Representative comments follow.

- I truly enjoyed the experiments and chances to try them out. The experiments could easy be adapted up or down for grade level. Also, the experiments don't require a lot of expensive supplies!
- I enjoyed the explanations of the 'heavy' science material. It was explained in such a way that not only do I understand, but now I can explain it to my students.
- Best was anything Mel did.
- Best was the chance to dialogue with professionals in their fields.
- I really liked all the activities that I can use in my classroom. With just minor adaptations, I can use most of the activities.
- Least useful was the elementary school activities (from a high school teacher.
- Time available for dialogue was insufficient – more discussion/interaction time would have been useful.

In an interview, Debra summed up the week from her perspective,

> I have especially liked being here...meeting with and working directly with the scientists from Lab A. The information and activities on weather were particularly helpful because I do a unit on weather. And we did a hike and talked about the geology of the Front Range and some climatology of Colorado and that was also helpful because I do a geology unit. So I think it tied in directly with the middle school science standards and has been pretty relevant for me. I know I plan

> to use this in my classroom. The stuff that we did on the Internet has been particularly helpful because we were shown how to hook up with a site that has information pertaining to each standard at grade level and subject matter and even has lesson plans and activities available. That will be very useful. This week was one hundred percent better than last week. My enthusiasm for the subject has been rejuvenated by being with these scientists. You know I can get excited about weather again and geology with some of this hands-on stuff. When I first started it was for the money and the credit....but indirectly I have gotten a lot more enthusiasm for the standards. Being with the scientists has been really fun.

Summary of Week Two

As the week progressed, fewer and fewer teachers were attending the sessions. Donna did not attend any of the sessions at Lab A. Julie and Amy did stop by periodically (especially during Mel's sessions), but did not stay very long. The end of the week had no feeling of closure or finality. The few remaining teachers finished up at the computer facility and left. Mel had put a lot of time and effort into her sessions with the teachers. She realized that she had little time with the teachers as a group and even less with them as individuals and she wanted to make the most of her time with the teachers. She kept their attention with unexpected demonstrations and insights. She was well organized and comfortable with the materials she was presenting. Her sessions were packed with information that was presented in an interesting and engaging manner. She had extended herself to gather useful resources and information to make available for the teachers to take with them. The talks were organized far enough in advance to make copies of the overheads for distribution. They were presented at an appropriate level for the intended audience (middle school science teachers). It was a bit too advanced for some of the elementary school teachers who were uncomfortable with science. Mel was concerned that the time would not be meaningful to all the teachers and continued to voice frustrations with having such a varied audience in terms of

grades and subjects taught. She frequently asked for input from the teachers. She was an approachable person who encouraged interaction and made it a point to have a few minutes with each teacher in attendance.

In contrast, Steve and Emily were not well prepared. The diversity of teachers in terms of grade and subjects taught never once came up with them. While cordial, they did not show particular interest in the teachers as individuals. They had put little time in up front planning. On the first day when he saw what Mel had put together, Steve remarked that he better get busy and start planning something. The teachers were not nearly as engaged with Emily and Steve. It would have been better if they had considered the physical fitness of the teachers before planning a hike as a key part of the field trip. When later asked if they would respond to further contact with the teachers, they both said they would. However, they had not provided any contact information when the teachers were at Lab A. They were both knowledgeable and willing to give their time, however, they did not put much in the way of planning or preparation and as a result, many of the teachers were not engaged during the time they spent with Emily and Steve.

Debra had a major turn around in attitude during the second week's time at Lab A. She was engaged and even seemed excited to be there. She actively participated in all aspects of the program and came away, in her own words, enthused for her subject.

The teacher evaluations were hurried and 'off the cuff.' Although she had requested written feedback, Mel never did receive the teacher's comments. Given that the teachers knew their comments would be read by Lab A scientists, the statements were predictably positive and glowing. No information of importance came from the brief and meager evaluations.

Final Week

The final week was held toward the end of summer at the same campus where the teachers had met for the first week of Program A. Teachers spent the week actively engaged in preparing and presenting their individual lesson plans. During this week, most of the teachers were involved in self-directed activities, so the lack of leadership was not apparent or a negative. The teachers continued to resist the concept of becoming lead teachers and being 'change agents' in their schools, although their objection was toned down. Of the original 24 teachers, 20 were present for the final week. All gave presentations, although none used the content information or activities from the week at Lab A. The final evaluation administered by Donna was not substantial and did not take much thought or provide much insight as to the teacher's perceptions of the summer workshop.

The week before the teachers were to return to their classrooms in the fall, they met for the final week of the workshop. Twenty of the original 24 returned. In the intervening weeks, the teachers were supposed to have taken the content and pedagogy as well as the new standards learned in the two weeks at the beginning of the summer and come prepared with classroom lesson plans that would be shared with the other teachers. Each was asked to give a presentation and to have handouts of their lesson plans available for the other teachers. Each presentation was peer evaluated. The teachers were given a checklist for their presentation and lesson plans. The presentations were to cover four main components - an overview, alignment to the standards, the activity itself, and a standards-based assessment.

The workshop was held back at the Lab A city campus, but this time in a spacious and well-lit classroom. Donna gave a quick welcome to the teachers and turned the session over to Julie. Julie asked each teacher to share what they had Done since the workshop had ended in June. Of the 20 teachers, 15 had participated

in some additional professional development program through workshops and classes. Several noted they had not spent as much time as they would have liked preparing for their upcoming presentations.

One teacher noted that when he left at the end of the summer, he had "gotten religion and become a believer" regarding the standards but now he was not as sure. Once he began to put the lesson plan together and delve into the standards, he was concerned about the "lack of specificity." He was not sure the standards would be useful for his teaching.

Julie assured the teachers they would have more time to work on the presentations during the first part of the week. She asked them to get into small groups to talk about the content they had learned earlier in the summer and devise plans on how to use it effectively. She asked them to share any strategies they had learned that might help each other.

The teachers had the first part of the week to work on their lesson plans and presentations. The last part was reserved for the presentations. Julie randomly assigned the teachers to time slots for presentations. She offered to make overhead transparencies for any one getting the materials to her at least a day before their presentation.

Most of the first part of the week was spent allowing the teachers time to work on their presentations with a few exceptions. Early in the week, Cheri and Julie led a discussion on standards. By now, the teachers were more comfortable with the concept and realized implementation was inevitable. Several of the teachers noted that most teachers were already "doing much of what is included in the standards...but not calling it that."

An afternoon was devoted to assessment and the development of rubrics. An assessment specialist was brought in to give an overview of student assessment from

a standards perspective. The extra help on the topic appeared to be helpful for those who were struggling with this issue.

In one of the morning sessions, the role of the lead teacher was brought up. The teachers were asked to work in small groups and brainstorm the role of the lead teacher in the schools. This caused a great deal of upheaval from the teachers as they voiced their concerns about having to assume a leadership role in their schools for the implementation of standards. They did not want to have to "police" others or be responsible for what other teachers did. Debra said she was there for the credits and the pay and she did not know until earlier in the summer that being a lead teacher was part of the deal. Another teacher said he did not know either and did not want to be a lead teacher.

Julie and Cheri became slightly defensive and told the teachers that standards were there to stay, whether they liked it or not. Standards were the law regardless of popularity. Julie pointed out the purpose of the workshop had been to assemble a grass-roots type of effort and get teachers familiar with the standards so they could help others in their schools. They said that lead teachers could take many roles and did not have to lead; they could "nudge from behind."

Debra was visibly disturbed and said that CPS needed to have every teacher in the district take a workshop on standards. She did not want to do the pushing in her school. She was not comfortable in that role of being a "change agent."

When Julie suggested she could just share with a person or two, Debra was less strident and allowed that she could talk to a couple of the teachers who she was close to in her building. The teachers split off into five groups and came up with comprehensive lists of the responsibilities of lead teachers. The lists were positive in tone and at the end of the discussion, all the teachers felt they could contribute at least some effort to helping others in their building.

Julie reminded the teachers that there would be monthly follow-up meetings to provide support and sharing. These would be held on the 3rd Thursdays for six months during the school year with the first one scheduled for October. They would start after school, at four o'clock, and meet at different schools each time. Pizza or sandwiches would be provided and the teachers would stay until about 7:30. They were looking into the possibility of securing funds to compensate the teachers for their time at the follow-up meetings.

The rest of the sessions were devoted to the presentations. Each teacher took about 30 minutes. Given the range in grades and subjects taught, the presentations covered many topics. Debra's presentation was on clouds. She did not use any of the activities or materials from Lab A. She had gone to her classroom and retrieved her usual worksheets from her weather unit and adapted them to standards. This appeared to be the case with many of the teachers. One of the elementary school teachers shared her lesson plan on weather. She noted she was not certain about some of the science content. Thomas suggested she contact Mel. He made the point that it is hard to teach science concepts if you do not understand them. He noted that Mel had encouraged the teachers to contact her so they might as well take her up on the offer. Both Maria and Debra said they planned on getting in touch with the Lab A scientists.

Overall, the talks were well done. They followed a consistent format and the teachers took pains to have good overheads. A number of the teachers set up the activity they were including in the lesson plan to show other teachers exactly what they planned to do. Although the teachers were used to speaking before groups of people every day, several of the teachers were nervous. One of them noted, "I am fine with the kids in my classroom, but put me in front a bunch of adults and I

really lose it." The teachers took time to fill out the peer evaluations after each talk.

Although it was evident that the teachers had put forth effort on their talks, many of the presentations did not have relevance to other the teachers in Program A given the diversity of grades and subjects taught. Not one of the teachers had drawn upon their Lab A experience in any way to enhance their presentations. Even the teachers who touched on the atmospheric science content did not refer to the Lab A activities.

Donna and Julie seemed to be happy with the presentations and thought they were a good start to implementing standards. Donna said,

> I think the presentations were strong because the teachers had a chance to reflect and figure out what they would use for the school year. I think they had time to talk with each other and with other people and had time to gather resources. One of the things I think that has come out of this is I know they had computer training. They already had basic training but I think that they are learning to do their research, do professional reading. Also, they wanted to look good in the eyes of their colleagues. That is why peer evaluation is an important tool. It gives them a chance to shine and get feedback from other teachers.

Almost all of the teachers had demonstrated a working knowledge of some of the standards and had covered those in their talks. When asked for her overall impressions of the summer workshop, Donna responded,

> I feel it went very well. Very positive. People I didn't know before, I know now and we talked and we may talk on computer or we may talk on the phone. In fact, just had a lot of messages from the teachers saying they were looking forward to our coming together again.

As the workshop was coming to a close, the teachers were making plans to transfer their Program A experience to the classroom which was a fundamental goal of Program A. The teachers were expected to use their newly crafted lesson plans

that reflected the new standards and use them in the classroom. Donna shared her goals for classroom transfer.

> The goal is that we are trying to change the way children are taught and the way that teachers measure what the children have learned. A big change is coming. Another change is we have a lot of teachers in our schools and so we are having to make the entire education institution understand that they have to do some changing and teach these children differently. The teachers need to come in and understand standards based education and the fact that it should be hands-on learning type of things. That is what we hope to accomplish in Program A.

Debra indicated she planned to use several aspects of Program A in her classroom and that she was going to try and change some of the ways she had taught in the past.

> I plan to use some of the activities. Some of the hands-on activities they showed us over at Lab A. Or at least a modified version of those. I will definitely use the OASIS web site. I intend to use OASIS because that had materials designed specifically for the standards and so was particularly good information.
>
> I will try to interject more hands-on which I am always trying to do, but the logistics and mechanics of that sort of thing is difficult. And it is just a matter of getting in the habit of doing it. So this next year I am going to try put in more hands-on than I have in the past. I personally Don't approve of a totally hands-on because I think they need more direction. I think they need it tied together a little more rather than just all hands-on. But I am going to add more hands-on than I have in the past.

Maria was also enthusiastic regarding her plans for transferring Program A to the classroom.

> Yes, I definitely plan to use some of the activities. I think they are really, really great and my students will really like them. And I really liked the web site. I will definitely use that in my planning. It lines up all the activities to the standards and even has assessment ideas. That will be a huge help this year since everything we do will be standards.

Thomas made it clear that he would not be incorporating any of the activities from Program A into his chemistry classes because they were too simplistic to be of use to his students. But he did indicate that he would be changing the way he assessed student learning.

For the final evaluation of Program A, Donna asked each teacher to write down his/her thoughts on three areas: evaluation of the three associate directors (1 – 10 scale), the relevancy of the workshop, the irrelevant portions of the workshop, and any other comments they wished to share. The teachers were requested to put their names and phone numbers on the written evaluations. As with the evaluation of time spent at Lab A, there was no evaluation form, the teachers just used a piece of notebook paper. This was assigned at the end of the workshop and the teachers did not take a great deal of time in completing the evaluations. Nineteen of the 20 teachers handed in an evaluation. None of the teachers took more than one side of a page and many took considerably less space.

The evaluation of the workshop associate directors was high. On a one to ten scale, all responses ranged between 8 and 10. The teachers who went to Lab A, consistently gave positive feedback on the time spent there. Other areas of workshop relevancy included being more familiar with the standards, student assessment, evaluation and rubrics, computer technology and internet training, classroom activities, and spending time with other teachers. Areas the teachers did not feel were useful included the focus on science and math (from non science and math teachers), the sessions in the first week that were irrelevant to many, the role of being a lead teacher, having a wide range of grade levels present, and not enough time to really feel comfortable with the standards.

Overall, the evaluations did not provide much in the way of critical review. In reading them, most of the teachers indicated a base level of satisfaction with Program A.

Summary of the Final Week

Even though the week was fairly loosely run, providing the bridge back to the school year helped getting the teachers to focus back on the content they had learned earlier in the summer, especially in regards to standards. They were able to work together on their presentations. In some ways, this last week was just a long planning period where they shared with each other.

This last week was much better organized than the first week. Handouts were provided and the teachers knew what to expect. It had direct relevance to their teaching.

The teachers seemed happy with the third week. There was not the same grumbling as was evidenced the first week of the program or the absentee rate that was experienced the second week.

The reaction of the teachers to the lead teacher role was strong. They were not aware going in to the program that they had to assume a leadership role in their schools. From the reactions, being a lead teachers was not a comfortable role for many of the participants. Many, like, Debra, voiced their opinions and concerns. It was interesting to note that when they wrote the lists, the lists of each group were complete, realistic, and had positive tones. It seemed that by making their own list of responsibilities, they could take some control in what their role would be.

It was interesting to note that none of the teachers called upon their Lab A experience for their talks, especially those presenting on topics in the atmospheric sciences such as clouds or weather. All of the teachers did link their lesson plan and

assessment to the standards. Overall, the talks were very good and well organized. Knowing in advance that they were being peer evaluated seemed to foster a sense of professionalism that had not been demonstrated by Program A teachers up to that point.

The teachers were planning on using information and materials from Program A in their classroom. Both Debra and Maria had enthusiastic plans and both still intended to contact Mel for a classroom visit. Thomas did not plan to use the activities and thought it unlikely that he would contact any of the Lab A scientists, but he did think he would be better prepared to implement the new district standards in his chemistry class.

The teachers hurried through the workshop evaluation. By not providing an evaluation form, the evaluation did not seem to be important. Each teacher took a sheet of paper and wrote down some overall impressions.

Donna was there daily. Phil did not attend any of the final week sessions.

Post-Summer Follow-up Meetings

Only two follow-up meetings were actually scheduled; one was cancelled and the other was scheduled in conflict with CPS's elementary school parent conferences. This resulted in only sparse attendance at the one follow-up meeting that convened. The meeting did not address or prove to be extension of the summer, instead it focused on new politics at CPS. No additional attempts were made to schedule follow-up meetings.

Believing that effective teacher professional development programs should not just leave the teachers "out there on their own without any help or support to do new things," Donna had included follow-up meetings as part of Program A. This had been clearly communicated to the teachers early in the summer. None of the

teachers responded negatively to the follow-up meetings. Donna had hoped to find some funds to compensate the teachers for their time at the follow-up meetings, but this was not promised. The follow-up meetings were planned to be held the third Thursday of each month. The purpose was to provide additional support for teachers newly implementing the standards and to provide a forum for the exchange of ideas of what was working and what barriers existed. In the case of barriers, teachers would have the opportunity to share their strategies on how to effectively overcome them.

Debra was looking forward to the first follow-up meeting on the 17th of September.

> It should be good. For one thing, we are going to plan the places for our other meetings. And then I just want to know how everybody's year is getting started and what they have tried that they learned this summer. Just feedback from the other teachers on how things are going for them. The first meeting in particular I see as more social although I think, informally, it will be really beneficial to find out what people have tried so far in their own classes. I have not done much yet about communicating with my faculty but I will as the year goes on.

On the 18th, she sent the researcher the following email message.

> I went to City High School on the 17th and no one else was there! The woman whose room we were to meet in said that the meeting had been cancelled and everyone had been notified. NOT!! She gave me a number to call since the meeting has been rescheduled for the 29th. I'll let you know when I find out what's going on! I was irritated, to say the least!

The researcher was able to attend the meeting scheduled for the 29th of September. Of the 24 teachers signed up for Program A, only seven teachers were in attendance. Debra was there, however, Maria and Thomas were not. Donna led the meeting and focused on general CPS policy and procedures. Little of the meeting was devoted to the specifics of Program A or any trouble the teachers might be

having in the implementation of standards in their classroom. Due to the lack of attendance, the meeting ended about an hour after it began. Donna suggested they reschedule and address the specifics of Program A at the next meeting scheduled for October 30.

About a week before the next follow-up meeting, Debra sent the researcher an email noting that the October 30th meeting had been rescheduled for November 15th. A few days before the November meeting, the researcher received the following email from Debra.

> I assume you got my phone message about the meeting? Typical planning by people have too much to do and not enough time. At least this time they are canceling in advance and not waiting for idiots like me to show up for nothing! They said the next meeting will be sometime after the first of the year. Will let you know if I hear anything.

No follow-up meetings were scheduled after the first of the year. When Maria was asked about the follow-up meetings, she indicated they had all been cancelled.

> Yeah, and they cancelled them. The first time I couldn't go because we had conferences. I don't know why they didn't check the district calendar. The second time I planned on going but they had cancelled it. I remember talking to Donna then but I haven't heard from them since about any follow-up meetings.

Summary of Post-Summer Follow-up Meetings

The follow-up meetings were ineffective. Although stated as part of the original Program A schedule, little thought or planning was put forth in making them useful or even well attended during the school year.

Surprising the researcher, Debra had actually looked forward to the follow-up meeting because she was interested in learning what the other teachers had been doing since the summer. She was disappointed by the lack of communication and follow through. The emails between the researcher and Debra regarding the follow-

up meetings made it clear that communication between Program A administrators and the Program A teachers was practically non-existent. The one follow-up meeting that was held conflicted with the district's elementary school parent conferences. The few teachers who did attend were middle and high school teachers. As a district administrator, Donna had access to the conference schedule, but did not use this information when scheduling the follow-up meeting which resulted in poor attendance. And even for those few teachers who took the time to show up, the topic of discussion was completely unrelated to the workshop. Instead, it quickly became a social session where the teachers mostly talked about the new school board members and the direction the district might take as a result.

Phil was not aware that Donna had planned to do follow-up meetings and when informed about the lack of attendance and the frequent cancellations, he noted that he was not surprised. Donna had good intentions, but did not seem to be able to follow through with her plans.

Teacher/Scientist Contact During the School Year

During the summer workshop, enthusiastic plans were made for teachers to invite Lab A scientists to visit their classrooms during the school year. The classroom visits did not happen, even though the scientists were willing. Time constraints and a moderate degree of intimidation prevented the teachers from issuing invitations.

Both Debra and Maria had indicated on several occasions that they planned to invite Mel or one of the other Lab A scientists to come to their classrooms during the school year. By spring of 1997, neither of them had contacted any of the Lab A scientists. Both teachers indicated that it was due, in part, to not having enough time. Maria acknowledged that it was hard to get the time to set things up guest

visits. When asked if Mel or one of the other scientists had contacted them, both teachers readily agreed that they would have taken steps to make it happen. Debra identified an existing, if intangible barrier.

> I suppose there is a certain amount of just feeling too separated from the scientists. That I don't feel like my concerns with my classes are as important as what they are trying to do. I think it is hard for me to really believe that the Lab A scientists are willing to do all this, the kinds of things that I might envision for free, there seems to always be a cost somewhere. And I think those fears just keep me from making the initial contact. And I suppose I don't know the scientists well enough to know if their expertise is something I could use or not.

In the spring of 1997, Mel was contacted to see if any of the Program A teachers had contacted her. There had been no contact. She was asked for her opinion on who should assume the responsibility for initiating contact after workshops – the teachers or the scientists.

> I think it depends. Certainly I don't want to go and talk to the teachers who are only mildly interested. But if it can overcome one of the barriers of intimidation that teachers have, I would contact them. One of things we had heard from teachers at a workshop last month was that a lot of times scheduling is very problematic. They try to schedule time and the scientist isn't available. Or they will organize a time and the scientist will cancel.
>
> During the workshop, things are different. It's like the beginning stages of a relationship where you say to someone, "Oh, I'll call you tomorrow" and they go "okay, great" and they never call. So even with good intentions the follow through is not always there. If there was a way to identify the teachers who would really benefit, that would be great. I would be willing to make a follow-up call.

Emily was asked the same questions. Like Mel, she had not been contacted by any of the Program A teachers. Her thoughts on this were similar to Mel's.

> I guess I didn't really expect a lot of contact from the teachers. Everyone is busy and follow-up is hard. You have the main event and everyone gets excited and then everything falls apart afterward. Mostly, everyone just is so busy. But I did like getting feedback from the teachers on the spot. It was very positive. I don't really think that my part in the workshop changed anybody's curriculum in a big

> way, but I hoped it promoted a warm, fuzzy feeling for geology. And it would have been fun to see how geology was taught in a classroom, but I would only go if a teacher cared enough to ask me. I don't think it is the scientists' responsibility to call the teachers.

Summary of Teacher/Scientist Contact during the School Year

During the workshop, there was a high degree of enthusiasm and interest in having the scientists make classroom visits during the school year. Both Debra and Maria had adamantly informed the researcher that they would definitely take Mel up on her offer of coming to their classroom. Debra, in particular, had been excited and, in addition to her scientific expertise, was also interested in having her students, especially her female students, meet with Mel to dispel stereotypical images of a scientist's appearance. Neither teacher called Mel or any of the other Lab A scientists. Debra admitted that part of the problem was simply the time and organization involved but part of the problem was also not quite believing that Mel or any of the Lab A scientists were really that interested in coming to her school. However, Mel and Emily were both willing to make classroom visits if asked. Mel had made the offer several times, written contact information on the board, and included it in the hand-out she provided. She did recognize the scheduling difficulties that teachers often have. Mel also was willing to explore ways to have her initiate contact if intimidation was the barrier, but she was also quick to note that she did not want to put the time out for teachers who were only mildly interested. Emily was also aware of how busy teacher schedules get but was willing to make classroom visits if asked. Even with the encouragement and good intention, there was no additional contact between Program A teachers and Lab A scientists.

Classroom Impacts and Teacher Reflections

At its core, Program A was developed to make changes in the way CPS teachers taught science and math in the classroom. Teachers initial expectations of how their participation in Program A would impact their classroom teaching varied from anticipation of using all aspects of Program A to simply making a few minor adjustments. In practice, the actual changes were less than originally stated, however, a number of attitudinal and unexpected changes also occurred.

Classroom transfer was a fundamental goal of Program A. The summer workshop had ended with a presentation by each teacher giving an overview of how they would use their new-found knowledge in the classroom and they each gave a sample activity and assessment they planned to use. At the end of the summer, most teachers were enthusiastic about the changes they would make during the upcoming school year. Donna had been explicit in her expectation that the summer experience would change the way that teachers taught and measured what teachers had learned. During the school year, it became obvious that the great intentions of late summer did not materialize as planned.

On numerous occasions Debra had indicated that she planned to use several of the activities and demonstrations she had learned during Program A. At the end of the summer, Debra told the researcher she planned to use some of the activities from Program A, the OASIS web site, incorporate and more hands-on activities in her classroom. Six weeks into the school year, the researcher visited Debra in her classroom with the intent of asking Debra is she thought participation in Program A was making a difference in how and/or what she taught. At that time, Debra reported,

> This year seems better than it has the last couple of years. And my attitude is better and part of the reason that I have a better attitude is that some of the enthusiasm that I got this summer from the

> workshop. Being with the other teachers and getting some of these activities and getting familiar with using the standards. The workshop took a lot of the stress out of gearing my lesson plans to the standards especially when I discovered they are actually pretty much geared to the standards already.
>
> This workshop gave me some enthusiasm for doing more hands-on activities. I have been using more hands-on activities. I have been trying to have as much hands-on activities as I can. Throughout the year that probably comes to maybe at lest one per week. One activity per week that is hands-on and designed to match the standards.

Debra was asked the same question again the following spring,

> I would say the impact, at this point, has been mainly indirect. As it turns out I have not used as much of the materials that I gathered this summer in class. This year I did not have a chance to get to the weather unit and so I haven't had a chance to do anything with the materials from the Lab A people. I still plan to do it, maybe next year. I don't consider that over with.

When asked what the barrier was to using the Lab A experience Debra said,

> I just got too involved in the present curriculum and what was happening and the pressures at work. I just haven't gotten to that unit yet. I still think I have used a lot of the same methods. I am using a lot more inquiry. And I have gotten to do at least one lab a week that uses an inquiry method. I use a lot more where the student runs their own experiment as a post test for a unit or the student does their own research and data gathering for a culmination of a unit and using that as the unit test rather than the traditional written test.
>
> My way of assessing kids has definitely changed. I think for the first time it occurred to me that there were other ways of testing kids other than written tests. Although I think that the public, the parents, still are geared to the old way of testing and it is real hard for them to accept some other ways of evaluating the students.

Finally, Debra was asked what she perceived the value was for science teachers to spend time with scientists.

> When you're a teacher, you lose track of what's happening with your field and its just really motivating to be with the scientists. If nothing else, it is motivation, it makes you want to learn more about science again. It is interesting, it's fun, it's exciting stuff. Some of that, even if you don't directly carry it over, you can't help but indirectly get some new enthusiasm. And that has definitely helped

> me this year. This is the best year I have had in middle school in 10 years.

Debra explained that she had not used the OASIS web site due to difficulties in computer hook-up in her classroom, but she would "definitely use it once the Internet is up and running."

At summer's end, Maria had also been enthusiastic and positive in her plans for transferring the Program A experience to the classroom. She planned to use some of the activities from Lab A in a standards format and also to use the OASIS web site.

In the spring of 1997, the researcher visited Maria in her classroom and asked her if the time in Program A had impacted her teaching in any way. Maria believed it had made a difference.

> Science is real hard for me. But this year it has been much better. I think a lot of it was due to the fact that I really focused on science this year. I attacked the hardest thing for me which is weather and storms, and I designed a unit and project for the kids where they had to do a written report on natural disasters. It's been a good year. I could see where I grew and I can see where I can grow later on, too.
>
> What this summer provided for me was some background information. And some activities. Like the day on the hike, it was mostly for myself. Which was fine. But I find myself reading a lot more because I realize it is an area I need to learn more. And it is hard to carry on the lesson if you don't know a lot. I think you will find a lot of elementary school teachers who feel that way. Science kind of gets left out.
>
> I used a lot of the experiments that they showed us at the summer workshop. We did them in class and that helped a lot to simplify the concepts the kids had to learn. So a lot of the activities I took from the summer and used this year.
>
> I really enjoyed listening to the scientists and came to realize I need so much more background knowledge so that I can make my lessons simpler for the kids because I need to understand the science concepts better so that I can break them down. That's what I was trying to do this year. I think the way they explained things when they lectured to us was really good. I have used the visuals they gave us in class.

> This has probably been the best year for me for science and I think it is because I went to the workshop.

Like Debra, Maria had not been able to use the Oasis web site in her classroom due to computer limitations but was still interested in using it once the classroom Internet linkages were more reliable.

The researcher had several phone calls with Thomas during the school year to see if he felt that his participation had made a difference. He explained that he did not learn much new content knowledge that was useful in his chemistry class, especially his advanced placement chemistry class because the content had been "directed towards the lower grades." He did note that had the audience been all high school science teachers, he probably would have learned much more content because it was clear that Mel had expertise in this area, but had "watered down the science for the elementary teachers who dominated the audience." Thomas thought this was fine as he believed the elementary teachers needed the science background much more than he did. He did suggest that he would be more likely to use topics such as climate change and stratospheric ozone depletion as they applied to chemistry as real world examples for his students, but he had not yet done so. Thomas thought the area that had made the biggest difference was being more aware of how to align his teaching with the district's science standards. He noted that participation in Program A had made him much more knowledgeable about the assessment practices and that he had made some significant changes in his approach to student assessment. He had not used the OASIS web site, but it was not due to computer difficulties. He said he simply did not have a use for it, but would use it if he thought it would be helpful in the future.

Summary of Classroom Impacts and Teacher Reflections

The major purpose of teacher enhancement programs is to make changes in the classroom. Program A was no exception in its intent to encourage teachers to make changes in their teaching. In the case of programs involving scientists, it is usually desirable that the teachers feel more comfortable and enthusiastic with the science content so that they do teach more science. Because classroom transfer is a desired outcome of teacher enhancement and professional develop programs, it was important to find out how participation in Program A had impacted the teachers.

Debra had planned to utilize much of what she had learned in Program A in her classroom. However, towards the end of the academic year, she had not used any of the information or even her lesson plan that she had already completed and presented to the teachers at the end of the summer workshop. While she did not use any of the new content knowledge or classroom activities, she did become more enthused about her teaching science in general and she did increase the frequency of using hands-on activities in her classroom. She had also changed her assessment approach and noted that she realized, for the first time, that assessment could be more than pen and paper tests. Debra was also much more comfortable with using a standards-based approach to teaching and had little negative to say about standards. Debra made changes in how she taught, became more enthusiastic about teaching science, and changed her approach to assessment.

Maria made a number of changes as a result of her participation in Program A. She had successfully used a number of the activities from Program A in her classroom. She had also moved to a more standards-based approach to teaching and assessment. For Maria, the strongest impact Program A had was on her confidence and comfort in teaching science. She was much more enthusiastic about teaching

science and attributed her new-found confidence directly to her participation in Program A.

Thomas used the information from Program A to better adhere to the district requirement of standards-based instruction. He had not come to the program to increase his scientific content knowledge, he already was a confident science teacher and a leader within CPS. The impact on his classroom teaching was in using the materials and topics he already covered and aligning them with district standards.

All three of the teachers did transfer their Program A experience to the classroom but in varying degrees. Maria used the new content and activities, was more enthused and confident in teaching science, and was teaching to the required standards approach. Debra reported changes in her enthusiasm for teaching, in the frequency of how often she did hands-on activities, changes in how she assessed students, and her willingness to implement a standards approach to teaching. Thomas reported the changes he made as having to do directly with standards implementation. Program A had an impact on all three teachers in different and, in some cases, unexpected ways.

Scientists' Reflections of Program A

There was no mechanism to get feedback or input from the Lab A scientists. Although happy to be involved, Mel was frustrated with the lack of communication from the program directors. She would have liked to have been included earlier in the planning stages. Emily was not as interested in the early stages, but did note that she would have liked feedback from the teachers in some form to help her assess her effectiveness.

Program A did not solicit any formal or informal feedback from the Lab A scientists regarding their view of the program. On separate occasions, the

researcher contacted Mel and Emily to ask them for their thoughts on various aspects of the workshop.

Mel noted she would have wanted to be more informed during the early stages of the workshop and to be included in the planning process.

> We knew nothing about the schedule for the other two weeks. What I really wanted this year and what I had been hoping was that they would call us up and say, "Okay, we are in the planning process for this workshop, can you attend any of the planning meetings we would like your feedback." I thought they might want our feedback so they could better design the science content days because it was so clear to me not only from last year, but from the years before that there are problems with the way they do the science content and I thought they knew that.

Mel was clear that she would have wanted to know the grade and subject range of the CPS teachers. She noted that she had gotten conflicting information from Phil and Julie, and in hindsight, realized that the organizers really did not know who would be coming until the last minute. But she did express frustration when she found out that Donna had recruited so many elementary school teachers and that information had not been passed on to her. She saw this as important information that she would want to know much earlier on for future programs.

> We had been told we had a group of 30 middle school earth science teachers which was totally inaccurate. I don't think we had more than one or two middle school teachers and I don't think they even taught earth science. So, I would want to know exactly who we were getting, exactly what their background was, and exactly what we were supposed to be addressing.

Despite her frustrations and concerns, Mel enjoyed the time she spent in planning with her colleagues and in the time she spent with the teachers.

> What went well was that the three of us who were working on the project work well together. We were able to divide the areas and each of us work on our own stuff and trust the others to take care of their stuff. We had a lot of activities that the elementary and middle school teachers liked. And most of the teachers personally appreciated the exposure to the content so they could make some

> decisions. They at least knew what the ozone hole was. I think that part all worked out okay and went well.

Mel wanted to stay involved in teacher enhancement programs and had given thought to what she would do differently for future workshops.

> If we still had limited time for content, I would completely redo the way we did it. Instead of doing a lecture with the activities optional, we wouldn't lecture at all. We would have them basically getting all the content through some kind of activities so there would never be a period of time with someone standing up in front and lecturing. I would have the activities be grade level specific to whatever teachers we were teaching and also there would have to be some kind of technique to assess their background. Either we would know that their content background was very low or very high. So that way we could work with the teachers at their level of understanding. There would be some built-in assessment for the teachers. Maybe some kind of pre and post test. I would like to see time for the teachers to develop something to plan on using in their class.

Overall, Emily was happy with how her time went with the teachers. She noted that she enjoyed the interaction and watching them work out the activity. When asked if she would have liked more time for preparation, she indicated that she had plenty of time and would not have put too much additional time into her presentation. She did share that she was somewhat surprised at how out of shape some of the teachers were and maybe they would not have planned a hike if she had known in advance the poor physical condition of some of the teachers. Emily was not concerned with the range of grades and subjects taught. She did not seem to have a sense of who the teachers were. She was not surprised by the lack of contact from the program directors but would have welcomed some feedback.

> I really would have liked to know if what I was doing was useful to the teachers or if I was just wasting my time. A small part of me was disappointed that we did not get any comments or feedback. I really would have valued some feedback. Because I would like to do more educational outreach, I would like feedback on how to increase my effectiveness.

Summary of Scientists' Reflections of Program A

Although Program A did not solicit feedback from the Lab A scientists, the researcher gathered reflections from Mel and Emily. Mel gave thought to what she would do differently and where she saw areas that needed real improvement. She was interested in having the teachers go away with a better sense of science and a better way to approach science teaching. She wanted to do the best job possible and wanted to maximize the limited time she had with the teachers. She felt that scientists had an important role to play in science teacher enhancement and took her part in this seriously.

Emily did not give her participation in Program A as much thought as Mel did. She enjoyed her time with the teachers and would participate if asked again, but she did not offer much in the way of changes expect for acknowledging that the field trip was too much for some of the teachers. She was satisfied with the level of information she had received in advance, but did note that she would have liked feedback from the teachers on the time they spent with her at Lab A.

Program B

Overview

Program B involved a partnership between individual teachers from six nearby school districts and a research laboratory hereafter referred to as Lab B. As part of a large federal agency, Lab B had a unique scientific research mission that was focused on renewable energy development and application. Lab B was located in a suburb of a large urban area. Teachers in Program B came from a range of school districts in terms of socio-economic profiles.

The administrators for Program B were Beth, the Lab B Education Program Director, Jim, a middle school science classroom teacher who served as the Program B workshop facilitator, and Kim, a middle school science classroom teacher who had taken an 18 month leave from teaching to work with Lab B's Education Program. Initial contacts were made with Beth and Kim. They provided the necessary approval to conduct the research and the names of other key individuals. They also provided useful background information regarding the intent and direction of the collaboration. All three of these individuals were accessible and enthusiastic about the research study.

Program B was just one of Beth's responsibilities as Director of the Education Program. Prior to coming to Lab B, she had worked with the human resource (HR) departments of several private corporations. She did not have a background in K-12 education. Beth oversaw all of the administration (budget, funding, project accountability, public relations, etc.) and relied heavily on Kim and Jim for the planning and facilitation of the workshop. She summarized the beginnings of Program B,

> Program B started out when a group of (*the agency's*) national laboratories got together because we wanted to do a teacher professional development program. And each lab (*in the agency*) had a unique research mission. We looked at our core competencies at Lab B and realized there is a lot of misconceptions about what is renewable energy. We liked the idea of having the teachers work in the labs with scientists doing research. But we also thought it would be a good idea to have the teachers spend some time together for some basic pedagogy. So we came up with the idea that part of the summer workshop would be a teacher research program and the other part would be an institute for teachers to learn more about assessment, standards, and things like that.

Kim had taught high school and middle school science for 15 years and was working at Lab B for 18 months as an education support administrator. She would be returning to classroom teaching at the end of the summer. Although Kim's time

was divided among several projects, Program B was her primary responsibility. She shared her thoughts on Program B.

> Program B is a program for middle school science teachers. They come here for three weeks in the summer and then we will have five days during the school year...what we call follow-on days. But while they are at Lab B, the bottom line is we want them to have a research experience that is really research in the real world of a science lab. So, in the mornings they will work with mentor scientists and we want them to have an immersion experience. And then in the afternoons we will have an institute to cover other issues teachers have to deal with like assessment and gender equity and diversity issues and standards and technology. I think this will combine content and processing so the teachers can get as much out of Program B as they want.

Jim was in his 27th year as a middle school science teacher (at the same school). He had been an instructor of record at several nearby universities teaching science methods courses or current topics in science education. Jim had worked on a number of teacher professional development projects for various national laboratories and private corporations initially as a participant and later, as a program director. He had a contract with Lab B to facilitate the summer workshop and was planning to lead the follow-on days.

Between them, the program administrators had a variety of skills and knowledge that were important in the planning and preparation for Program B. Beth had extensive knowledge of working within the national laboratory environment and was successful in securing funding and recognition for education and outreach activities. Having worked with Program B for an extended period of time, Kim had been able to gain a working knowledge of Lab B and meet scientists and staff who had a proclivity towards working with classroom teachers. Her teaching background and contacts were very useful in recruiting teacher participants and in helping to plan the pedagogical component of the workshop. Kim noted that it was up to the teachers to get what they wanted to from Program B. Jim, a well-known

science teacher in the metro area, was able to foster a sense of unity among the teachers. He was clearly "one of them" and acknowledged their concerns and understood the day to day challenges of working in a classroom.

Planning Meetings

From the earliest stages, it was clear that a significant amount of planning and attention to details had proceeded the planning and orientation meeting. Beth, Kim, and Jim had met numerous times during the 1995 – 96 school year for planning. Kim was largely responsible for planning the internship portion of Program B; Jim took the lead in planning the pedagogical component. The planning meeting brought together program administrators, Lab B scientists, and teachers who had participated in the previous Lab B summer internship program. This meeting provided the opportunity for teachers to discuss how they used their Program B experience in the classroom and it gave the scientists a chance to ask the teachers what type of laboratory internship would be most useful. Because planning the summer program was the key component of Kim's job, details were well tended and communication appeared to be effective. At this point, the leadership team came across as a cohesive group.

Program B had held a similar summer workshop the previous year and used comments and suggestions from that year as a basis to plan, prepare, and improve the upcoming summer's workshop. Beth, Kim, and Jim began planning for the workshop in the fall of 1995 and had used feedback from the previous year's participants to modify and improve the 1996 workshop. Preparation and planning of Program B was a large part of Kim's job responsibilities and she had taken time to review the previous year's evaluations.

The researcher was invited to attend a full-day orientation and planning meeting in April of 1996. The meeting included teachers who had participated in the previous summer workshop, Lab B scientists, and the program directors. The orientation meeting served as the final follow-on day for the previous year's program.

Jim was the meeting facilitator and began the meeting by passing out agendas and asking the attendees to introduce themselves. Only teachers and the directors were at the morning session. Seventeen of the previous summer's 24 teachers attended the meeting.

Jim asked the teachers to spend 30 minutes working in small groups and arrive at a consensus of what were the top 10 obstacles/hurdles that teachers/education face today. The teachers shared the results of their small groups with the larger group.

The major barriers included: inclusion (how to meet the special needs of every student), class size, accountability (students not held responsible for learning), funding, time, parental involvement, standards ("all the lofty talk about standards, but no money to implement"), poor administrative management, and deterioration of students' work ethic.

When later asked why he started the morning as he did, he responded,

> I have been in the classroom for a long time and have worked with many teachers. Whenever you get a group of teachers together, the first thing they do is complain about things that in many cases they don't have any control over. Mostly it is just validating to let them know they are heard and that there are real barriers. I think it is real important in programs like this when it almost seems we are saying that improving content knowledge will make huge changes. It really won't. But it will make small changes and it could enthuse some teachers and build the confidence of others. The barriers they talk about are real. And it is important for planners of workshops to hear them and not dismiss them as whining.

All teachers were asked to report on how they had transferred their Lab B experience to the classroom. As with the upcoming summer, the previous year had also used a hybrid format where the teachers spent half of each day working in a laboratory setting with a scientist (mentor/protégé relationship) and the remaining part of the day in a teacher development 'institute' as a group addressing five specified pedagogical topics of interest - assessment, curriculum, diversity, standards, and technology.

The teachers reported a range of results from undertaking research projects in the classroom with their students to doing nothing. The teachers did not share many specific details, although many of them suggested their time at Lab B was valuable. Of the 17 teachers, three reported significant changes in their science teaching. Five offered no evidence of classroom impacts and nine reported they had done something, but did not make big changes as a result of their time at Lab B.

Seven Lab B scientists joined the meeting in the afternoon. New introductions were made. Several of the scientists had worked with some of the teachers the previous year. Others were new to Program B. The meeting encouraged the returning scientists to share their experiences with the new scientists and to present potential summer of '96 projects to the teachers for their feedback. The teachers were available to answer any questions the scientists might have about working with teachers. Each researcher was invited to give a brief description of their research and what they had planned for teachers during the upcoming workshop.

Not all of the scientists who would participate in the summer were at the orientation. Research and travel schedules conflicted. One scientist, Jennifer, stood out as being interested, committed, and excited about working with teachers again

this year. The teacher who had worked with her was one of those who reported making significant changes in his classroom teaching.

Jim asked the scientists to share some of the obstacles they faced in their work. Some of the concerns from the scientists included: funding, frustration by administrative requirements (too much time on the phone and in paperwork away from research), too much to do, not enough time, bureaucracy and red tape, shifting program goals (very nebulous targets), split too many ways, and the challenge of being an effective communicator.

The conversations between the scientists and teachers was informal and comfortable. Conversation flowed freely and everyone seemed to be interested in what others were saying. The meeting ended with snacks and beverages being served to encourage continued conversation between the participants.

Summary of Program B Planning Meetings

The teachers shared their thoughts on what they thought the barriers to effective teaching were and none noted lack of science content as a concern. Yet, this was a foundation for Program B from Lab B's perspective. When the teachers were asked how they transferred their Lab B experience to the classroom, a small number indicated that they had made significant change. Most of the teachers reported that participation in Program B had made little or no impact on their teaching. The program administrators did not appear to be concerned with the minimal classroom transfer. It might have been useful to spend more time discussing this issue.

The scientists talked to the teachers as fellow professionals asking for their feedback and input. Although, the summer workshop was still two months away, the scientists had already spent time thinking about how they would structure the

internship experience. Asking teachers for their opinions was an effective approach to developing useful teacher research opportunities for the upcoming summer.

Overall, this meeting had a positive feel to it. The group was able to share their thoughts openly and honestly. Jim demonstrated good leadership and meeting facilitation skills. He led the meeting while Beth and Kim observed and occasionally asked or answered questions. The three program leaders appeared to be comfortable with each other and their roles in this meeting. This did not seem so much a planning meeting as a de-briefing and orientation meeting. It provided a venue to get scientists and teachers talking. Kim, Jim, and Beth had done the real planning and organization earlier and by the time of the orientation meeting, much of the schedule was in place.

Recruiting Teachers and Scientists

Program B had a formal application process for interested teachers and ended with more applicants than available positions. Kim had widely advertised the program in nearby school districts. Scientists interested in participating as mentors had to provide Kim with a description of their proposed research project. Not all scientists who expressed interest were chosen to be mentors. Program B had 28 teachers, 11 scientists, and 3 administrators involved. The teachers came from six different school districts. Seven of the teachers had been in the program the previous year and were returning in the role of lead teachers. The focus audience was middle school science teachers, but several upper elementary and high school teachers were also accepted into the program. All of the teachers in Program B taught science in some capacity. The application process for both teachers and scientists proved to be beneficial.

As part of her job in the Education Program, Kim had the responsibility for recruiting and selecting the teachers and scientists. She had begun the recruitment process the previous fall. To best match the teachers and scientists, Kim had developed an application that asked the teachers for information on their science background, what area of science they taught, and any experience they may have had with scientific instruments. She believed that getting the teachers and scientists identified early on would allow for making the most effective matches.

> We really worked at getting the Program B advertised early. We sent out brochures to all the local school districts. We had applications for the teachers to fill out. At first we thought it would just be first come, first served if we had more than 24 teachers. But then it became clear that we needed to be more selective. The application had a place for them to tell us what areas of research might be more appealing to them and also how much science background they had. So we picked 24 teachers who met the criteria and applied before the deadline. We also ended up with 10 people on a wait list. We may take a few more teachers if I can get the go-ahead. No more than 28, though. And that will include the 7 teachers from last year. They will be the lead teachers and their job will be to help the newbies.

Kim had also given thought to how to best identify mentor scientists from Lab B. She sent out an email to all Lab B scientists soliciting help for the summer program. Those who expressed interest were given more information about Program B and asked to provide details on what kind of project they had in mind and what they expected from the teachers.

> Well, because we have had some real serious downsizing, we have a lot of scientists who are begging for extra hands and extra brains to help them out. We really have to be careful because when we do select mentors, we are looking for those who have on-going projects or projects that we know are going to get teachers into a laboratory and they are going to have some hands-on experiences. Because this is a small enough lab, we know a lot of the scientists. A lot of it just comes down to do they have a viable project that is interesting and hands-on? Are they good people to work with? Do they truly take on the role of mentorship as it is intended. Are they flexible?

The information provided by the scientists was used to describe the research projects in the teacher application. By having advance knowledge of the research project, Kim was able to get input from the teachers as to what kind of project was of most interest to them.

> Teachers could tell us what they were interested in at Lab B. And I linked those topics here at Lab B, the research project here with the kinds of subjects that they teach in middle school. I tried to make some real loose links....for example, alternative fuels involves a lot of microbiology so I really tried to get a life science teacher into those kinds of positions. And photovoltaics involves a lot of physics so I tried to get teachers who taught physical science into those laboratories. So their research experience was more likely to tie in back to what they teach in the schools.

Kim devoted a large amount of time to the selection and recruitment of both teachers and scientists. As a result, she had an enthusiastic group of teachers who wanted to work in the labs with scientists. Most of the teachers did have some background science knowledge. The scientists who participated, for the most part, put forth effort in planning projects for the teachers.

In total, there were 28 teachers, 11 scientists, and 3 administrators in Program B. Most of the teachers were middle school science teachers, but several upper elementary and high school teachers had also been accepted. Kim explained that several of the internship opportunities would best suit a teacher with a strong physical science background and that some of the high school teachers who had applied had the necessary knowledge base. Kim completed the process of matching teachers and scientists several weeks prior to the start of the workshop. At that time, she sent emails to the Lab B scientists providing them with a brief bio of the teachers who had been assigned to them.

In the spring of 1996, Kim was able to provide the researcher with a list participating teachers. A letter explaining the research (Appendix E) with a self-

addressed post card asking for volunteers was mailed to the participating teachers. From the 28 requests sent out, 8 volunteers for the study came back. The researcher intended to identify a middle school science teacher as a key informant but also wanted to recruit an elementary teacher and a high school teacher to take part in the study as secondary informants.

Cathy, a middle school science teacher who volunteered for the study, was contacted before the workshop began. This contact allowed the researcher insight as to Cathy's thoughts and expectation prior to the actual workshop. Cathy had been teaching middle school science for eight years and had participated in several science teacher enhancement programs involving scientists. She was looking forward to participating in Program B.

> I want to do research and that is why I applied for Program B. Hopefully, by doing some research myself, I can bring that back to class and somehow not water it down, but bring it to the kids' level so that they can see, "Yeah, this is why I need to learn chemistry so that I can understand other things." I want what I do this summer to show the kids relevance....working with a scientist doing actual research sounds great. Well, I hope to get stuff I can use with my kids. Actual labs and activities that I do that my kids can do in class. Things that I do in the summer to show them the relevance.

Additional teachers and scientists were recruited for the research study once Program B commenced in the summer.

Summary of Program B Recruitment

The thoughtful planning and application process resulted in many excellent research situations for both teachers and scientists. There was not enough space to accommodate all of the teachers who applied to Program B. Having a formal application process helped Kim assign teachers to mentors that would maximize the potential success of the internships. Also, knowing who the teachers were and a little about them gave Kim knowledge that helped in planning the internships and

other activities and events. Kim did not accept all the scientists who responded. In one case, she rejected a scientist who was looking for some 'free labor' while he was away. The attention to detail in the recruitment process contributed to Program B in a positive way.

All of the teachers taught some form of science or mathematics combination. Although targeted at middle school science teachers, Program B did accept some high school science teaches and several upper elementary school teachers. In several cases, the upper elementary teachers only taught math and science. They team-taught with other teachers who taught language arts and social studies. Kim felt strongly that by taking time in the selection process and finding the best matches between scientists and teachers, there would be better chance that meaningful classroom transfer would occur. From the applications, Kim had selected a strong cadre of teachers and scientists for Program B. Her initial screening process appeared to be effective.

Administrator Expectations

At the initial orientation/planning meeting, the administrators did not appear to hold vastly differing philosophies or expectations regarding the implementation of Program B. Unfortunately, there was little discussion of program outputs and it was not clear if the administrators had spent time together discussing this important topic. Later in the program, it was evident they hadn't and that omission would compromise the effectiveness of Program B.

As the workshop approached, the researcher met individually with the administrators to ask what they expected for Program B. Consistent with their backgrounds and roles, the three administrators had different expectations for Program B. Beth's thoughts reflected a broader vision for Program B that would

validate Lab B's role in K-12 education and also address her concern regarding the caliber of science student in the United States.

> I expect to show that Lab B should be in pre-college education and that it fits our mission. To actually go in and educate. We are really very concerned from a national laboratory standpoint on the caliber of students coming up in the United States. We have got to engage them in science and math at an early age because they are opting out. That would relate to our core competencies at Lab B. We are seeing that there is a lot of enthusiasm for renewable energy but there is a lot of misconceptions about what is renewable energy. We need to provide information for K – 12.

Kim hoped the teachers would come away with a better understanding of the work at Lab B and would become more comfortable making contacts at Lab B and would use its resources.

> I would like to be sure that everyone has a good positive research experience that they can use in their schools. And that they have an appreciation for Lab B. That they have formed relationships with us and will call us. So that it becomes a working partnership and the partnership continues after the three weeks is over. I also want them to use the visitor center and the teacher resource centers. And to have a relationship with a mentor where they can call and maybe bring the mentor out to their classroom. Their kids stay in science, stay in math, their kids have an enthusiasm for the subject matter because the teacher has an enthusiasm. That is my the real pie in the sky goal.

Jim expected the teachers to feel that they were getting information and experiences that would be useful in the classroom. He also wanted the teachers to be able to share the Lab B experience with their students in terms of job and career potential.

> There is a big focus right now on school to work programs and I think that the more teachers can see what is on-site and what is available, not necessarily just in the laboratory but what support service is there available at a national lab. And when they talk to students they can say, "Hey have you thought about the technicians...not just the scientists"...and all the different things that go on day to day and how do you decide what the problem is and use the scientific thought processes to solve that problem.... and I think the real purpose of

Program B is to help the teachers understand their role in connecting real science with the classroom.

Summary of Administrator Expectations

Each of the administrators had expectations that reflected their own background and position. Beth's expectations revolved around Lab B and its position in K-12 education from a fundamental level and not necessarily focused on the teachers who would be there that summer. In a longer interview, she shared her frustrations with the continual need to have Lab B prove its involvement in education. She very much reflected a bureaucratic perspective. She wanted to have Lab B clearly align its mission with education. Budgets were being hit hard in the federal government at that time and education was one of the first areas to take hits. Beth realized that without projects such as Program B, her position was in jeopardy.

Kim had grounded expectations in that she simply wanted the teachers to have a good research experience and to make connections with Lab B scientists and resources. She admitted to having pie in the sky goals when it came to having kids stay in math and science as a result of their teacher having participated in Program B.

Jim based his expectations on having the teachers better understand the research laboratory environment and being able to communicate to their students where scientific information is generated. He also wanted the teachers to have a broader perspective of the laboratory environment to share with their students in terms of careers and societal needs.

Kim and Jim developed expectations that reflected the perspective of a classroom teacher while Beth took a much broader, and somewhat vague view. Neither Jim or Kim expected huge changes to occur in the classroom as a result of

participating in Program B. Beth and Kim both hoped that the teachers would use Lab B as a source for information. It was interesting to note that none of the administrators focused on program outputs or what they expected the teachers to produce as a result of Program B.

Program B Implementation

Program B ran for three consecutive weeks in the summer and had five follow-on days scheduled for the following academic year.

Week One

The week began with a mandatory laboratory health and safety orientation that the teachers thought was a waste of time. When the teachers did meet as a group on the second day, the program administrators welcomed them and distributed notebooks that provided information about Program B. A discussion of the program goals was covered early on. At this point, the teachers were informed that they would spend part of 10 days with a researcher/mentor and the rest of the time would be spent in a teacher development institute. The response from the teachers made it clear that they had expected to spend the entire three weeks in an internship program. Most of the teachers accepted this change and overall, the first week progressed smoothly.

A mandatory security clearance and required attendance at an all day Environmental Safety and Health orientation were the teachers first impressions of Lab B. The orientation covered basic laboratory procedures and safety issues. The orientation was dry and tedious and those in attendance looked visibly bored. During a break, several Program B teachers complained about a wasted day. One teacher said he thought he was going to be working with scientists, not sitting through

presentations that had no relevance to him. Many of the teachers agreed with his perspective. They thought the day was a waste and that the information did not apply to them.

The next morning, the administrators welcomed the teachers to Program B. Beverages and pastries were served. The workshop classroom was large and well-lit with a lot of work surfaces. The room was very conducive to conducting a workshop. Because the room could be locked at night, resources and materials could remain in the room for the duration of the workshop. A kitchen was adjacent to the classroom and coffee and other beverages were provided daily.

Introductions were made. The vast majority of the teachers taught 6th, 7th, or 8th grade science. Jim introduced the lead teachers and encouraged the new teachers to call upon them for guidance and help if they were having difficulties in any part of the program. There were seven lead teachers – two women and five men. The women both taught 5th grade science. The five men were all middle school science teachers, three were from the same school.

Jim went over some basic information including payment of stipends and how to sign up for college credit for those interested. He passed out three-ring binders for each teacher that had their names on the covers. The neatly divided binders had information on the workshop agenda, goals and objectives, logistics, and readings. Jim went over Program B's goals as listed in the binder. The goals suggested that teachers would:

- Use your experience to enrich your teaching skills
- Relate your laboratory experience with your classroom curriculum
- Take advantage of your opportunity to work with world-renowned scientists
- Develop and sharpen research and laboratory skills
- Network
- Nurture new ideas
- Learn all you can

Each teacher received a laboratory notebook that had been personalized. The teachers were encouraged to use the notebooks especially during the time when they were with the scientists. When asked when they would meet the scientists, Jim told them that a reception was planned for the following afternoon and they would receive their assignments at that time and could meet their mentor/researcher. They would begin working with their researcher on the 4th morning of the workshop. This news was met with some grumbling by the teachers. Several stated that they thought they would be spending all day, every day with the scientists "doing research."

Jim explained that the workshop was divided into two main components – a research component and a teacher development component. Beginning on the fourth day, the teachers would work with their researcher for ten days. They would spend the morning with their mentor, break for lunch, and then meet as a group each afternoon for the teacher development institute which would include information on standards, assessments, curriculum, gender equity and diversity, and technology. When appropriate, outside experts would be brought in to lead discussions on various topics of interest.

The teachers were assigned to small teams to work together on the "car" projects in the afternoons. Each team had to build a model car starting with vegetables, then build model wind-cars, and finally design solar cars as the culminating project on the last day. A race would be held each week.

The teacher development institute was news to many of the teachers. They wanted to spend time in the laboratories and were looking forward to meeting their mentor the following day. Jim acknowledged their disappointment and asked that they be patient.

Jim's easy-going manner and willingness to listen to the teachers kept the general mood congenial. Until they were able to begin their research experience, most of the teachers enthusiastically participated in the workshop activities that Jim had scheduled including several "icebreaker" games, sessions led by outside experts, classroom science activities and experiments, and a videotape on constructivism.

During the teacher development time, Jim would ask the teachers to divide into small groups to first discuss the assigned topic. Jim explained to the researcher that he liked to have teachers work in small groups whenever possible. He told the researcher that it was better than having him lecture continually. He explained that while at Lab B, the teachers were not bound by district or building politics and felt less constrained in expressing themselves honestly because there was no fear of retribution.

Jim referred to the previous year's workshop evaluation forms where teachers had indicated that they wanted time to talk with each other and small group discussion allowed that to happen. Jim let the teachers choose their own small groups. He told the researcher that he hoped the lead teachers would monitor themselves and each join a different group, but this was not happening as he had intended. Three of the lead teachers, including the two women, did split up and join other groups. The other four, including the three that worked at the same school, generally worked as their own group and did not interact with the other teachers.

Cathy was somewhat disappointed about not being able to spend the entire three weeks with a scientist in a laboratory setting. But she felt that Jim was doing a good job and had a useful schedule set up for them.

> It looks like they put a lot of time into this. And some of the stuff we have been going over is pretty useful. Also, the new state science standards are coming out and I have to be aware of what all those

> mean and how I am going to get all that into the curriculum. So the sessions that Jim is leading are pretty good. He is a good guy.

When the research assignments were handed out, it was clear that not all of the teachers would be working in a traditional laboratory setting. For example, several teachers were assigned to a team that was conducting an energy audit of Lab B's buildings. Others were going to inventory weeds on Lab B's extensive grounds. The remaining teachers were assigned to more traditional research experiences in groups of twos, threes, and fours. Jim strongly encouraged the teachers to make connections with their mentor scientists and to invite their scientist into their classrooms. He also suggested they take notes and try and come up with an action plan to relate their laboratory experiences to their students. But he did not provide specific instructions or guidance on how to develop an action plan.

Cathy had been assigned to work with Jennifer on a project and while she was looking forward to getting started in the lab, Cathy admitted to being a little nervous and hoped she was up for whatever Jennifer had planned.

> Most of my time is spent with middle school kids and I usually feel pretty competent with them. I just really hope I know enough to be useful and not have her think my being there is more trouble than it is worth. I just don't want to be in her way.

During the many small group discussions held during the first week, the researcher had ample opportunity to meet and talk with all of the teachers in Program B. After the Lab B research assignments had been received, the researcher recruited two teachers to participate in the research study – an elementary teacher and a high school teacher.

Patty was an elementary school teacher who was beginning her third year of teaching. She had returned to school to earn a teaching certificate after having raised a family. Patty was assigned to a project involving research on alternative

fuels. She and one other teacher would be working with a research team led by two mentor scientists. She was enthused about her assignment.

> I am so excited that I will be working with the scientists. That is why I applied for the program. In 6th grade and in elementary school our resources are so limited, you know, any time I want to do any kind of science experiment it is "how am I going to get the equipment...how am I going to do this? And just the opportunity to be able to work with real scientists with real science equipment, I am just thrilled about the opportunity. I am really looking forward to tomorrow morning. That is our first morning with our scientists so I think that will be really exciting.

Smitty, a high school biology teacher, was getting ready to retire. He had been teaching science for 28 years and was hoping to spend time learning more about what went on in a laboratory. He was exploring the possibility of finding a part time job as a laboratory technician once he retired from teaching. Smitty had been assigned to work in an instrumentation laboratory with several other teachers. By the middle of the first week, he was not very enthusiastic about Program B.

> My enthusiasm at the present time is pretty low. Mainly because I have been over most of this stuff already. I know, at least I know all I feel I need to know about what standards are and what rubrics are and I find the institute sessions extremely boring. Unless they have some kind of hands-on activity. Like yesterday I think the two little experiments they gave us were fun to do. But the follow-up was boring to me. Very uninteresting to me.
>
> I misunderstood or misread the flyer. My understanding, when I signed up for the program was that I would get an opportunity to do some research with a scientist. And that was the main object of the program which I was looking forward to.

By the end of the first week, the teachers had spent two days with their mentor scientists. Cathy said she was very excited about her research assignment and felt she had really "lucked out" in working with Jennifer. She thought most of the teachers were happy with their research assignments but noted that several who were on the weed inventory had been complaining, as had Smitty, who complained

loudly. Overall, she thought it had been a pretty good week and she had made several new friends.

Patty reported that she was thrilled with her mentors and her research project. She was not sure she understood all that they were doing as it involved a lot of chemistry, but she was looking forward to the upcoming week to learn more. When asked for her impressions of the first week, Patty said,

> Well the first day was really tiresome. All of these safety things. I really expected that Monday morning I would be assigned to a scientist and for three weeks would be working with that scientist. I had no idea that there would be these meetings and contact with the other teachers and all these dialogues and our car contests that we are going to do and all of this. I just really had no clue. But now that we are working with the scientists, it is just great. I am really excited and can't wait until next week. This is such a great opportunity and I am thrilled to be doing the work in the laboratory.

Jim, too, felt that Program A was going pretty well. He mentioned that he was not too sure the lead teachers were really "stepping up to the plate" and assuming leadership roles. He said several of them were really sticking together and not mingling with the new teachers. He was also concerned about Smitty, who did not seem to be getting anything out of the research experience. Jim noted that Smitty was not shy about voicing his complaints.

Summary of Week One

The teachers did not understand the policies and procedures of a national laboratory as evidenced by their complaints during the required orientation the first day. It would have been useful if the teachers had received a letter informing them of the orientation requirement in advance of the workshop. This is an example of one culture not understanding the working environment of the other. While the teachers thought it was a waste of time, many of them would be assigned to work in laboratories that conducted experiments using hazardous chemicals. And while it

may have been overkill to spend a full day in orientation given the teachers would be on-site for only three weeks, this policy was beyond the control of Lab B's Education Program.

Program B did provide the teachers with a list of goals, however, they were vague and all encompassing. The teachers did not receive a description of any outputs expected of them.

From the teachers' perspective, the single biggest point of frustration and confusion stemmed from the teacher development institute. With the exception of the lead teachers, the new teachers believed they would be working each day, all day with a scientist. They had not received adequate information regarding the afternoon sessions focusing on five main pedagogical themes – assessment, curriculum, diversity, standards, and technology. A review of the goals did not suggest a teacher development institute. The goals reflected a laboratory research experience.

The role of the lead teachers did not seem well established or understood. The two women lead teachers did make an effort to get to know the new teachers but there was little indication that the five men lead teachers had made any overtures in that direction. Conversely, it did not seem that any of the new teachers had sought advice from the lead teachers.

Jim made a point to see things from a classroom teacher's perspective. For example, prior to the special education presentation, he led a discussion asking what the various districts did to prepare them for the special education students assigned to their classrooms. The general consensus was the district did little to support teachers with special education students. He was quick to acknowledge the problems teachers face on a day to day basis in the classroom.

From first week observations, the workshop was generally well-organized and the teachers liked and respected Jim. Beth came in and out as did Kim. The

notebooks and handouts were high quality and well-organized. The room was a good one to hold a workshop. The teachers were frustrated earlier in the week as most had expected to be working with the scientists right away. They expressed mixed feelings about the afternoon teacher development institute sessions. But, overall, the teachers were enthused and engaged. The teachers had fun building the vegetable car and staging the race at the end of the week.

Week Two

The teachers spent each morning of the second week with their mentor. The afternoon teacher development institute sessions had a variety of topics and activities and work time. The majority of the teachers clearly preferred the time they spent with their mentors to the afternoon sessions. Jim continued to lead the afternoon sessions from a classroom teacher perspective and the teachers did appreciate this effort. Towards the end of the second week, Jim told the teachers that Beth expected the teachers to produce documentation of effectiveness of Program B in achieving its goals. No direction or hand outs were available to give the teachers guidance on how to produce the documentation that Beth wanted. The teachers viewed the documentation as extra work being 'dumped' on them half-way through the workshop and let Jim know they were not happy. While not as blatantly apparent to the teachers, it was obvious to the researcher that communication and interaction between Jim and Beth was deteriorating.

During the second week, Program B teachers fell into a daily routine. At 8:30 each morning, Jim led a brief update and recap of the program. This quick meeting allowed for reminders of upcoming events, general logistical updates, attendance, and an opportunity for teachers to give input on their experiences thus far. After a 15 minute meeting, the teachers left to work on their assigned projects.

At noon, they stopped for lunch and then reconvened for the afternoon teacher development institute. The afternoon sessions were spent listening to presentations from local experts in the pedagogical topics of interest, participating in favorite classroom science activities presented by volunteer Program B teachers, working on the car activities, and preparing for their final presentations that were scheduled for the last week. The workshop ended at 4:00 each day.

Participation in all Program B activities was mandatory. Attendance was taken each morning by the lead teachers. With only a few pre-excused exceptions, all teachers showed up every day.

The mandatory participation expectation was put to the test during the second week. Beth did not think the teachers could get a full view of the breadth and depth of Lab B research efforts with just the time they spent with their mentors. Therefore, she had made arrangements for the teachers to take a tour of Lab B guided by a staff member whose job responsibilities included giving public tours of the facility. As one of the nation's only laboratories devoted to renewable energy research, Lab B had a unique research mission. Many of the buildings at Lab B operated using some form of alternative energy that made for an interesting tour. To make the tour more manageable, Beth had assigned the teachers to two tour groups. The tours were scheduled for Tuesday morning, conflicting with the time the teachers spent with their mentors. Recognizing the conflict, Beth had sent an email to all mentors asking that they "release" the teachers for an hour. For the first tour, nine teachers showed up. Only two teachers participated in the second tour. Those who did participate in the tour found it worthwhile and enjoyable. Less than half of the teachers had participated in the tours, and of this group, only two were lead teachers.

Beth was not on either tour, but did hear of the poor turnout from the Lab B tour guide the following day. She was angry and told the researcher that the lack of attendance was an embarrassment to her program.

> We ask Lab B staff to make themselves available to do things like give tours to teachers and then only a handful show up. We could have done just one tour if we had known. But that is not the point. All teachers are supposed to take part in all the planned activities. It really makes the Education program look bad. And it makes it harder for us to get volunteers to help out when no one shows up.

Beth was already angry that morning because one of the lead teachers had not shown up and had not called in to inform anyone that he would not be there. She told the researcher that such behavior set a poor example to the other teachers and she debated whether or not he should be terminated. When he did show up the next day, Beth decided to let him continue in the program, but only after she had a talk with him to let him know that such behavior was unacceptable and would lead to termination if it happened again. But she remained angry.

The teachers were largely unaware of Beth's frustrations. She only dropped in for short periods of time, and by now, they were immersed in their assigned research project.

Mornings with the Mentors

Cathy was thoroughly enjoying the time she spent in the research lab with Jennifer, her mentor. She and two other teachers were working with Jennifer and Cathy clearly felt she had "lucked out."

> Jennifer is great. She is real willing to help us. There are some researchers that aren't even working with their teachers or there are three people doing one experiment. Jennifer has us each doing very, very different things. We are responsible for our experiment, it is basically ours. We have to write up a paper that goes into to Lab B's stuff, just like any other researcher here. There is a lot expected of us. We are working long hours and we work during lunch hour almost every day. I came back one night at seven o'clock to run

> samples. But to me, that's much better than doing a lot of stuff that doesn't really count for anything.

Patty, too, was pleased with her research assignment. She and another teacher had been assigned to work with two scientists who led a research team. Both Cathy and Patty were working on projects where the scientists were making use of them as additional team members.

> I can't believe George and Mike are doing all this for us. They have been so wonderful and treat us as fellow scientists even though we don't know what we are doing half the time. They answer questions and have us work on collecting data that they actually plan to use. I wish I could spend the whole summer working with them.

Smitty, on the other hand, was not happy with his research assignment as he felt he was not doing "real research."

> The only thing I do is observe. I don't do anything but observe. I sure didn't get the research experience this was supposed to be. And being in science for all of these years, I taught for 28 years, I am pretty sure nobody can do real research in 10 days. So I am not sure why they set it up like this. Maybe if they had us here for the whole summer we could actually do some good. But not in 10 days.

Cathy recognized that she had a special situation with Jennifer who had put a great deal of planning into the time she would spend with the teachers. Jennifer took her role as a mentor seriously and fostered a sense of collegiality with her intern teachers. Jennifer had been at Lab B for five years working as a biologist. At one time, she had considered being a science teacher and still had an interest in education. She had worked with Program B teachers the previous year and had put time and effort into improving the current experience based what she learned the year before. At the end of the previous summer, Jennifer had met with the Program B directors and made suggestions to improve the research experience for the teachers. The directors listened to Jennifer and had made changes accordingly. The

biggest change was the daily contact to allow on-going research and make the time in the laboratory more meaningful.

> Basically, last year was really a fun experience for me. But last year I only had them on Mondays and several days later I would have them for a morning and certain days later I would have them in the afternoon so we couldn't pull off the microbiology experiments. This year I am doing actual experiments with the teachers because they come on a daily, dependable schedule. I was really glad that Beth and Kim listened to my suggestions.

Jennifer acknowledged that it did take some effort on the part of the scientist to set up the experiments and think them through. But she also realized that it was helpful for her to have a fresh eye observing and asking questions. In addition, if the experiments worked out, Jennifer would be further along in her own data collection.

> The teachers I have this year are great. They are very enthusiastic and really want to be here. They like the experiments and it is fun to see science from their perspective. What I enjoy is showing them things and I enjoy their questions. I hope to get a new perspective on what I do. Like "why don't you just do this?" "I don't know, we probably didn't think about it." And also I am going to have three experiments that are going to be done in a week. It pretty much triples my productivity for the week. So if their experiments work out, I have got a lot more data than I had before and that puts me a lot more closer to my goals than I was before.

There were two projects that did not provide teachers the opportunity to participate or observe in research projects at Lab B. Both had the largest number of teachers assigned (five and six teachers). One was an energy audit of Lab B and the other was a weed inventory of Lab's B's extensive grounds. The teachers involved in the energy audit included the two women lead teachers and three other upper elementary teachers. Their mentor was with them continually and was delighted to have a group of teachers willing to work hard. While they did not have exposure to research, several noted they would now be able to have their students

conduct energy audits of their schools which made the experience directly transferable to the classroom.

The weed crew did not have daily contact with their mentor who was a facilities person, not a researcher. The weed inventory was made more exciting by the daily presence of rattlesnakes. At that time of year, the mesa and surrounding land that Lab B occupied was prime rattlesnake habitat. The weed crew wore snake guards and had frequent snake sightings. The presence of snakes gave the project an added dimension of difficulty. Two of the teachers assigned to the weed inventory flatly refused to go in the areas where snakes were usually spotted. Although they grumbled about their assignment, overall they seemed to enjoy the time outside and visiting with each other. Because they had no guidance, they generally made their own agenda which included many breaks.

Kim was very disappointed with the weed inventory project as she did not believe that it gave the teachers a taste of the research at Lab B. She told the researcher that it was her fault as she should have asked for more detailed information on this project. She thought it would involve research. The teachers on this project were not unhappy at all. But there did not seem to be substance for classroom transfer for this project.

Afternoon Teacher Development Institute

Significant planning time and thought was evident in the range of topics addressed in the afternoon teacher development institute sessions. However, with the variety of presenters, some sessions were of more general interest to the group than others. For example, a woman from the State Department of Education presented information on the new licensure procedure that was of great interest to all of the teachers (except Smitty). A presentation on securing grants for the

classroom was well received. The session was presented by a teacher who had been successful in getting outside grants. Other topics were less well received such as the session on inclusion and gender equity. These were topics that the teachers felt they had already received plenty of information on through their own districts and they did not need more information from Program B.

It was not unusual to observe teachers sleeping during the afternoon sessions, particularly if the session was scheduled right after lunch and the presenter used overheads and dimmed the room lights. Smitty's lack of interest and respect for the afternoon presentations were evident in his posture. On several occasions, he removed his shoes and placed his sock-clad feet on the table in front of him. Jim was inclined to ignore such behavior but it irritated Kim. Kim told the researcher that Smitty's behavior was a blatant display of disrespect for the afternoon presenters. She wondered what Smitty would do if his students did the same thing in his class. Kim was willing to bet that he would not tolerate such behavior in his own classroom.

There were many 'fun' events interspersed during the afternoon sessions. One afternoon, Jim arranged for a cake to be brought in to celebrate one of the teacher's birthdays. A pot-luck lunch was scheduled half-way through the workshop. Reflecting the western location of Program B, each day Jim wrote a quote on the board, such as "Sometimes even a cowboy has to ride sidesaddle" or "Make sure the bit you use fits the horses mouth." He asked the teachers to interpret the quote from a teacher's perspective. While corny, the teachers seemed to enjoy them and would laugh and make comments about the message in terms of teaching. Some of the teachers recorded the quotes in their journals.

Time was also reserved in the afternoon for teachers to spend working in the car teams preparing for the wind and solar competitions. Each group strategized

how they wanted to design their cars for competition and there was a great deal of good-natured kidding among the teams. The wind car race took place at the end of the second week and the solar car race was planned to be the culminating event and was scheduled for the final day of the workshop.

Between the race car preparation, classroom activities presented by Program B teachers, and the outside speakers, there was not much time available for the teachers to work on their presentations or on the documentation that Beth wanted. In general, the workshop atmosphere during the second week was congenial and friendly even if the teachers felt somewhat overloaded with all that they were expected to accomplish during the afternoon sessions.

In observing Jim, clearly he genuinely enjoyed his role as facilitator. He was enthused and took effort to present the workshop from the perspective of a classroom teacher. His style was easy going and relaxed. Because Jim was generally upbeat and engaging as he facilitated the workshop, his somewhat down behavior on Thursday morning was noticeable. When later questioned by the researcher as to his demeanor, he explained that he had just been "chewed out royally" by Beth. According to Jim, Beth did not believe the teachers were working hard enough on the documentation she needed for the Program B official evaluation. She was also very angry that one of the lead teachers had been a no-show the previous day and had not called to advise anyone of his plans. Finally, she was upset over the lack of teacher turnout for the scheduled Lab B tours earlier in the week.

From previous conversations with Beth, the researcher was aware that exposing the teachers to the entire culture of Lab B was one of Beth's personal goals. Unfortunately, over half of the teachers had not shown up for the tour either because they were so immersed in their research (e.g. Patty and Cathy), they had

been there the previous year (e.g. several of the lead teachers), or they just did not care enough to participate.

The poor turnout for the tour became a watershed event for Beth. Much of the remaining time the researcher spent with Beth was listening to her many complaints and frustrations with Jim. In listening to Beth, it became clear that these frustrations were not newly developed but had a history. Beth was worried about not getting the documentation she needed to demonstrate the effectiveness of Program B to those allocating funds for its continuance.

In a conversation with Jim, he sheepishly admitted to not having been specific about products. He believed that the research project write-ups, presentations, and laboratory notebooks would provide sufficient documentation. There would also be a multi-page exit questionnaire distributed early in the final week for the teachers to complete.

After his "chewing out," Jim was much more vocal in his criticism of Beth and her management style when talking privately with the researcher. In particular, he made the point how undesirable it was to have individuals with no classroom experience leading education projects.

> I think that having some time in a classroom with a teacher would be invaluable for Beth. She leads education projects so she should get some first-hand experience. See things from the teacher's point of view. One of the most important times would be the first week of school. Then come back again in a month and spend a few days and come back again in another month. It would make a huge difference in how she views the teachers. I know she just thinks they are lazy and trying to get away with things. Part of the summer gives them a chance to hang out together and re-charge their batteries. They don't care about promoting Lab B. They don't care about her documentation. The things that are important to Beth are not important to them and she just doesn't get it.

When asked if he would be comfortable interacting with the bureaucracy of Lab B to keep the project going, Jim admitted he would not like that role. He said

that Beth did a good job of keeping the 'powers that be' happy and in securing funding. Jim believed that by combining the strengths of both of them they should have a good management team. He knew the teaching environment and Beth knew the Lab B operating environment.

As a result of Beth's concerns about not having enough material for documentation, Jim set aside most of Thursday afternoon for the teachers to spend time documenting their experiences. The teachers could also use the time to catch up in their journal writing and work on their presentations. The concept of documentation was new to the teachers. Jim had spent little time explaining to the teachers what Beth wanted from them at the end of the workshop and he had never used the term documentation before. He informed them that Beth would be collecting the journals at the end of the workshop to photocopy and they would later be mailed to the teachers. This pronouncement brought a chorus of negative comments from the teachers as this was new information to them. They wanted to know just what exactly Beth meant by documentation. In addition to the oral presentation, Jim explained that Beth expected that the teachers would also write-up a report on their research experience and how they planned to transfer the Lab B experience to the classroom. The teachers were not happy with what they saw as additional work being asked of them mid-way through the workshop. Beth was not there to address their questions and there was not a hand-out for the teachers as to the format of the documentation report. Jim did not make this out to be a big deal and suggested that the teachers not worry too much about it. If they just put together a lesson plan, he thought that would probably suffice.

To make it easier for the teachers to provide documentation for Beth and to work on their presentations, Kim had arranged for a bank of computers to be made available for their use.

> The documentation is important. It will get them started thinking about classroom transfer. But the teachers are not really taking advantage *(of the computers and software)*. But I guess that is partly our fault. I think our schedule got pretty tight. We do not really have blocks of time for them to work on the computers for their presentations. I guess we have not done a very good job letting them know that we needed documentation. Beth takes it for granted and Jim kind of blows it off. Beth is not happy with the progress, or lack of it, on the presentations.

When asked if she would use the computer facilities available to the teachers, Cathy said she just did not have enough time. She was much more interested in her research project than in making a 'polished' presentation about it.

> They just haven't given us enough time for all this stuff they want us to do now. The research is great, but the rest of it is time consuming. The cars take a lot of time. And we are supposed to do a presentation. That's okay, but I didn't think it was any big deal. I can use my computer at home to put together a 10 minute presentation. I don't know what I will do about the documentation. I don't really know what they want. You know, I don't have any extra time here. And if I did, I would rather be working with Jennifer.

On Friday afternoon, the wind car race was held in one of the large hallways. It was enjoyable to see the diversity of car designs and the teachers had a lot of fun with this activity. Jim dismissed the teachers about an hour early. Many of the teachers used this 'free' time to meet at a nearby restaurant to have a drink. The researcher was also invited. Except for some grumbling in regards to the documentation, the conversation was upbeat and it was clear that the teachers were enjoying their time in Program B. From their conversation, the teachers seemed unaware of the increasing tension between Jim and Beth.

Summary of Week Two

The second week was the only one of the three where the teachers spent part of every day with their mentors. For most of the teachers, the research time was the highlight of the workshop. Some of the research opportunities were impressive.

It was clear that some of the mentors had taken time to really make the experience a good one for the teachers. Not all teachers had this positive experience. Smitty was not at all happy with his situation, yet, he did come everyday and did participate. Of the three key informant teachers in Program B, he was the only one who did attend the Lab B tour. And he enjoyed it very much.

The teachers assigned to the energy audit were not being exposed to research but they had been well placed. In many cases they had the least amount of science background and would have had the most difficult time in the research labs. It could be argued that they were the ones who could most benefit from working in a lab as they had no prior exposure. Their mentor was engaged and spent a great deal of time working with the teachers to come up with a plan so their students could conduct a useful energy audit in their school. The teachers assigned to the weeds were having fun and their task became more of a social gathering as the week progressed. The facilities person who was their mentor viewed them as 'free labor' and just put them to work with little regard for their having a research or Lab B experience.

The afternoon sessions proved to be mixed. Some of the information was useful and some was not. The teachers did become restless in the afternoons and as the week progressed, spent more time off task and socializing. Towards the end of the week when the documentation was brought up, the teachers were not happy. The program leaders had not given the teachers a concrete description of what they wanted for documentation. Although Program B had a goal of transferring the lab experience into the classroom, there was no clear method to do so. The teachers had been told early on that they were to do a presentation of their work to the other teachers. They had not been told that they had to do a written report or that they had to come up with a lesson plan. Not surprisingly, they balked when they learned of this requirement towards the end of the second week.

The teachers really liked Jim and were supportive of his efforts to make Program B as meaningful as possible. They did not seem to be aware of the mounting tension between Beth and Jim, however, they saw little of Beth, but when they did, they viewed her as a bureaucrat. Jim was one of them, a classroom teacher. In general, Kim stayed in the background taking care of the day-to-day details. She took the time to visit every teacher in their research situation to find out how it was going. The teachers were comfortable with Kim – she was a classroom teacher and also, she was the one they turned to when they needed detailed information. Jim was not a detail person, but Kim was.

Final Week

The final five days of Program B actually spanned two weeks. Friday of the final week fell on the 4th of July, therefore, the teachers returned to Lab B on the following Monday. The first two days were the last the teachers spent with their mentors. Most of the week was spent preparing presentations and working on the car projects. Communication between Jim and Beth continued to be problematic. Kim was in the middle. Once the research time was over, the teachers were not as engaged and seemed to be more restless and anxious for the workshop to end.

Beth began Monday afternoon's session by distributing a multi-page evaluation form to the teachers. She asked that they take their time in responding as the information would be used to improve future Lab B education programs. Beth asked the teachers to return the evaluation forms and their laboratory notebooks to her by the end of the workshop. The laboratory notebooks would later be returned to the teachers by mail. Although she had the opportunity to do so, she did not elaborate on what she wanted for documentation and did not ask if there were any questions. When she spoke to the teachers, it was in a rapid-fire "this-is-what-I-

want" format and then she left. In this instance, Beth appeared uncomfortable in talking to the teachers.

When the researcher asked her about this later, Beth explained that she felt the teachers were not as cooperative as she would have liked them to be. She also noted that she was aware that they thought Jim was wonderful, and that, in contrast, she was the "wicked witch of the West." The researcher asked Beth what it was that she wanted for documentation. Beth fumbled in answering the question. She noted that the purpose of the workshop was to transfer the Program B experience to the classroom and she wanted to document that. But she was not able to clearly articulate what it was that she wanted.

Tuesday was the last day the teachers spent with their mentors. When the teachers convened for the afternoon session, there was a general discussion about the time they spent with their mentors. With the exception of Smitty and the teachers who were doing the weed inventory, there was a general sense of gratitude and appreciation for the opportunity to work so closely with Lab B scientists and staff. Beth stopped by to tell the teachers she had decided that the documentation she needed could wait until the follow-on days scheduled to begin the following fall. She hoped the teachers would develop lesson plans based on their experience and have a chance to document their lesson plans by implementing them in the classroom and then provide a written report for her. She did not provide an example of what she wanted from the teachers.

Jim and Beth continued to express frustration with the other when talking with the researcher. Beth told the researcher that the lead teachers were Jim's idea and that they had not done the job they were supposed to. When asked for his opinion on this, Jim agreed that this had not worked out the way he had hoped. The idea had

been to have teachers who had already spent a summer in Program B be available to help new teachers adjust to Lab B and to answer any questions they might have.

> Yeah, it was a good idea but it did not really bear fruit. I guess I should have been more on top of them, you know, ridden them a little more. The guys really didn't do a thing. The gals were much better. We planned on having the lead teachers help the new teachers make connections back to the classroom. We wanted them to start to talk about how this was going to go back to the classroom. And Mary and Juanita did this pretty well with the energy audit group. They really did take the lead and help those teachers figure out the program. But the guys were pretty much useless. They didn't reach out at all. They really kept to themselves and almost became a clique. Something they must have learned from their middle school students.
>
> Guess I can't blame Beth for being upset about the lead teachers. I wouldn't do it again. But I still think it was a good idea and it might have worked if I had been more on the ball.

When asked about her lead teacher, Cathy had to think for a moment before replying. She said that Matt was her lead teacher, but he had not been assigned to Jennifer's lab, so she had not spent anytime with him. Because Cathy felt Jennifer had provided a great overview of Lab B, she did not really have any questions for a lead teacher. She said that she thought Matt was 'a nice guy' but that she had not really interacted with him.

The remaining time in Program B was spent as a group. On Monday and Tuesday afternoons and most of Wednesday, the teachers were encouraged to continue work on their presentations and to build their solar cars. Some of the teachers used this time to fill out the exit interview Beth had distributed. During the remaining group time, there was much less structure than had previously been the pattern. The teachers spent a lot of this time in side conversations and general socializing. There did not appear to be a lot of time spent working on the presentations. Instead, most of the teachers met with their solar car team and, even then, spent more time

in general conversation than actually working on the cars. The researcher used the time to find ask the teachers to share their overall impressions.

Cathy was saddened by the end of her time with Jennifer. The 10 days had "just flown by." Cathy planned to keep in contact with Jennifer and they had discussed how to best transfer Cathy's Lab B experience to her classroom. Cathy and Jennifer were already making plans for Jennifer to come to Cathy's school in the fall.

> You know, it's been a great experience. I worked with somebody who is an awesome teacher. I'm pumped, I'm excited, it's been great. It was a fun experience.
>
> I have already talked to Jennifer about coming out to the classroom next year. There is a lot I can do with the stuff I learned here. I think with my 7th graders, we can do a whole thing on energy and renewable and non-renewable, so a lot of the things I did this summer will be useful. Jennifer has some experiments she is going to show me that we can do without using ethanol because we can't really use ethanol in the classroom. So I will use some experiments like that and I have a better understanding of alternative fuels...much better now that I ever did before so I will do that with my 7th graders. With my 8th graders I'm gonna introduce them to the experimental design we learned with Jennifer.

When asked if the program met her expectations, she replied,

> I would say it probably exceeded them. The research was definitely the highlight. I felt like I wanted more time in the lab. Not only just on a daily basis but also on a more extended time. I was just getting to the point where I can know what I was doing in Lab B and function by myself in Lab B and now it's over. You know, I wish we had a chance to now say "Okay...now I want to take this based on what your data showed and take it one step farther and keep going and going." So, I guess I feel like I want more time, more extended time. The afternoons were not so great. There have been some that have been good like the ones on assessment and multiple intelligences were probably the two best. You know, some of the other stuff again I've kind of had in pieces and stuff like that. In the afternoon, more time to work on all the stuff would have been good. I am still not sure what I am doing for the documentation that Beth needs.

Like Cathy, Patty was finishing up the workshop with overall positive impressions. She was delighted with her research experience and wished she could do more. Like Cathy, she would have preferred less time in the afternoon sessions and would have liked better directions on the documentation that Beth needed. Both Cathy and Patty fully intended to use their Program B experience in their classrooms. Patty informed the researcher that she had a videotape to share with her students and was excited about that.

> I can show them the experiments we did and how we did it and the testing. We used chromotography in some chemistry experiments and I am going to try and do that with the students. It won't be nearly as fancy but it is still the same sort of thing. It will be exciting to show the kids what they do in a 6th grade classroom is real similar to what real scientists do in real science labs.

In marked contrast to Cathy and Patty's enthusiasm regarding the workshop, Smitty had a much different take when asked about his thoughts overall.

> I guess the only thing I would say about the program is they need to get a little better organization at the beginning so that the teachers and the scientists know what they are doing. The afternoons were a waste of time. Talking about standards and assessment and all. Since this is my last year of teaching that is coming up I really feel that I personally don't have to buy into it as much as some of the other people might. And the car projects were fun for a little while but took up way too much time and really were not very useful. I guess it has been okay. But it is not what I expected. I thought I would be doing research not just watching someone work on instruments for 10 days.

It would seem that Smitty received nothing from the program. But the researcher recalled an earlier conversation with him where he was genuinely excited about what was going on in his lab.

> I would feel very frustrated if I just gathered data and never saw anything come out of the data. For instance, I am very anxious tomorrow because yesterday we did a test sample in the atomic force microscope. What I would like to see is what happens when they do regular samples plus they have used the new equipment that didn't

work the last time they did it so I am anxious to see what happens there.

Smitty had proudly shared the enlarged photographs of the samples with the researcher explaining them in detail. He was a contradiction. He complained almost constantly about almost everything. Yet, he was friendly and never missed any of the activities.

On Thursday morning, the teachers met Jim at a local botanical garden for a field trip. The tour of the gardens did not have any connection to the Lab B experience. Several teachers noted they could come to the botanical gardens on their own and would have preferred to use the morning to finish up their presentations and work on the cars. Back at Lab B, a catered lunch was served. All the mentors were invited to attend and many of them did. The mood was upbeat as the teachers and scientists chatted freely about the projects they had worked on. It was evident that relationships had been made.

Beth and Kim were both in attendance for the afternoon's presentations. Teachers were given 10 minutes to report on their summer experiences. Smitty volunteered to go first. He took about two minutes to tell the group that he never did do any research but just sat and watched. He told them he hoped they all had a better experience than he did. He did not expect that any of his time at Lab B would be useful in his classroom. The teachers were quiet after Smitty's harangue. Beth did not appear to be happy with Smitty's 'presentation' but Jim quickly made light of it and noted that Smitty was already in 'short-timer' way of thinking.

From there, the teachers went one after the other in no particular order. The teachers who worked together in groups gave group reports. The presentations were quick, and in most cases, not well planned. In one case, a teacher used an overhead diagram that his mentor had given him. However, he could not explain

what the diagram was. Another teacher read from a report that his mentor had written. Some of the teachers who worked in instrumentation labs talked about the instruments they had used and what their use was. Cathy and her group gave one of the better talks of the day but did not discuss how they would transfer the experience to the classroom. Patty and Dan showed a videotape they had made to take back to their classrooms to show their students what they had "done on their summer vacation." It was clever and well done. With the help of their mentors, they videotaped themselves in the laboratory talking about the research and what they were doing. With a few exceptions, the presentations were not very thought out or delivered. Kim later noted

> The bottom line was the presentations were not exemplary, in fact they were mediocre at best. Because not only did they not take on the format that I had hoped for, but I do really not think they addressed the issues that we had hoped for. It was pretty loose, pretty shoot from the hip, kind of 'b.s.ey.' That doesn't mean what the teachers have done is not effective and it does not mean that the classroom plans are not good. It just means the information that Beth needed was not in a format that was really very useful.

The solar car race was held on the following Monday and was the wrap-up event for the workshop. The race was a big deal to Beth. Lab B sponsored solar car races and treks using human-sized vehicles across the country. These small, solar powered cars were a microcosm of what a major part of Lab B outreach was all about. The morning of the race was uncharacteristically cloudy. The race would have to wait until the clouds lifted. In the meantime, the teachers posed for a group photo. Copies would be made and sent to them all. A breakfast buffet had been set up and the teachers ate and visited with each other and with Jim, Kim, and Beth. When the sun broke though mid-morning, the race began. A track had been laid out and each team readied their car for competition. The elimination race lasted about an hour and the teachers enjoyed themselves as they cheered and hooted. The race ended

late morning. The teachers spent some time saying good-byes, handed in their exit questionnaires and lab notebooks, and then left.

By the time the workshop ended the tension between Jim and Beth had become obvious to the researcher. Their reflections on the workshop were clouded by the tension between them. When questioned individually about their views on the strengths and weaknesses of the workshop, it was hard to keep either of them on track. Instead, they wanted to veer off and blame each other for perceived weaknesses. When asked about the workshop, Jim said

> Overall, I guess it was pretty good. Not perfect, mind you, but pretty good. They really wanted to do more research and I guess we should have done more of that and less of the afternoon stuff. Or maybe we should have had them do the research for two weeks and take some time off and then come back for another week to do their lesson plans. They could have something to think about. In other words, design standards based criteria for lesson plans that they would have a month to develop, bring it back, fine tune it and have it ready to go for the school year and then be ready to implement it.
>
> Beth's problem is that she wanted things finished the day people walked out and be able to use them in a classroom. But there was not the development time during that three weeks to have people find resources, develop pedagogy, and what have you. To me it is a long term process we are talking about, maybe nine months of generation, reflective thinking, review, go back, analyze change, an ongoing process. And I think hers was a very deliberate, it will be done, this is what you deliver and don't worry about it because now we have something in hand, called evidence or documentation. And I don't think she cares if it is useful to them or not as long as she has something that says it was. And it's just different viewpoints and we have talked about this before. Education people and HR people.

At the end of the workshop, Beth was frustrated with the lack of progress in the areas that she felt was important, notably the documentation she needed. She put much of the responsibility at Jim's feet even going so far as to suggest they may replace him prior to the follow-on meetings during the school year with a staff person. She thought the afternoons had been wasteful in that Jim had lined up too many speakers on topics that were not useful. She would have preferred that time

be spent in more product-oriented ways. Beth focused on the videos as being a weak link. Over the three weeks, Jim had shown three short videos.

> We didn't need to do a rehashing of what they have already covered in school in-services. I thought we hit that a lot with constructivism in the summer, where we showed video after video. The teachers did not want to see videos in the afternoon after they had done research. They died terrible deaths and it was very dry and very hard for some teachers. Especially after they got the enthusiasm from doing the research and were ready to charge ahead and then Jim slaps on a video.

> We might need a new leader. We need to take a look and maybe get somebody from the outside or somebody that is not hooked into a school and could actually bring in expertise, certainly with an education background but maybe not a teacher to lead the workshops. I am kind of thinking of that. I think that we would really have to sit down and rethink what we want out of this program.

The day after the workshop ended, the researcher met with Kim who had offered to share the results of the exit questionnaire with the researcher. Kim had read the exit questionnaires and had also talked with several of the teachers to solicit their feedback on the workshop. Kim indicated she would make some changes to the workshop based, in large part, on the teacher feedback. Overall, she was happy with the research component and recognized it as the "heart and soul" of Program B and "what the teachers are really here for." She recognized that they had piled too much work on the teachers during the afternoons and had not been clear about exactly what was expected of the teachers.

> And then we would have to be clear about what we want them to do. Now they have to work on wind cars, solar cars, projects, and they had research presentations. So they had four major things they were juggling. Most of the feedback was that the teachers liked the research component and they were not all that impressed with the afternoon sessions. So let's keep what we know is working and open the rest of it up so they have the opportunity to do what is more effective. We got positive feedback on some of the presenters and others were not very effective. We could just have a few of the best come back.

She noted that there were too many tasks assigned to the teachers in the afternoon and not enough time or resources to accomplish them.

> Next year I would decrease the tasks that the teachers do. It is very important for them to work in groups but I think we need a single focus. We need to have them work on a solar car. But I would not throw in the veggie car and the wind car even though they are really good build up activities. I think I would just do the solar sprint project and the presentation which encompasses their research and their classroom plan ideas all together in one big lump sum. So that when we have afternoon work sessions there are only two things on the agenda. They are either working in their group on their car or they are working on putting a presentation together. And the presentation would include a major part on how they were going to use the research in their classroom. And then the last week or last two or three days, they would put their presentation together and say this is what we did in the research lab and now, here is how I am going to translate that to my classroom. Let them tell us how they plan to transfer.

There was a 100% response rate to the six-page questionnaire. The teachers had been encouraged to be open and honest in their responses and were asked to exclude their names to encourage more forthright answers. The form included general information regarding the respondent (grade level(s) currently teaching, subjects taught, and years in the classroom). The exit interview was composed of five major sections each with a Likert-type scale statement for the teachers' response. In addition, room was provided for teachers to give additional comments in their own words. The first three sections had statements relating to the teachers' individual teaching philosophy, how they felt about various aspects of science teaching, and their own thoughts on their current knowledge of science and technology (these were related to an entry questionnaire which was not made available to the researcher). Of interest to the research study, were the two sections asking the teachers for feedback on the program. The teachers were asked to rate various aspects of the program including, program administration, advance communication, orientation, availability of resources, assistance provided by

program staff, workshop leaders, interactions with other leaders, interactions with Lab B scientists, and support for sharing the experience with the classroom.

Of the 28 completed evaluations, the responses to the sections on the program were mostly positive with seven teachers giving all ones (excellent) on the Likert-type scale addressing the aspects above. Eleven gave mostly one's (excellent) with a few twos scattered (very good). One person gave all three's (good). The remaining nine gave a distribution of 1, 2, and 3 with three individuals noting a 4 (fair) for the orientation. 'Excellents' and 'very goods' dominated the responses by far. About half of the teachers chose to list additional comments about the specific strengths and weaknesses and those were very brief. Again, the comments were mostly positive. Most of the teachers felt the opportunity to work with the mentors/scientists was the highlight of the program. Representative samples included:

- I gained confidence in teaching science and the motivation to change a few things in my classroom to include more hands-on things.
- I really liked working in the research labs as I feel I better understand science.
- The hands-on learning while doing research was great. I can hardly wait to utilize all I learned in my classroom.
- Some of the talks were pretty boring but I liked the relaxing environment and interaction with the scientists.
- My own hands-on experience and dialoging with other professionals on how they incorporate science and math into their classes was absolutely the best!

The evaluations did not provide a great deal of insight or critical review of Program B. Most of the teachers gave high marks on the evaluation form. Surprisingly, even Smitty was positive when it came to writing down his evaluation of the workshop. Although he did not include written comments, his responses on the Likert-type scale were mostly 'good' with several 'excellent' and 'fair' notations.

Summary of Final Week

The workshop came to an end on an upbeat note with the solar car race. It was a chance for the teachers to say good-bye. Many of them were ready to begin summer vacation. Once their time with the research scientists ended, it seemed that the teachers became restless and were not engaged in the remaining teacher development sessions. Even while working on the cars, the teachers were not focused.

The workshop ended without the teachers having a clear sense of what Beth wanted for documentation. It seemed that even Beth was not sure what she wanted for documentation, but would know it when she saw it. The confusion surrounding the documentation continued to be frustrating for all involved. For the most part, the Program B teachers were cooperative, however, they needed direction in knowing what to give Beth for documentation.

Initially, Jim, Beth, and Kim had come across as a cohesive team. In looking beyond the surface, the communication between them was fraught with problems. A lot of the problems came back to different expectations. They each recognized the others' strengths, but were frustrated by their own ideas of what needed to be done. Beth did come across as a bureaucrat and Jim was not supportive of what Beth needed. She needed documentation of the program's effectiveness if they wanted to continue offering such programs in the future. It was expensive for Lab B to put on such a program. Jim was very sensitive to Beth's needs. Beth needed to have documentation of the success to share with those allocating the funds for the project.

Cathy and Patty were excited and enthused about the time they had spent with their mentors. They spent time in interesting research projects and had mentors who took the time to make it useful. Both of these teachers were positive and hard

working and took their job as a teacher seriously. They looked for things that would make their teaching more effective and were especially excited about using the lab experiences. Smitty was not happy. Because he was retiring and had no interest in teaching his final year, it was hard to understand why he had applied for Program B. He was considering looking for a part-time job after he retired and it seemed as though he hoped participating in Program B would give him laboratory experience that might help him determine what his next step would be.

Overall, the evaluations were positive. Even though the teachers did not have to include their names, many of them did. The teachers gave overall positive grades for the program. Smitty's overall positive responses were a surprise given his continual verbal complaints. Beth was happy with the evaluations because she interpreted them as an indication of Program B's success. And at this time, it was impossible to tell from the evaluations what the classroom impact would be.

Post-Summer Follow-on Meetings

Program B scheduled five, full day meetings (referred to as follow-on days) during the school year. Jim's role for the follow-on days was still uncertain at the end of the summer, but once school got underway, he and Beth had come to an agreement as he facilitated all of the meetings. At the beginning of the school year, the teachers received the follow-on day schedule for the year. Not all teachers attended all meetings as school districts had their own time conflicts. Attendance at the follow-on meetings began strong and started to taper off by the spring. The documentation Beth wanted was still not clear but most teachers did hand in a lesson plan.

Program B held five follow-on days during the 1996-97 school year. Before the first one, the rift between Jim and Beth was still apparent as Jim was

not certain of his role. Originally, Jim had been hired to lead the follow-on days, but due to the tensions of the summer, Beth had put him on a "to be determined" status. Jim was clearly frustrated with the uncertainty as to his role in the Program B and the follow-on days.

> Part of the problem is that we have not sat down and figured out the responsibilities yet. I am in limbo. I told Beth that I would do the agenda and send it out, after she looked at it, and then pass it to the teachers. She could have input. But it's a unique situation because she said I was the visionary. Originally, she wanted me to come up with the ideas but the deal is whether she agrees with my ideas or not. She is still the stop and go person as far as what is delivered. And now she wants to take it over and put it on a tighter time schedule.
>
> I like the flex-flow approach where things are well organized but there is a chance for discussion and what not. But Beth thinks that means they are not doing anything. It's a perception more than a reality. And that's the difference, you know, HR people, they stand around and talk for an hour, but they are still on the job even though it seems that they haven't done anything. Well, teachers are the same way except they usually don't have the luxury of standing around talking for an hour with their peers.

Although Beth was frustrated with what she thought was Jim's loose approach to Program B, she realized that she was not the person to lead the follow-on days. She would have liked to turn that responsibility over to Kim, but Kim had left Lab B at the end of the summer and returned to teaching.

> We have not determined where to use Jim. He is a big picture guy but we need the documentation. I don't think he has the skills now that we have to get in the nuts and bolts and really be there getting the lesson plans nailed down. We need to have someone lead working sessions and Jim would rather lead philosophic discussions. He just does not seem to realize it is important to hold the teachers accountable.

Despite Beth's concerns, in the end, Jim did lead the follow-on days. The follow-on days covered a variety of topics including, classroom transfer, standards implementation, assessment and evaluation, and technology training. When originally signing up to participate in Program B, the teachers were required to get the commitment from their school administrators for their participation in the

follow-on days. In practice, having administrators honor the commitment proved problematic for some teachers. Cathy noted,

> Five follow-on days is hard to get an administrator to swallow. I mean they freak out when they find out they have to pay for five sub days. Our staff development money is like, 16 dollars per teacher for the school year. Well a sub is 86 dollars and I go in there and say I need five sub days, I have just wiped out the school professional development money. So we have to get pretty creative to make it work. I think five is a good number but is a difficult number to get.

Despite difficulties with getting the days off, the overall attendance at the follow-on days was good. Because they had teachers from six different school districts participating in Program B, scheduling conflicts did arise making it impossible for all teachers to attend all the follow-on days.

After the first follow-on day, Smitty shared his impressions.

> I think the point of the follow on days are to make sure we go through with what we planned during the summer. I'll tell you how impressed I am with the follow-on day.....I can't remember what we did last Tuesday. I was racking my brain all day and I don't have the foggiest memory of what we did. And that's how much they impressed me.

When reminded that they addressed evaluation, lesson plans, the purpose of Program B, and the move towards standards based teaching, Smitty replied,

> Those things are a waste of time. And I am afraid that the next four are not going to be any better than what we did and in fact, kind of off the record, but when they went around the room to hear what everyone was doing, they missed me entirely. I was glad. If I were running the program, I would probably do away with most of the follow-on days. I thought that there was not very much accomplished at the follow on day.

One of the follow-on meetings was held in conjunction with the State Association of Science Teachers (SAST) annual convention and the National Science Teachers Association (NSTA) regional convention held in the fall of 1996. At that

meeting, the teachers convened as Program B participants for two hours and then were free to attend the conference for the rest of the day. The two-hour meeting was led by Beth and focused on documentation and what the teachers had done in their classroom. Beth wanted the teachers to address the five pedagogical topics from the afternoon sessions (standards, assessments, curriculum, gender equity, and technology) in their lesson plans to be used as documentation.

Cathy recognized that having the meeting in conjunction with the SAST convention, allowed the teachers a good opportunity.

> I am really glad the next follow-on day is with the SAST/NSTA convention. I think that there are a lot of us who would not have been able to go or wouldn't have been able to pay for subs. And now we are going to be there. I think it is especially important for the elementary school teachers. How many of them have been to a SAST convention or an NSTA convention? It was really smart of Program B to have the follow-on day so we could all go to SAST.

After attending several follow-on days, Patty shared her opinions.

> Well, I don't know. I certainly haven't gotten as much out of them as I did the days this summer. I felt I got a lot out of days this summer. I haven't objected to anything. I am sitting here trying to remember (laughs) what we did on the follow-on days. Since I can't remember, it must not have been too impressive (laughs). Hmm, we had a speaker, but I am not sure...oh yeah, sexual harassment. To me it seems that everybody should have known that by now. It wasn't great. I didn't object to it or anything but I don't think it was that valuable. Obviously since I can't remember.
>
> I would like for them to be a little meatier...I would like to be able to share with other teachers what we are actually doing in our classroom. Sharing curriculum. Sharing lesson plan ideas and something that I can take back to change my teaching. And we did a lot of that this summer, we talked to a lot of people and got some great ideas for changing my curriculum or adding to it.

Cathy liked the follow-on days. Her school district was going through a lot of stressful changes and the days away provided a respite of sorts. She would have

preferred a different content focus. As Jim had noted earlier, Cathy spoke for many when she said much of the value was having the time to interact with other teachers.

> The follow-on days have been good. I like meeting with the other teachers. I think especially this year with all the turmoil and all the headaches and all the hassle, it was real valuable for me to kind of escape school and hang out with the teachers. Number one being able to vent and number two being able to hear their frustrations and know that it is the same all over the place and I am not alone. I think as a classroom teacher you get real locked into your own room and especially this year, we don't have a planning period. So just from the standpoint of interaction with my peers, I think it is invaluable. Just being able to go and hang out and talk and gripe and ask questions. That part is valuable in and of itself.

> How much I am getting out of the days? Probably not as much as I could if it was done differently or it was structured differently. That's not to say that you don't pick up stuff. I think maybe it should be more hands-on. Some kind of hands-on activity that we are walking away with. Maybe that is the time we could be sharing. Each teacher brings their favorite. That's where you get cool ideas and good ideas. So maybe that's what we could have been doing more of in the follow-on days. But overall, I think the follow on days were good.

The documentation was an on-going point of contention between Jim and Beth. Although they were given the additional time of the follow-on days to hand it in, it never was really clear to the teachers what they were supposed to do. Jim was not concerned with the documentation and thought it was doable in the time allowed.

> We are gonna ask for components to be completed by each of the follow-on days. So every time we will add a segment of the lesson plan so it will be completed by April. I am not worried about the order, but by the end they should have all five of the areas covered. And then hopefully, they will bring them on disk and they will be disseminated to all of the teachers. We can make copies and hand them out.

Patty explained her thoughts on the documentation.

> It was not clear what I was supposed to hand in but I did hand in a lesson plan at the end of the summer. I like to finish things when I start them so I did my lesson plan and I addressed all the five things, diversity, technology, etc. If I were being given a letter grade on that and my raise or degree depended on that, I would say, "Man I didn't do a very good job on that" and I would want to do it over.

> And I did ask Beth if that is what they wanted and is this good enough? And Beth said it looked good and she said I could add to it during the follow-on days and I think I will because I know there is room for improvement. But I also know I am a very busy person and at this point in my life, if I can get away with sliding under on something just a little bit, I will.

Like Patty, Cathy was still not clear on just what was required for documentation.

> Well, we are supposed to hand in documentation for each of the five things but I still don't get it, I mean I still don't know what we are supposed to turn in and I know that Jim tries to explain it every time. I gave Beth my stuff that I did on factorial design. I gave her all my stuff, my lesson plans that I did with the kids. And I gave her all the stuff I did on assessment. I don't know if that covers me. I don't know if I have done what I am supposed to do. I am real confused and I know Jim has gone over it and maybe I am just not listening. I don't know if I have done what I am supposed to for documentation.

Most of the teachers did bring components to the follow-on meetings or sent them to Beth throughout the year. When asked if she was getting the documentation she needed, she responded,

> I am getting more and more. Initially, I would say we have been getting re-typed lesson plans, so something that they have already done, it's already been proven in the classroom. Nothing had changed. So this was the lesson plan that we had observed back in the spring, before they even came. We are not saying re-write it, maybe just look at it differently and be able to actually say "what is different about this" and how did it related to the experience you had at Lab B. So, yes I am finally getting it (the documentation).

Summary of Post-Summer Follow-up Meetings

The follow-on meetings were well attended, especially considering that the teachers were from different school districts and, therefore, had schedule conflicts. Although Jim's role was initially uncertain, he did facilitate the follow-on days which provided important continuity. By this time, Kim was back in her own classroom and no longer involved in Program B. The teachers were not aware of the

level of conflict between Beth and Jim. To his credit, he never publicly discussed their differences.

Jim was well aware of the simple fact that teachers enjoy time spent with other teachers. He provided free time at each of the follow-on days to provide the teachers with the opportunity for informal sharing. Unlike Beth who viewed the interactions as a waste of time, Jim recognized the value in the informal sharing between teachers.

The follow-on days were facilitated from a classroom teachers perspective. Beth did not have the experience to do this. It was excellent planning on Jim's part to schedule one of the follow-on days in conjunction with the SAST/NSTA regional meeting. He understood that most teachers have a difficult time getting release time to attend such meetings. By having a two-hour get together, the teachers were freed to spend the rest of the day at the SAST/NSTA meeting.

Beth never did make the documentation process clear to the teachers. And Jim tended to make little of it. Without clear guidance, the teachers did the best they could. Beth wanted to have clear classroom transfer, but they did not spend a great deal of time during the summer visualizing this. It was a fundamental goal of Program B, but little direction was given. Beth wanted more than lesson plans. She wanted lesson plans that reflected the time at Lab B. She wanted to be able to demonstrate that participation in Program B had an impact on teaching. Because she had never been a teacher, she was really not certain what that would look like and counted on Jim to help. Jim had little concern for the documentation and did not provide Beth with much help.

Teacher/Scientist Contact During the School Year

Cathy had already made plans to have Jennifer visit her classroom. In the fall, Jennifer did teach in Cathy's class which provided an interesting role reversal. In the classroom, Cathy was the expert. Cathy and Jennifer had forged a friendship and were in touch frequently via email. Patty never did make contact with George or Mike. She thought it would be fun, but was concerned about bothering them. Smitty did not even consider making contact with any of the scientists in the instrumentation laboratory.

At the end of the summer, Cathy and Jennifer had already made plans to keep in touch and have Jennifer visit Cathy's classroom. Kim had hoped early on that on-going relationships would be established because of the time the scientists and teachers had spent together. Cathy and Jennifer represented a best case scenario. Cathy and Jennifer remained in contact throughout the school year. When Cathy was having difficulty setting up a factorial design project with her class based on her summer experience, she contacted Jennifer.

> Early on in the fall I tried to do the factorial design with my 8th graders and as I got into it and started setting things up, I couldn't figure it out. So I called Jennifer - I don't know how many times on the phone, and emailed her - I don't know how many times and said "you've got to help me." And every time she would call right back or emailed right back or whatever. She was great and I did it with my kids and they grasped it far better than I ever anticipated. I mean they just kind of whizzed right through it.

When Cathy was doing an energy unit with her 7th graders, she invited Jennifer to spend a day in her classroom to give her students an overview of the history of energy and an introduction to renewable energy. Cathy gave Jennifer free rein in how to present the materials. Jennifer was very enthusiastic about visiting Cathy's classroom, but when the time came closer, Jennifer was the one who repeatedly initiated contact asking for guidance.

> I really was not sure how to do this. I wanted to give them kind of an overview but I am more used to giving lectures. Cathy said that's probably not going to go over very well with middle school kids, they would be bored. So, I decided to make a game out of it. So, I emailed Cathy and I wanted to know what kinds of rewards would be good and she just basically said "food." I don't think I could have done it without all of Cathy's suggestions.

Jennifer went to the classroom where she realized Cathy was the professional and she was a bit out of her league. She met with the researcher at the end of her day in the classroom to share her thoughts. Jennifer's initial impression of the school and the lack of security prompted her to notice that they were coming from different cultures. After the mandatory security checks at Lab B for all visitors, Jennifer was surprised that a school full of kids would have such lax security.

> When I came here this morning, it was strange. I walked past a couple of women standing in the hall. They could have been teachers, substitutes, or parents. But what was weird was that here I am, a stranger in a middle school. I had asked Cathy if I would need a badge or anything, is there a security check, do I have to come in a certain way, and she said, "No." So I walked right in to the middle school carrying huge bags of stuff with all my gear. I thought, "Whoa, what kind of security is this?" I could have had a bomb or something. And these women out in the hallway did not even greet me or ask, "Hi, what are you doing, who are you?" It's not like Lab B. It is a different culture.

Jennifer had two topics she wanted to cover – the history of energy and how we make renewable energy. She quickly discovered that she had too much material to cover in too little time. The first class she taught was chaotic to her because "everybody was raising their hand at once" and she did not know what to do. Cathy provided feedback after the first class that helped Jennifer better manage the classroom.

> To get the students' attention Cathy had suggested that Jennifer provide candy as a motivator. Jennifer thought the food did work as a motivator but she was not sure it was facilitating learning because they were focusing on the reward. But she was aware that it kept their attention and made it easier for her to ask questions and provide information.

Jennifer admitted that she was a bit intimidated by the size of the class.

> I am used to working with small groups of people and definitely not used to working with that many people at once and I noticed a lot of times I would focus on whoever was "up", for the game. I could focus on one person in the beginning or three or a team, a small group of people and try to interact with them. I don't really know how to deal with a huge group other than lecture. A nice oral presentation and everyone is quiet and then asks questions. But I think you have to be older for that to work and to sit for that length of time because a 20 or 30 minute lecture is too much for middle school kids.

Jennifer came away with a healthy respect for Cathy's job.

> There is a lot to being in a classroom. I could not imagine doing that every day and being responsible for making sure each kid is learning science or whatever. When the kids got out of control, Cathy would step in and help out. She made it look so easy.

Cathy and Jennifer stayed in touch socially throughout the school year. They visited each other's homes, went out for dinner together, and stayed in touch via email. In addition to the professional relationship, they had become friends. Cathy felt that Jennifer had fostered a working relationship that put them on equal footing. Cathy noted,

> Jennifer was a good teacher, she was an excellent mentor but Jennifer also was a friend by the end of the summer. We could just sit around in the lunch room. Jennifer brought wedding pictures and I brought fire fighting pictures and it was just that kind of thing. It was friends in addition to working.

When asked if she had any follow-up contact with her mentors since the summer, Patty said she had not but she would love to.

> I would love to. I just thought maybe I could give them a call and see if we could meet for lunch during the lab time (follow-on) but I haven't. But I would like to. But maybe I shouldn't disturb them.

Smitty made no attempt to contact any of the people at Lab B.

Summary of Teacher/Scientist Contact During the School Year

Cathy and Jennifer provided an ideal outcome of an intern/mentor program but one that was also unusual. Their experience was the only example in this research study where any follow-up contact occurred. They developed a relationship that was ongoing. It is unlikely that many teacher enhancement programs have outcomes like this nor should they be expected. Cathy and Jennifer represented a relationship that was probably outside the norm. In addition to their time spent together in Cathy's classroom, they became friends and got together socially. This friendship made them equals and it did not occur to Cathy that she might be bothering Jennifer or vice versa. Both women initiated contact. Cathy admitted to initiating more frequent contact while she was implementing the factorial design experiments because she needed Jennifer's guidance. And Jennifer felt that she made frequent contact with Cathy to get guidance for her time in the classroom with the students.

Patty did not have any contact with her mentors, although she indicated she would have like to but worried about disturbing them. Also, she had not made clear plans for her classroom transfer and did not see a clean fit for her Lab B mentors.

Classroom Impacts and Teacher Reflections

Central to most teacher development programs is the intent that a teacher's experience will transfer to the classroom. Cathy transferred a tremendous amount of her experience to the classroom including a sophisticated factorial experimental

design for use with her advanced students. Patty used her Lab B experience to a lesser extent in the classroom than Cathy, but believed that as a result of her time with the scientists, she better understood 'the scientific method.' She felt that she had more confidence and more experience to tap. Smitty made no attempt at classroom transfer. Cathy and Patty both felt that their time in Program B was well spent; Smitty continued to view it as a waste of his time.

During the 1996-97 school year, the researcher met with with Cathy, Smitty, and Patty in their classrooms, to see if they thought that their participation in Program B had any impact on their teaching. Cathy felt that her experience at Lab B made a difference in her teaching.

> I think there were probably a lot of little things that made a difference that I did without even being aware or making an intentional effort. Little things that got incorporated that just became routine. Jennifer came out to teach the kids. Experimental design was something that I did with my 8th graders, teaching them an alternative way to set up an experiment. The assessment part was probably the biggest thing because we did a school-wide pre performance for 7th and 8th grade and we will do a post performance assessment which will count as the kids final this year.

When asked if that was a direct result of participation in Program B, Cathy replied,

> Yeah, and I used a lot of their stuff, I changed it somewhat. I felt their rubric was too easy (laugh), mine is a little more intense, like I require the kids to do multiple trials. My kids also did the cars that we did. The veggie cars, the wind cars, and we just finished up the solar cars. And I think they really had fun in that. It was a competition and they had fun laughing at the veggie cars and the wind cars were cool. Solar cars were real hard for my kids cause it was my first year of doing it and I couldn't guide them as well as I would have liked in terms of gear ratios.

Cathy shared her overall reflections on Program B.

> I think it is good. I think Jim cares about what is being done. I don't think they just throw something together and says whatever. I think he listens to us. I think they try to put the best program together. It is pretty well organized. When I talked to Beth, she said there are something like 18 of us coming back this summer (1997). And that speaks for itself. If it were worthless, I don't think you would have

> that many returning. So the fact that there are 18 of us returning says that the program was valuable and that there was good stuff there that was worth us giving up three weeks of our summer.

Mid-way through the 1996-97 school year, Patty was asked if participating in Program B had changed her teaching in any way.

> So far I am teaching the same curriculum to date. But I am going to make some changes in the extension for it. We are starting to get into water now and then we are going to go into carbon dioxide a little more and I have some good ideas from the summer on extending that. And then that will take us into chemistry which is something that I needed to add to my curriculum and I have got a lot of good ideas on that from the summer workshop. And, I knew I had to work on the scientific method with the kids and this summer I saw that scientists really do use the scientific method. I knew I had to do it and this gives me a little more feedback on that, yes, it is important that we work on the scientific method. Even in 6th grade. So I have been kind of working on that a little more and of course will throughout the year.

Patty went on to explain that her participation was making a difference in the way she was teaching science even though she had not used the summer science content in her classroom. She was now giving her students more time to answer questions and was comfortable in telling them that she did not have all the answers.

Even during the school year, Smitty continued to complain about this summer.

> My feelings about the summer experience is that I didn't really enjoy it very much. I really did not bring back anything from the lab experience except the fact that I personally enjoyed it and it would help me possibly explaining some of the research that is going on in earth science. As I already said, I did not get a chance to use the equipment, I got a chance to observe, which I thought was very worthwhile, but not 10 days worth. So I thought my summer lab experience was very disappointing for me. As far as the classroom activities, I have to say, well first, I didn't expect that much classroom time. And I found it to be extremely boring. I really did not enjoy the classroom time. I found the classroom time extremely, extremely boring, in fact I was really suffering by the end. I really was.

Smitty did not indicate that he had any intention of using anything from Program B in his classroom. He did not think his experience was relevant to the classroom nor did he find the information from the afternoon sessions of interest to him. Smitty was in his last year of teaching and was angry with his school district's new retirement policy. He was routinely taking between two and three days each week of sick time since he had accrued many days of sick leave during his career. In addition, he had a student teacher who did much of Smitty's teaching. Smitty took pride in spending as little time as possible teaching his class his final year.

Summary of Classroom Impacts and Teacher Reflections

The classroom transfer was direct and significant for Cathy. She used much of what she learned and experienced from Program B in her teaching. Cathy was an enthusiastic teacher and one who was always looking for ways to improve her teaching. She was an innovative and creative teacher. The problems she encountered were not major. She noted that she had some problems with the solar cars because it was her first time doing that. Cathy was not afraid to jump in and try new things. Her willingness to explore new ideas and activities was not a result of her participation in Program B, but some of the new ideas and activities she tried were a direct result of her time in Program B. She thought the program was worthwhile and noted the high rate of return of teachers for the upcoming summer.

At the time the researcher spoke with Patty, she did not feel she had made any curriculum changes but she did think she was changing how she taught. Having spent time in the lab gave her the motivation to let the students take time to figure out things. She did not give answers as readily. She was a fairly new teacher learning the ropes. She felt her time at Lab B had given her a perspective she would not have had otherwise. Patty's time in Program B did have an impact on the way

she viewed and taught science. Like Cathy, Patty was an enthusiastic teacher and it was difficult to determine if her enthusiasm was increased as a result of participation in Program B.

Smitty made no attempt to transfer any of the Program B activities to his classroom. Smitty was an extreme situation. He was unhappy with his school and therefore, he pretty much quit teaching. He had his student teacher do most of the teaching and he was calling in sick several days a week in protest over the district's retirement plan. While at the lab, he made no attempt to develop a plan for classroom transfer. In every conversation, he noted his overall displeasure with the program. Smitty was done teaching before he even started his final year. It would have been interesting to see what he would have been like with a different Lab B research situation. But given his overall attitude, it is unlikely it would have made much of a difference. Interestingly, Smitty liked being part of the research. It could have been that he enjoyed having someone listen to his continual diatribes.

Scientists' Reflections of Program B

The scientists' thoughts on their time with the key informant teachers was in alignment with what the teachers thought of their time with the scientists. The week after the workshop ended, Kim distributed a questionnaire via email to all the mentor scientist. Patty's and Cathy's mentors enjoyed their time working with the teachers, while Smitty's mentor did not. The scientists who took the time to make the internship experience interesting had good experiences. Most of the scientists indicated they would participate again and would recommend the experience to others at Lab B if they clearly understood that Program B was a teaching opportunity, not a chance for gaining experienced help.

Shortly after Program B ended, Kim sent an email questionnaire to the Lab B mentors. The questionnaire asked for feedback on specific areas to "assist in strengthening Program B and modifying it to better benefit both you and the teacher participants." Five scientists responded. By happy coincidence for this research, three of the responding mentors had worked with Cathy, Patty, or Smitty.

When asked if the participation of the teachers was useful for her research, Jennifer replied

> The teachers I had this year were extremely useful to my research group. They each completed their own experiment, including an experimental write-up. The data they generated provided answers to questions that my team needed to continue its work and the reports are not part of the detoxification data base.

Jennifer believed that the teachers were adequately prepared to participate. Her main criteria was that they had an open mind and a willingness to learn. She felt that having the teachers every day for half a day worked very well for laboratory experiments. She summed up her time with the teachers by explaining what they had done.

> Their time in my lab included a class on Biosafety Levels, how to use pipetmen, laminar flow hoods, chemical fume hoods, shakers and autoclaves. We discussed the classification of microorganisms and possible classroom activities with microbes. They learned about and participated in fractional factorial experimental designs. They learned about the cellulose-to-ethanol process. They analyzed their experimental samples using HPLC, GC, and YSI instruments. They also learned how to use MS WORD and EXCEL programs to graph their data and write their reports. Although it may take awhile for these concepts to sink in, I think they were enriched by the experience. Their questions and fresh perspectives certainly enriched my summer and has made a lasting impression.

Jennifer said she would recommend the experience to other scientists at Lab B without hesitation.

George, one of Patty's mentors, also indicated that he would recommend the experience to others but with some reservations. "It must be made clear that this is a TEACHING opportunity. It will never be an opportunity to let some "free hands" loose in the lab for a couple of weeks. If a potential mentor doesn't have time to watch the teachers and interact with them for the complete time they are here, they absolutely should not volunteer to be a mentor."

He based his response on his experience with Patty and Dan. He noted that having the teachers was highly useful for his research because

> We were able to have a compound important to our research prepared for us. Because of the lack of experience of the teachers in this field, constant monitoring was required, but the interaction with the teachers and the opportunity to teach them about organic chemistry and synthesis was great. Both Mike and I were greatly impressed by the interest, enthusiasm, and drive exhibited by our participants.

George went on to note that the teachers were not really adequately prepared, through no fault of theirs, to participate. But he and Mike decided to take the time to teach Patty and Dan what they needed to know to assist in the experiments. He indicated that the teachers were able to carry out almost every activity involved in a modern organic synthesis lab, as long as their activities were monitored. George was glad he participated and both he and Mike would welcome additional contact with Patty and Dan and hoped he could visit their classrooms during the upcoming year. Overall, he thought the teachers had a good experience.

> Our intent was to expose them to laboratory experiences on a very basic level, and let them do a lot of hands-on work so that they could decide on their own what was most interesting to take back to their classes. They came in enthusiastic, and I believe they went out both enthusiastic and much better informed about the role of science and research.

The questionnaire responses from Smitty's mentor were completely different from Cathy or Patty's. Smitty was assigned to Dr. Smith's lab. Dr. Smith

was one of Lab B's most acclaimed scientists. When he had told Kim that he would like to participate, he had forgotten that he would be away for the entire month of June. This information was not communicated to Kim. When Smitty showed up on the first day, Dr. Smith was not there. The research associates in the lab were not expecting Smitty, although Robert did agree to be Smitty's mentor in the instrumentation lab.

During the workshop, the researcher had a brief meeting with Robert. He explained that he and the others in Dr. Smith's lab had only found out at the last minute that they would have a teacher assigned to them. He offered to mentor Smitty because he thought it would be a rewarding opportunity for them both. He had told the researcher that Smitty was angry from the start. He understood that it must have been uncomfortable for Smitty to come to a lab where no one was expecting him, but that he and several others on Dr. Smith's research team tried to make the experience interesting for Smitty. According to Robert, Smitty seemed to prefer hanging back and not getting involved.

After spending two weeks with Smitty, Robert noted on his questionnaire that he would not recommend the experience to other scientists at Lab B. In his situation, he felt having Smitty in the lab on a daily basis was not useful or instructive for either of them. He wrote,

> In this case, for this particular teacher, no new skills, very little understanding, and no change in the attitude of the teacher occurred. The attitude of the teacher prevented him from being a very good learner/student. This teacher was not open to suggestions and to investigation of links or possible links between the research in this lab and his classroom. For this mentor/intern experience to work, the teacher must come in with a positive attitude and be receptive. The teacher must fit into the lab process and not expect the lab to fit his/her needs. The teachers should realize the research lab is not a high school classroom or a teacher workshop facility.

Robert indicated he had no intention of having any future contact with Smitty.

Summary of Scientists' Reflections of Program B

Providing an avenue to solicit scientist input and feedback gave Kim important information for future teacher development workshops. It was clear that Jennifer and George enjoyed their time with the teachers and that they put time into making the experience worthwhile for the teachers. In addition, both noted that their own research benefited from having the teachers work with them. George made an excellent point when he noted that Lab B scientists must view their participation as a teaching opportunity and that it would take time and effort. He made it clear that the interaction was worth his time.

In sharp contrast to Jennifer and George's comments, Robert noted that he had a much less pleasant experience with Smitty. He did recognize that Smitty initially was unexpected which was probably unpleasant for Smitty, but that the research team tried to get him more involved.

Analysis of Program A and B Commonalities and Differences

At the outset, it appeared that Programs A and B had significant commonalties in their programmatic core characteristics. In early discussions with program administrators, it was clear that these two programs, as described, had many similar features at a basic level. Both were teacher enhancement programs with secure funding, preparing to begin the second of three years. Both programs intended to conduct three-week summer workshops for approximately 25 middle school science teachers focusing on enhancing science education and aligning classroom science instruction and assessment with the newly adopted state and district standards. Both programs intended to conduct five additional days for

follow-up contact and instruction during the subsequent academic year. Both programs had a stated intention of having scientists as key participants and allowing teachers ample opportunities to interact and work with the scientists for the purpose of enhancing the teachers' science content knowledge and enthusiasm for teaching science. New teachers made up the majority of participants, but both programs allowed teachers from the previous year to return.

From the initial meetings with the administrators, it was clear that the programs had different 'feels.' The programs had significant differences in the planned project designs. Program A followed a somewhat typical teacher professional development approach in that it was mostly in workshop format with presentations from subject matter experts. Program B was a hybrid – part of it was a teacher internship program where teachers worked with scientists in the laboratories and the remainder of the time was spent in a more traditional teacher development workshop.

Both programs held meetings prior to the summer implementation. Program A held several planning meetings each attended by a separate set of individuals, so there was little consistency from meeting to meeting. Phil was the only one who attended each of the planning meetings. Donna attended only the first one at CPS and Mel was present at the two meetings held at Lab A. The classroom teacher turn out at the meetings was minimal during the workshop planning.

It did not appear that much headway had been made in planning the Program A summer during the meetings. There was not a clear and shared vision for the workshop. Phil, Donna, and Mel seemed to be working independently of each other and not for a common goal. At times they seemed at odds with each other and the interpersonal conflicts impacted the effectiveness of the workshop. These key players did not have similar philosophies or expectations regarding the program. In

fact, they did not even seem to have similar views of the purpose for teacher enhancement programs or what role of scientists should play in scientist/teacher interactions. As the only person who attended all three meetings, Phil was in the best position to bring clarity and continuity to the planning meetings. However, he was generally quiet except at the final meeting at Lab A where he strongly noted his preference for having science content drive the workshops. H e was a minority voice in the group as the others, including Mel, did not agree that content should be the focus of the workshops.

Several months prior to the summer, Program B held a orientation meeting as the final follow-up meeting for the previous year's program. In attendance were the program administrators, approximately three-fourths of the previous year's teachers, and a handful of Lab B scientists. About half of the Lab B scientists were new to the program and the rest had participated as mentors the previous year. The purpose of this meeting was to ask the teachers to report on how they had used the previous year's information in their classroom and to provide a forum for Lab B scientists to ask teachers what type of laboratory experience was most useful from their perspective. This meeting was congenial, but could not be considered a planning meeting. The real planning had been conducted by the three administrators with Kim taking on most of the responsibility. Kim had reviewed the evaluations from the previous year in shaping the current year's program.

Program A did not have clear programmatic leadership while Program B did. In Program A, Donna was the leader from the CPS perspective and Phil was the leader from the Lab A perspective. Rather than coordinating and communicating one grand plan, it seemed that two different workshops were going on with Program A– one led by Donna and CPS and the other led by Phil and Lab A. And within Lab A, the leadership for the scientist involvement was also lacking. The scientists were free

to do as they wished without coordinating with the other scientists or other portions of the workshop. In fact, the scientists were largely uninformed as to the remainder of the workshop. There was little accountability evident in Program A.

Beth was the clear leader in Program B, however, she worked closely with Jim and Kim. The researcher did not have the opportunity to examine the initial planning for Program B because most of the real planning had taken place prior to the spring. Having Kim full time was instrumental in the attention to planning details. Beth was not involved in the planning process.

Program A did not have a list of program goals to guide the planning meetings. In general, the planning meetings were open-ended and unstructured. Mutually agreed upon outcomes were not a hallmark of Program A planning meetings. The researcher did not observe the planning of Program B, but in an early meeting with Kim, she was able to provide the researcher with a list of the program's goals.

The list of program goals that Kim shared with the researcher was the same list that was included in the teacher's notebooks and that Jim covered with the teachers on the first day of the Program B workshop. The goals for Program B were vague and far-reaching. Program A did not have a list of program goals for the teachers. During the first week, and largely due to the teachers' prompting, one of the associate directors told the teachers that the goal of the workshop was to have them be comfortable in implementing the new CPS science standards.

The administrators from both programs held their own expectations, that in large part, reflected their experience, background, and familiarity with middle school classroom science teaching. In Program A, Donna and Phil both spoke of the outputs expected of the teachers. Program A teachers were expected to put together a hands-on science or math project that their students could use. Each teacher was

to develop a written lesson plan that would be made available to the other teachers so they would each have a packet of lesson plans for classroom use based on science standards. Phil expected the lesson plans would reflect the science content from the time the teachers spent with Lab A scientists. Donna wanted the lesson plans to focus on standards. Mel wanted the Program A teachers to teach a little differently, but she also wanted the opportunity to improve her own teaching.

In Program B, Beth wanted to 'prove' that Lab B belonged in the K-12 education arena which can be a continual struggle in many federal and national laboratories where K-12 education is not always valued. She had vague expectations in regards to teacher changes but noted the national need for better prepared students in math and science. Kim and Jim both focused on the classroom teacher and both indicated that it was unlikely that earth-shattering changes would occur as a result of participating in Program B, but that they did hope the teachers would make some changes. Kim also hoped that the teachers would be comfortable using Lab B as a resource and contacting Lab B scientists when they had science questions.

Both programs expected outputs from the participating teachers. Teachers in Program A received a handout during the first week detailing the standards-based lesson plan they were expected to produce by the end of the workshop. The handout explained what was to be included in the lesson plan. The teachers were informed that they would be presenting their lesson plan to the other teachers and that they should have enough copies to distribute to each Program A teacher. In Program B, specific outcomes or expected outputs from the teachers were not covered in depth. Early on, the teachers were asked to take notes in their laboratory notebooks and were informed that they should be prepared to present their Lab B research experience to the other teachers. Mid-way through the workshop, the teachers were asked for documentation on how they planned to use

their Lab B experience in their classroom. No explicit instructions were provided as to format or content of the documentation leading to a lot of frustration and confusion on the part of the teachers.

Consistent with the lack of clear goals and differing program expectations, communication between the administrators was an apparent problem with Program A at the outset and with Program B during the implementation phase. By the end of the final planning meeting, Program A appeared disorganized and without a commonly held vision. Although professional and cordial, there appeared to be some tension between Phil and Mel. Donna did not appear to be interested in what was being planned at Lab A. The communication was poor between Donna, Phil, and Mel. Initially in Program B, the communication between the administrators appeared to be effective. But during the implementation phase, communication broke down. This was especially apparent in the expected output from teachers as they did not receive clear guidance from any of the administrators.

The advertisement for both programs did not give a true reflection of what was planned for the summer. Through word of mouth, Program A had indicated that the program was a workshop focusing on science and mathematics standards for lead teachers. Program B had excellent distribution for teacher recruitment, but the flyer suggested that the program would be a laboratory experience where the teachers would spend their time with scientists. No indication was given of the teacher development institute.

Both programs were targeted towards middle school science teachers. To advertise the Program A's summer workshop, Donna simply 'put the word out' to principals at targeted schools and relied on the principals to inform teachers of the opportunity. Program A did not have a formal application process; teachers could call if they were interested in participating. Program A did not have an organized

acceptance procedure. Some teachers discovered during the week proceeding the workshop that they had been accepted to Program A. No one was denied participation. In advertising Program B, Kim developed a combination flyer/application form and distributed it widely to nearby school districts and also advertised the workshop at the state science meeting and other appropriate venues. Program B had a formal application process that had a deadline two months prior to the summer workshop. Not all teachers in Program B were accepted. All Program B teachers were notified as to their acceptance two months prior to the summer workshop.

Although targeted to middle school audiences, both programs also accepted elementary and high school teachers. The range of grades taught was not as much of a problem in Program B as it was in Program A. Program A ended up with mostly elementary and high school teachers with only two or three middle school teachers participating. Science teachers were the minority in Program A. Most of the teachers were elementary teachers or those who taught in alternative schools. Only one teacher fit the middle school science teacher profile. Program B was dominated by middle school science teachers. Other grade levels were included, but these individuals were science teachers.

Program A was limited to teachers from one large, urban school district. Program B drew from six neighboring school districts and had teachers representing urban and suburban schools, with most teachers coming from suburban schools.

The teacher recruitment was much more effective in Program B. They did not take everyone who wanted to participate, rather, Kim took time to do a thoughtful selection process to ensure the success of Program B as much as possible. And, most of the teachers did teach middle school science. The selection was done

well in advance of the workshop and participating teachers were notified in a timely manner. The scientist/teacher match ups were also done long before the summer began. The scientists were given a brief biography of the teachers they would be working with. Conversely, by taking everyone, Program A ended up with a huge range of diversity in the teacher participants making it more difficult to make sure all of the teachers were getting the most out of their participation. The recruiting and selection was disorganized and until the last minute, no one knew who would be participants. This made it very difficult for the scientists to maximize the effectiveness of their time.

In Program A, the scientists were self-selecting. Bob had put the word out at Lab A via email and whoever replied was pressed into service. This method of communication worked well with Mel and her colleagues as they were very interested in K-12 science education. This was less effective with Emily and Steve. Kim had taken time in the recruitment of Program B scientists, and, this worked out in most cases. Two glaring weakness were the fact that the scientist Smitty was scheduled to work with was out of town and that the weed project has been misrepresented.

Both programs had workshops that were scheduled to run for three weeks in the summer and then have five or six follow-on days during the school year to support the summer workshops. Program A had the teachers come together for two weeks at the end of the school year and then meet again for a final week immediately prior to the start of the new school year. Program B met for three consecutive weeks in early summer. Program B scheduled five full day follow-on days. Program A scheduled six follow-on days with teachers meeting after school for several hours. The amount of scheduled time was very similar. Program A's summer schedule proved to be effective in having the teachers 'gear up' for the

school year. Donna liked this schedule because it was less likely the teachers would forget all they did earlier in the summer and more likely that they would actually use some of the information in the classroom.

Program A followed a traditional professional development model where teachers were given information from subject experts in a workshop format. Program B was a hybrid program. Part of the program involved teachers working with scientists in an intern/mentor format and the remainder of the program was a more traditional professional development model.

Both programs had pedagogical components that addressed topics of common interest such as standards and implementation, assessment, curriculum, and technology. Program A had standards implementation as a central tenet. Program B also included diversity. The pedagogical component, or teacher development institute, was not understood to be part of the program and was not well received in Program B. In Program A, the teachers did not have many pre-conceived ideas regarding the workshop, expect for the understanding that the workshop would address the districts new science (and mathematics) standards.

Both programs had the involvement of scientists as a cornerstone and the avenue to increase content knowledge. Program A had scientists in the role of leading presentations, a somewhat traditional approach to programs involving laboratory scientists. In Program B, the scientists served as mentors to the teachers in a research internship model. Both programs made an attempt to provide a forum for scientist preparation and/or orientation.

Program B had excellent classroom and work space for the teachers. During the first two weeks, Program A moved the teachers from small overcrowded classrooms to big auditoriums. The physical space was not conducive to working or formulating lesson plans. The last week was in a better location.

Teachers in both programs received a stipend of 60 dollars per day. Although the researcher did not have access to the budgets of either program, it appeared that Program B had more funds available through all aspects of the program. For example, Program B had discretionary funding available for providing some niceties for the teachers, e.g. personalized binders and laboratory notebooks, beverages each morning, catered lunch and breakfast for special occasions, and other snacks. Program A did not provide food or beverages or personalized notebooks.

During the sessions, the teachers in Program B were much more social than those all from the same school district in Program A. Program B did provide more social opportunities. In Program A, the teachers tended to stay in the groups they already knew. This was not the case in Program B because few of the teachers knew each other initially.

In Program B, returning teachers were given the responsibility of helping the new teachers navigate the Lab B culture and were referred to as lead teachers. Teachers in Program B were not expected to be change agents in their districts or schools. Teachers in Program A were expected to be 'lead' or 'master' teachers in standards implementation in their schools. This information had not been conveyed to them early on, and many resisted this role. Serving as a change agent had not been communicated during the recruitment process and, in general, was not well received.

Although both programs expected teachers to make changes in their classrooms, Program B did not have a clear method to do so. Program B teachers were told that they would be presenting what they did with their scientists to the other teachers. Although Beth wanted documentation of how Program B changed their classroom teaching, instructions as to what she wanted were not provided. As

the program progressed, it became clear that Beth was not certain exactly what she wanted making it near impossible for the teacher to fulfill her needs.

In Program A, specific directions were provided for the expected outcome. Teachers spent the time between the end of week two and the beginning of the final week later in the summer developing a lesson plan that included alignment to standards, assessment, and a hands-on activity. In Program A, the teachers did what was expected although there was no reference to the summer content. Overall, Donna was happy with the lesson plans. In Program B, the teacher presentations were mediocre and most did not explain how they would transfer the experience to the classroom. Both programs wanted teachers to provide handouts of their 'lesson plans.' This was never done in Program B. In Program A, the wide range of grade levels and subjects taught made sharing lesson plans ineffective.

Administrators in Program B encouraged the teachers to stay in touch with their mentor scientists. In Program A, continued contact was encouraged by the scientists (the contact between Jennifer and Cathy was unusual and probably not to be expected).

Neither program did any long-term follow-up to find out if they were making a difference in the classroom. Program B did have the teacher give self-reports at the follow-on days.

The internal evaluation of both projects was limited. In Program A, it was treated as an afterthought and the last-minute nature returned little useful information. The teachers did give overall positive comments and where they were expected to use a 1 to 10 scale with 10 being the most positive score, none of the responses were lower than an 8. Program B had a much more lengthy evaluation process. A large part was devoted to the pre-test that had been given prior to the

summer workshop. Most of the responses on the Likert-type scale indicated overall satisfaction with the program.

Most of the feedback on the evaluations focused on workshop structure and organization. It would be difficult to get more than intent in terms of what the teachers would do. Consistent with most participant satisfaction evaluations, the marks were high.

CHAPTER V
DISCUSSION AND CONCLUSIONS

Introduction

A full understanding of a program's goals, objectives, and expectations by all participants is of paramount importance in any educational enhancement effort but particularly so in those linking individuals from different institutional cultures (Sirotnik 1988). Most science education partnership programs are designed, developed, implemented, and managed by a relatively few administrators and then made available to a larger number of teacher participants. Because of the separation between those planning and administering such programs and those on the receiving end, it is imperative that communication be well established and effective at all levels and between all participants (Loucks-Horsley et al., 1998). The results of this research describe two science education partnerships involving classroom teachers and laboratory-based scientists and identify best practices that emerged from the study.

The determination of best practices in science education partnerships provided the framework for this research which clearly showed the underlying importance of the need for all participants to understand the goals and what is expected of them before the program gets underway. To be achievable, individual and programmatic expectations must be in alignment with the overall goals of a program. To be attainable, the goals must be understood by all and provide a framework for the expectations. Without a clear and shared vision of a programs direction, goals and expectations are not likely to be fulfilled. The common thread

for each of these components is communication and its importance during all stages of a program cannot be overstated.

Additional findings suggest a variety of areas that should be considered important in science education partnerships. Insight into effective classroom transfer, the role of lead teachers, the role of scientists and science content, and program evaluation were developed as a result of this study.

This chapter discusses the results already presented and provides interpretation of these results in light of the research literature. Limitations of this study are also discussed, but in light of the limitations, important implications of this research are outlined. The research results highlight various aspects of programs involving classroom teachers and scientists that must be adjusted if such programs are to maximize their effectiveness. This chapter also suggests avenues for further research that expands on the firm foundation established in the results of this research.

Interpretation and Discussion of Results

The results of this research highlight the need and recognition of the importance of basic and fundamental components of science education partnerships such as goals, vision, expectations, and communication. Additional results from the research provide insight into other important areas including classroom transfer, program evaluation, follow-on days, and the role of scientists. In setting out to study programs that were considered partnerships between scientists and teachers, a better understanding of what is representative of such partnerships took place.

From the literature review, a list of characteristics was compiled that appeared to be associated with effective educational partnerships (Atkin & Atkin,

1989; Dodge, 1993; Goodlad, 1988; Goodlad, 1993; Maeroff, 1983; Parkay, 1986; Reed, 1988; Seely, 1984).

1. Partners should be true equals and have representative voices in all phases of collaborative projects. Key players must be included in the early stages to encourage ownership of the project.
2. The expected outcomes of the partnership should be specific and realistic. Goals should not include broad claims of general, sweeping educational reform.
3. The needs and beliefs of all involved (both individually and institutionally) in the collaborative effort should be stated up front.
4. Collaborative inquiry should be an integral part of the partnership program.
5. It is important to have the support from the top-level of each institution (e.g. school administrator s, college deans).
6. The reward system must provide benefits for all.
7. The partnership should be flexible enough to accommodate changes and make adjustments where necessary.

While the above list was not based in research, it did provide a comparison for reference as the findings of the current study were being examined. In particular, the need for commonly held visions and goals and expectations by all participants was found to be true for this study. In this study, neither program was a true partnership and therefore those characteristics associated with true partnerships were not applicable. Collaborative inquiry did not play a role in either partnership in the study.

Goals/Vision/Expectations/Communication

Consistent with the literature review, a key finding of this study is the need for an explicit statement of a program's goals that all participants understand and are in agreement. Equally important is a clear vision of how the program intends to accomplish the stated goals with specific attention being given to what is expected of all participants making certain that all individuals fully understand what their

participation entails. Within the realm of expectations is the role that each individual assumes, including that of program leadership and accountability. Finally, avenues of communication between all participants must be open and honest feedback must be encouraged. All of these seemingly basic and straightforward components need to be addressed in the planning phase of the programs and communicated during all aspects of program implementation. Goals, visions, expectations, and communication are inextricably linked together and it is difficult to discuss one without intentionally or unintentionally addressing the others. In the literature, there were many examples where these topics were together with recognition that they could not thrive in isolation (e.g. Loucks-Horsley et al., 1998; Frechtling, 1997; Sirotnik, 1988; Williams, 1988; Kaser et al. 1999).

It is highly desirable to make certain all program participants are aware of and have bought into the goals and expected outcomes. While this seems to be so obvious as to overlook, it turned out to be a constant and irritating thorn in both Program A and B. Kaser et al. (1999), put it succinctly, " A quality program has a clear set of goals that are understood by participants, program staff, directors, sponsors, and communities. If representatives of all these groups were interviewed about the goals of the program, they would provide similar or equivalent responses. There is a consensus of what to expect from the program."

A clear and defined set of goals that guided elements of the program was not evident in either Program A or B. In Program A, Phil and Donna had different thoughts on the program's goals that reflected their own philosophies regarding teacher professional development. Phil wanted to increase science content knowledge and Donna wanted to prepare the teachers to implement the new district standards in their classrooms. These two goals were not at fundamental odds with

each other. But by not communicating, Phil and Donna were at odds with each other and their interpersonal conflicts resulted in many program inconsistencies.

In Program B, the three administrators also had varying views of the goals. The stated goals were overreaching and vague and did little to guide the actual program. Beth wanted to improve the scientific literacy of our nations' youth, but was not able to express a clear sense of how teacher participation in Program B would meet that goal. Jim and Kim interpreted Program B's goals with a more grounded view. Their background as classroom teachers influenced their assumption that the goals could be achieved but in much more modest increments than Beth indicated. For them, a primary goal of Program B was to get teachers thinking about classroom change and they believed, over time, that teachers would make changes in how and what they taught, but that huge, measurable changes were unlikely.

An understanding of the program goals by teachers and scientists in both programs was not evident. Teachers and scientists were excluded from any meaningful dialogue in the development of the goals for Programs A and B. This exclusion is counter to the determination of characteristics associated with successful science education programs where all participants have, at the minimum, an understanding of the program goals, and ideally a voice in shaping those goals (Pellicer & Anderson, 2001; Kaser, et al. 1999; Williams 1988).

In the development of goals is the need for a shared programmatic vision that is especially important in programs that link individuals from diverse institutions (Schlechty & Whitford, 1988). In this study, K-12 teachers were working with laboratory-based scientists – two distinct institutions with unique cultures and missions. In particular, it is critical that program leaders agree to and support an overall vision. By doing so, institutional differences can be put aside as the leaders

set the tone for cooperation and continuous interaction where they may relinquish short-term self interests for the long-term common vision.

A program's goals are strongly associated with expectations. It is important to note the differences and listen to and respect the different expectations of others. It is not necessary that all individuals have identical expectations; however, it is important that all individuals understand what is expected of them and how this contributes to the greater good of the program. By doing so early on, those with unaligned expectations can discuss them as not to subvert or compromise the integrity of the overall program (Kaser et al. 1999). In this study, by asking participants what they expected of the programs, the answers revealed different individual and programmatic expectations.

A glaring example of differing expectations was evident in Program B regarding the design of the program itself. Teachers new to the program expected to spend the entire time working in a laboratory setting with a scientist as mentor and did not have any advance knowledge of the afternoon teacher professional development institute. This caused for a large amount of confusion and frustration that could have been easily avoided if Program B had advertised itself to accurately reflect the summer program.

Beth's frustrations with Jim and her need for documentation from the teachers was indicative of her expectations that were not clearly explained to the others, especially to the teachers. She would likely have been much more satisfied with the documentation process if it had been discussed with the teachers from the outset. Ideally, she would have had a handout that would have guided the teachers through the documentation process.

Without a clear understanding of the program's goals and expectations, trust between the representative groups erodes resulting in a tension that is not

conducive to an effective program. Building trust is especially important in programs with different cultures working together (Williams, 1988). In Programs A and B, different cultures were working together but in many instances, without a sense of trust. In some cases, the participants were viewed in adversarial roles and were fighting with each other. Conflicts were compounded by the communication problems evident throughout the implementation of both programs. Open and effective communication between all participants could have mitigated the problems with differing goals, visions, and expectations.

Lack of communication is seen as an ongoing problem in programs with diverse cultures and representatives working together to improve K-12 science instruction (Loucks-Horsley et al., 1998; Kaser et al. 1999). The lack of communication was evident in both programs and there were ample examples of problems that could have been avoided with better communication. Problems in leadership and accountability in both programs were born of poor communication. With better communication, Mel would have been less frustrated had she known the make-up of her audience, the teachers in both programs could have had less confusion as to their roles and what was expected of them, Jim and Beth could have avoided issues that became personal, Donna and Phil could have made sure they both had goals and visions that were realistic and in sync with each other, and the scientists in both programs could have had a better understanding of the entirety of the programs. Effective communication could have altered the problems associated with differing goals, visions, and expectations. Because of poor communication and shifting expectations, neither program was as effective as it could have been given the resources available.

Classroom Transfer

Most administrators of teacher enhancement programs have lofty goals and objectives for their programs in terms of classroom transfer and Programs A and B were no exceptions. Increasing teachers' content knowledge and transferring the new knowledge to the classroom is a key part of teacher development programs. Indeed, classroom transfer would seem to be the central desired outcome of such programs. If all of a teacher's needs (content and pedagogy) were already being met, there would not be a need for K-12 teacher programs at national laboratories. The premise for scientist involvement is that they can increase teachers' content knowledge and let them experience the enterprise of science in action. And an often expected outcome is that the experience will transfer to the classroom (Frechtling & Katzenmeyer, 2001; Loucks-Horsley et al., 1998). However, there have been few studies that have been able to corroborate the actual implementation of changes in the classroom (Frechtling, 2001). In a thorough review of four decades of teacher enhancement programs, Frechtling et al. (1995) conclude that there is some evidence that teacher enhancement does extend to the classroom but they urge caution in this conclusion. The changes are unlikely to be of the magnitude or speed that project administrators desire. Beth wanted the Program B teachers to be able to 'document' the classroom changes before they even went back to school. Change takes time and is often made in small steps (Pugalee, et al. 2001).

The findings of this research are consistent with Frechtling et al. (1995) in that some changes reported by the teachers could be traced to their participation in Program A or B. Because the ultimate intent of science education partnerships designed to enhance teachers' knowledge in science and science teaching is to make a difference in the classroom, that can be used as a reference for success. Programs A and B wanted participating teachers to transfer their experiences to the classroom.

But to have this transfer take place in a consistent and meaningful manner, it is important that expectations be clearly stated and that a clear vision of classroom transfer is shared. It is important that the teachers and scientists have a voice in this discussion. And while all participants understood that some degree of classroom transfer was the point of both programs, the individual expectations did not necessarily reflect this understanding.

In Program A, Debra, Maria, and Thomas indicated that, to some degree, their participation in the summer program had transferred to the classroom. In Program B, Cathy and Patty reported that their participation in Program B had made a difference in their classroom. Smitty indicated that his participation in Program B did not make any difference in his classroom, but it can be argued that Smitty was a special case and had other issues in his life that clouded any potential classroom transfer. The degree of impact was not uniform or consistent. Both Cathy and Maria used content information and activities and also indicated that participation in their respective programs had helped them implement standards in their classroom. Cathy clearly stated that her experience at Lab B made a difference in her teaching. She believed that many of the changes were little and she did them without being aware or making an intentional effort.

Thomas noted that he did use his summer experience to help him organize his lesson plans in a standards-based format. In terms of attitude changes, Debra demonstrated the most radical change. She did not use any of the content, but did implement a standards based instruction and assessment and she also increased the amount of hands-on activities she used. Debra was unique in this study because she shared the results of Program A with other science teachers at her school. She also believed, consistent with Pugalees et al.'s (2001) findings, that she would continue to make changes in her teaching over time. Maria and Patty, both elementary school

teachers, reported more confidence in teaching science as a result of their participation in the summer programs. As evidenced, Maria noted that she was spending a marked increase in the time she was devoting to science instruction.

From this study, there was evidence that participation in Program A and B did make a difference in most of the key and secondary teachers' teaching. But given the resources available, so much more could have been accomplished. By making relatively minor changes in the implementation of the programs, better results could be expected.

Scientist Involvement and Science Content

Unique to this research was the inclusion of laboratory scientists as subjects. Because they directly and greatly impact the 'science' content delivery, only a partial understanding of science education partnerships would be gathered without including a very important group of contributors.

To better prepare for the summer, the scientists in both programs noted they wanted to know more about the participating teachers. Knowing the grade and the subject level taught of the teachers they would be interacting with was important. Mel expressed this frustration early on when she was initially told Program A was a middle school science program and she planned accordingly. In reality, it was a mix of subjects and grade ranges making it much more difficult for her to reach the audience at a level that would be useful for them. By not knowing their audience, Steve and Emily planned an inappropriate field trip for Program A teachers. The strenuous field trip was not physically realistic for many of the teachers, therefore, only the fit and motivated took part in this educational opportunity. The scientists in Program A, particularly Mel and her co-workers, wanted to make a contribution to K-12 education. Most of them had put forth time

and effort. To have their attempts be sub-optimal due to lack of communication was discouraging and Mel noted she would not be as interested in participating in future Lab A programs linking scientists and teachers if the lack of communication and cooperation was ongoing.

Kim communicated to the Lab B scientists information regarding their intern teachers in terms of subject taught, and science background. In most cases, her interaction with the scientists before, during, and after program implementation contributed to most of the scientists feeling that their involvement was worthwhile. And, in most cases, the teachers enjoyed their time with the Lab B scientists. Kim solicited feedback from the scientists at the end of the program. The feedback was useful in getting a full picture of the program and also for Kim to make changes in upcoming programs.

In program A, Phil strongly believed that the point of the program, and the involvement of scientists, was to increase the teachers' content knowledge and therefore, content should drive the workshop. Donna, and even Mel, a Lab A scientist, did not agree with the content focus. Bower (1994) found that workshops that focused primarily on increasing the level of science content knowledge for teachers were missing the mark. Indeed, he noted that an inordinate focus on content could actually reinforce a teacher's sense of inadequacy if they were already struggling with their own science content knowledge. Bower also stated that, when asked, teachers rarely noted lack of content knowledge as a barrier to effective science teaching. Instead they noted such things as classroom management, time, or lack of materials as real impediments to their science teaching.

Bower's findings are consistent with Jim's informal survey asking teachers to list the top 10 barriers to their classroom teaching. None of the teachers noted a lack of content knowledge. Yet, lack of content knowledge continues to be a

cornerstone of most programs that involve scientists and teachers. In Program B, science content did not drive the workshops. Although the overall focus was on research related to renewable energy, the teachers each had a different science content experience. In Program B, there was a greater focus to immerse the teachers in a research laboratory experience. Hays (1994) noted that teachers who experience scientific research change in important ways because science has now become something to do rather than something to read about. Hays went on to note that, as a result of their research experience, teachers were better prepared to teach the concepts and principles of science, mathematics, and technology. Hays was referring to a program where teachers spent eight weeks working in a laboratory with a science mentor. It may not be appropriate to assume that teachers in Program B had the same depth of experience by spending 10 mornings with a scientist.

With the exception of Cathy, teachers in this study were not as comfortable contacting the scientists even though continued contact had been strongly encouraged by either the scientists themselves (e.g. Mel, Emily, and Steve) or by program administrators (e.g., Jim and Kim). During the summer programs, many teachers enthusiastically indicated they would stay in touch with the scientists and would even be inviting the scientists to make classroom visits. Continued contact did not happen. The key barriers were lack of time and teachers not feeling comfortable, and even intimidated about making contact with the scientists. It is worth considering who has the responsibility for making contact in relationships that are unequal. As Mel noted, if the teachers were only mildly interested, she did not want to take the time from her busy schedule. But if the teachers were truly interested and the only reason they did not call was because they did not want to 'bother' the scientists, it may be desirable to set up an avenue for follow-up contact during the

school year. Clearly, Jennifer and Cathy established a personal relationship that made it easy for additional contact and classroom visits. In this study, it appeared that potential relationships were left unfulfilled. The barriers preventing these relationships could be removed.

In discussion, the scientists at Lab A expressed disappointment regarding the lack of feedback they received from the program administrators. Feedback on their performance is another form of communication and welcomed from their perspective. Not asking for information from the participating scientists was a missed opportunity for important feedback for the Program A directors. The scientists had a unique perspective and their comments could have been used for future workshop planning.

Lead Teachers

Many recent teacher development programs have had as an outcome, the development of 'lead' or 'master' teachers. This role has become more prevalent as large systemic initiatives gained favor that required teachers to serve as 'change agents' in their buildings or districts. Simply put, the lead teachers would participate in programs designed to change the way science was taught. The newly informed teachers would then carry the message back home and help institute the changes in their own buildings. Kaser et al. (1999) suggested that such teacher leadership is a hallmark of a quality teacher program. Little evidence could be found in the research-based literature that large scale systemic changes are made through the development of lead teachers alone. Frechtling et al. (1995) found that many teachers did share their professional development experience with others, but there is no discussion as to the extent of the sharing.

In Program A, unbeknownst to the teachers prior to the workshop, the teachers were expected to be lead teachers and serve as change agents in implementing CPS's new standards in the classroom. They were not provided with any leadership training or given clear support from their school administrators to assume such a role. Most of the teachers in Program A balked at being expected to assume this role and noted that they were not comfortable in being leaders in implementing standards. Despite her original concerns, at a school in-service day, Debra did share her new understanding of standards with other science teachers at her school. However, she also believed that every teacher in the district needed to attend a workshop similar to what Program A had offered if they were going to be able to make significant changes. It is not realistic to expect teachers' to be exposed to a new idea for a relatively short period of time and then carry the message forth for change.

In Program B, the lead teachers were those who had participated the previous year and were expected to help the new teachers acclimate to Lab B. They did not have any explicit responsibility for making changes in their schools. The lead teachers in Program B were mostly ineffective in fulfilling their expected role during the workshop. Discussions with the program administrators indicated that lead teachers would not be used in subsequent teacher programs.

Follow-on Days

A current trend in teacher development programs is continued contact with teachers during the school year. In the past, many teacher development programs were held only during the summer (Frechtling et al. 1995). It was determined that additional contact during the school year would provide additional support for the teachers as they implemented the new information gathered during the summer

(Kaser et al. 1999). Ideally, teacher development programs are not viewed as discrete events, but rather as on-going events that are part of a strategic plan to achieve the program's goals.

In this study, both programs planned to hold sessions during the school year and both referred to these sessions as follow-on days. Schedules of the follow-on days were shared with the teachers during the summer. In Program A, six follow-on days were planned, with only one actually taking place. Poor planning and communication in regards to the follow-on days underscored the poor communication that was evident throughout this program.

In Program B, the follow-on days were more structured, but there was not a common theme linking them. Each of the five days was loosely organized with a significant amount of time for teachers to simply share and interact with each other. Strong connections with the summer program were not evident. The follow-on days did provide opportunities for the teachers to support each other and share issues they were facing in the classroom, however, these were not necessarily tied to Program B. The teachers liked getting together, but did not find the follow-on days useful. The follow-on days may have had some value, but not of the magnitude envisioned by the administrators.

Kaser et al. (1999) suggested that quality teacher development programs have follow-on days to help achieve and enhance a program's goals. Programs A and B did not provide any evidence that the follow-on days contributed to their respective goals.

Program Evaluations

Most evaluations of science teacher enhancement programs are limited to exit surveys or questionnaires or follow-up questionnaires (Frechtling, 2001).

The focus of such questionnaires is generally on 'participant satisfaction' and usually gets high scores. In reviewing teacher enhancement programs over a 40 year period, Frechtling, et al. (1995) determined that results of such evaluations using a common Likert-type scale asking for feedback where responses are 1 (very dissatisfied) to 10 (very satisfied) had an average response of 9, indicating a high degree of participant satisfaction. They found little reported beyond the participant satisfaction level.

In their review, Frechtling and coworkers described the state of the art in evaluation of teacher professional development programs, documenting the paucity of strong studies. Their review indicated that as one moved from the least to the most demanding criteria for success, the number of evaluations dropped off dramatically. In addition, the vast majority of evaluations were based on teacher self-report and examined success immediately after participation in the event. Few used external measures of impact or provided follow-up on outcomes after the teachers had returned to their schools and classrooms. This practice has only recently begun to change, and studies that address broader outcome questions are, by and large, not completed.

Evaluations are generally designed to gain insight into various aspects of a program and to determine if the goals have been met. Frechtling et al. (1995) found that on-site evaluations are of limited use in understanding standing the full breadth and depth of such programs. They are particularly ineffective in determining if programs met the goals of classroom transfer.

Consistent with Frechtling et al.'s findings, this study came to the same conclusion regarding the limited insight provided by the on-site evaluations. The evaluation in Program A was vague and asked for the teachers' self-reports on what they liked or did not like. The overall positive statements are consistent with the

findings of Frechtling (2001). Donna believed getting the teachers to present and prepare lesson plans was a clear measure of effectiveness and success of the program and further evaluation was not needed. Program B had a more in-depth evaluation, but did not address actual changes in classroom teaching. It asked for the teachers to project changes they planned to make, but did not have any way to document if teachers followed through or not.

The on site evaluations can be useful in generating feedback on workshop structure and function, but not necessarily for getting feedback on classroom impacts which is the key intent of such programs. Program B did use some of the evaluation information from the previous year to improve or change portions of the workshop itself. And Kim noted she had read the current year's evaluations and would recommend that Beth use them for the next year's program.

It is informative to note that in most science education programs, only the teachers are asked to complete evaluations. Even the 40 years of science education programs that were reviewed by Frechtling and coworkers, there was no mention of how working with teachers impacted scientists, or how their involvement impacted the success of the program (if it did). Program B asked the scientists to provide feedback after the summer; Program A did not ask for any feedback from the scientists.

It is also informative to note that the administrators who want to know if the program 'works', appear loathe to include themselves in the evaluation component. Kim and Mel were probably the most willing to critically examine their roles in their respective programs. Donna did ask the Program A teachers to rate the associate directors on a scale of 1 (very dissatisfied) to 10 (very satisfied). Consistent with Frechtling et al.'s findings, the scores were very high and did not necessarily reflect comments the teachers had made during the summer workshop.

Miscellaneous Findings and Determinations

In addition to the findings discussed in detail above that were determined to be central to effective science education partnerships, other items came to light that should also be given consideration.

There did not appear to be any advantage to what type of workshop was held – i.e, having a traditional professional development workshop versus. a teacher internship experience in meeting program goals. It is important to consider the unique aspects of the supporting laboratory and its facilities in planning a science education partnership.

Workspace that is adequate to conduct the program or workshop should be identified. Rooms should be well-lit and well-ventilated. If the teachers will be spending significant time together as a group in a central room, it should be large enough to comfortably hold the teachers, administrators, guest speakers, and other guests. Workspace should be available for hands-on activities. During the first week, Program A did not have adequate space for the teachers to develop lesson plans or to engage in the development and exploration of hands-on activities.

If attendance is mandatory, an effective method to take role should be established. Also, required participation in special tours or events should be clearly communicated. Required attendance can be a sensitive issue if teachers are made to feel like less than responsible professionals. In programs where teachers receive daily stipends, it is not unreasonable to expect that they be present. Program administrators are fully aware that their programs can be audited and if stipends are being paid when teachers are not present, programs could be placed in jeopardy. Finally, to eliminate having participants come and go, beverages (hot and

cold) should be provided in the room where the workshop is held. This will down on people taking longer breaks as they go in search of coffee, water, etc.

Partnerships – What Does This Mean?

The over usage of the term partnership threatens to dilute its usefulness and meaning (Sirotnik, 1988). The term is used frequently in any pairing of teacher and outside entities (e.g. universities, businesses, national laboratories) in programs designed to improve educational practices. Spector et al. (1996) note that the term collaboration is also currently being used indiscriminately in the education reform movement.

The initial intent of this research was to investigate science education partnerships or collaborations. The intent was to identify and examine programs that linked laboratory-based scientists and pre-college science teachers for the purpose of improving educational practices in the K-12 classroom. From the literature review, the working definition of partnerships or collaborations referred to those educational programs that had mission or goal statements that suggested shared responsibility, commitment, and support from diverse institutions.

The letter soliciting institutional participation, sent to the 12 federal or national laboratories, specifically noted that the researcher was looking for such partnerships. Both Programs A and B presented themselves to the researcher as science education partnerships (from the literature review, a consistent criticism the researcher had was the lack of any real partnership characteristics attached to the programs reviewed). Almost immediately, it became obvious that Programs A and B were not partnerships in the true sense, i.e, shared development of goals, responsibilities, etc.

Both programs were run by the supporting institutions. In the case of Program A, leadership responsibility was shared by CPS and Lab A. In the case of Program B, Lab B was the sole leader. In neither program did the teacher participants have any input in the planning stages. The only teachers who had input in the planning stages were not participants. For example, in A, the teachers attending the planning meetings were there to provide feedback on what was already planned. Their presence had little impact on the direction of the program. In Program B, Kim and Jim were classroom teachers, but during the program implementation they served as administrators. If being true to the concept of a partnership, none of the participating teachers could be considered partners or collaborators. Both Programs A and B fit the model of programs that were 'working on' rather than 'working with' the teachers.

While Programs A and B did not represent a true or ideal partnership or collaboration, they are representative of what type of programs are available for science teachers when they interact with scientists (Loucks-Horsley, 1997; Frechtling & Katzenmeyer, 2001). In studies by these women and their co-workers, they reviewed many agency supported science education programs that were similar in format to Program A or B. And many of the programs described in the studies also considered themselves partnerships or collaborations.

Teachers did not question their roles in the programs. They appeared content to not take leadership roles in program implementation. Teachers did not seem particularly concerned with the imbalance of power and it may reflect the fact that they did not expect it. But it seemed that the unbalance in funds and voice made the needs of Lab B and the CPS administrations more important and less attention was given to the practitioners. This imbalance is a mistake as the teachers are the ones doing the implementation and making the changes.

The intent of a partnership where all participants have a voice or are equal, is probably not the norm in teacher enhancement or development programs. The programs in this study were representative of the types of programs that link laboratory scientists and classroom teachers and, therefore, do warrant investigation to determine best practices. In reality, partnerships or collaborations have limited definitions and must be expanded to also include other programs that advertise themselves as such.

Frechtling (2001) notes the use of the term 'teacher enhancement' is relatively new, but in general, the underlying goal of such programs are to 'improve, broaden, and deepen the disciplinary and pedagogical knowledge' of K-12 teachers in the public schools. They do not suggest such programs are true partnerships or collaborations, however, teacher enhancement programs are likely what will be found in bringing teachers and scientists together. After reviewing four decades of such programs, Frechling et al. (1995) suggested that teacher enhancement programs can be described in terms of their focus and their structure. Focus is used to describe the content (or what type of knowledge and skills are being taught). Arguments frequently arise around the recurring issue of how much weight to place on content (subject matter) versus process of instruction. In Program A, those from the educational side (Donna, associate teachers) and Mel disagreed with Phil who wanted the science content to drive the workshop. In most cases, when scientists are doing the planning, it is not unusual to find that science content is stressed. Afterall, scientific knowledge is what they bring to the table. Frecthling et al. (1995) found that the focus is usually defined by those offering the program, and if it is being organized at the laboratory level, content is likely to take center stage. Programs that stress content see the role of teacher enhancement programs as that of providing teachers with advanced knowledge in specific areas.

The programs in this study were representative of science education partnerships bringing together classroom teachers and laboratory based scientists.

Limitations of the Study

One of the strengths of the current study, the depth of data collected from all participant groups, necessitated the focus on only two programs. And within those programs, only a limited number of participants could be included. By focusing on only two programs, broad generalizations cannot be made. Limiting the study to two programs did allow for a manageable size for the researcher to capture a complete picture of key participants' experiences. In consideration of the results, therefore, it must be remembered that the results developed out of the experience of six teachers, six administrators, and four scientists from two teacher/scientist programs at two national laboratories.

The researcher did not approach this project without some preconceived notions of what such programs should look like. The fundamental design of this study involved the researcher in all stages of data collection and analysis thereby creating opportunities for researcher biases to influence the results. Before the study began, the researcher's background and biases were identified and acknowledged. To guard against researcher bias distorting the study, the researcher kept a record of her reflections during the study. Although the intent was to approach the research to find out "what was going on here," a literature review and the researcher's experience with scientist/teacher partnerships did influence to a certain degree the initial questions the researcher considered.

A clear limitation of this study was that it did not address classroom impact on students directly. It can be argued that classroom impact is the point of all

teacher enhancement/development programs. For this study, teacher self-reports were used to determine the extent of classroom impact. Neither program had any avenue to determine student impact. In this study, effectiveness was limited to those goals and objectives that could be observed, however, teacher self reports of classroom transfer were deemed to be of importance.

Implications

This research resulted in findings that can be used in planning and implementing future science education partnerships. What was learned can be thought of as best practices. Below is a list of best practices associated with partnerships between classroom teachers and laboratory scientists. Some of the initial points (e.g. goals, etc) may have generic use in any teacher development program and should certainly be considered during planning stages and prior to implementation.

Because the research did not allow for an in-depth examination of classroom impacts, which can be viewed as the ultimate determination of a program's effectiveness, for this study effectiveness was determined by those practices that appeared to be key in meeting those programs goals and objectives that were observable.

Best Practices Associated with Effective Science Education Partnerships

- Clearly stated goals
- Commonly held program vision (especially important for program leaders)

- Awareness of programmatic and individual expectations (including classroom transfer)
- Clear and open communication throughout every aspect of the program
- Clear program leadership and accountability
- Established criteria for participant selection (teachers and scientists)
- Planning process that considers input from all representative groups
- Orientations for participating scientists
- Evaluations that reflect program goals
- Work from the strengths of the supporting institution

Goals. It is important that goals be clear and cover the scope of the program. The goals should be attainable given the available resources, measurable, and understood by all participants. Program A did not provide participants with a list of goals and objectives. Program B did provide a list, but the list was vague and general and difficult to measure.

Vision. It is important the program leaders have similar visions of the programs' direction. Having a similar vision is especially important in programs linking institutions with different cultures and missions. Leaders of both Programs A and B did not have similar views of the programs' outcomes.

Expectations. Both individual and programmatic expectations need to be considered. From a programmatic perspective, leaders need to give thought to what is expected as outcomes. Individuals have different expectations, what do they expect to occur to consider their time well spent? What do they expect to get out of their participation?. It is important to determine and acknowledge individual

expectations. Expectations do not have to be identical but must align to the overall goals. Wildly divergent expectations can compromise the success of a program. As part of the expectations, it is desirable to make certain the program is accurately advertised so that those interested in participating have a clear sense of what they will be doing and what is expected of them. Teachers newly participating in Program A or B did not have a clear idea of what their participation entailed. This led to a great deal of confusion and unsettlement that could have been avoided.

Communication. Clear communication between leaders is essential. Communication is the key and needs to be open between all to engender a sense of trust and cooperation. It is dangerous to have any one person be a "keeper of information" that is not readily shared. The importance of communication cannot be overstated. The difficulties and barriers encountered in both Program A and B were directly tied to poor communication.

Leadership and Accountability – There needs to be established leadership that is understood and respected by all. If the program leadership involves more than one person, it is of critical importance that they communicate well with each other and the program participants. It is also desirable to have one person who oversees the details on a day-to-day basis. If the overseer is not the program leader, they need to have good communication established with the program leader. In Program A, there was never a clear indication of who was in charge. The day-to-day workshop implementation was carried out by a team of associate directors, but the real decisions were made by the directors. Program B had a clearer sense of who was in charge of the overall program.

Participant Selection. The target audience needs to be clearly defined. The participant selection (teachers and scientists) process should not be taken lightly. Careful attention to participant selection helps to ensure a more effective program. A formal application process and early notification needs to be included as in Program B. It is useful to have a formal application process and a deadline (the application deadline does not have to be inflexible).

Planning Process. The planning process must allow input from all representative groups. Teachers need to be involved in the planning process. The planning meetings provide the opportunity for all stakeholders in teacher/scientist programs to be represented and fully heard. In bringing together individuals from different institutional cultures, it is important that all be clear regarding assumptions, beliefs, goals, and expectations. There should also be a forum throughout the program to make sure that the program is progressing as planned. Although Program A held a series of planning meetings, there was little carry over and very participant continuity.

Scientist Orientation. It is important that the scientists be prepared to work with teachers. An orientation run by scientists who have previously worked with teachers helps new scientists understand the target audience. In choosing scientists, their motivation for participation needs to be determined. In both programs, the scientists were genuinely interested and engaged but could have benefited from an orientation.

Evaluations. An evaluation process that determines if goals have been met is essential. Programs need to gather feedback from all representative groups. It is

important to have a long-term evaluation plan that is designed to determine if classroom transfer is occurring, and if not, what the barriers are. In Program A, there was no significant program evaluation. In Program B, there was a formalized evaluation, but it did not adequately address classroom impacts.

Follow-up and Additional Contact - If a desired outcome is to have continued contact, it may be that the scientists need to check with those teachers who appear interested but are worried about 'bothering' the scientists. It may be important for scientists to do follow-up as the teachers are generally intimidated about contacting them. Scientists who want to make themselves available to teachers should do so. Scientists should plan on taking the first step in making contact. In both Programs A and B, the scientists indicated a willingness to have continued contact – avenues should be explored to capitalize on that willingness.

Work From the Strengths of the Laboratory - Topics (e.g. diversity, technology) that are not really addressed during the program should be eliminated. It is not necessary to include all aspects just because they are topics du jour and sound good just because they are supposed to be addressed in teacher education programs. In the case of research laboratories, they should work from their strengths and not address topics outside their area of expertise. Each laboratory should critically examine their own unique contribution that can be made in science education. In both Programs A and B, the science content was clearly tied to the research mission of the laboratory, drawing on the scientific strengths of each. Program B spent a great deal of time and effort addressing topics that many teachers felt were already adequately covered in their districts (e.g. diversity, assessment).

Consideration of the factors discussed above are not a guarantee of an effective program. But the chances of having a good program are higher if these best practices are considered. An encouraging aspect of this research is that the factors identified can be readily changed and/or adjusted in programs that involve teachers and scientists.

Recommendations for Future Research

This study provided an in-depth examination of partnerships between laboratory scientists and science teachers the extent of which could not be found in the literature. The study highlighted the need for changes to be made in such partnerships to increase their effectiveness and also resulted in a list of best practices to be considered in planning future partnerships. However, the study was limited to two programs at two laboratories. For a fuller understanding of best practices between laboratory based scientists and science teachers, additional research at all points of such programs is needed. It would be useful, through additional in-depth studies of such programs, to determine if the findings are similar to this study.

The list of best practices delineated in this research provides a starting point for future studies. A systematic study of the best practices list generated through this research would be useful though additional case studies of programs that link classroom teachers and laboratory scientists. The list generated through this research was based on one summer and the subsequent academic year. Because many teacher enhancement programs are multi-year in length, it would be desirable to conduct a systematic study of best practices over the course of several years.

Because the generally desired outcome of programs designed to enhance teachers' knowledge is through some form of classroom transfer, more research in this area is needed. This study did not include an in-depth exploration of classroom transfer. By learning more about effective practices that allow for classroom transfer, future programs can focus on enhancing those aspects of scientist/teacher programs.

Most programs developed at national and federal laboratories focus on the perceived needs of teachers. While most science education programs reflect the science content of the laboratory mission, it would be informative to better understand what teachers need and want from such programs.

The concept of lead or master teachers continues to be characteristic of many teacher development programs. To better understand if scientist teacher partnership programs are effective in developing lead teachers, additional research is needed.

A more rigorous look at the leadership teams in science education partnerships is needed to determine what skills mix and professional backgrounds best meet the needs of such programs. In particular, is it effective to have a team member with adult education training, such as found in many human resource departments? What role should classroom teachers and scientists play on leadership teams?

Further research in all aspects of programs linking scientists and classroom teachers is needed to increase the effectiveness of such programs. Given the huge commitment of dollars and time to such programs, research that better instructs and informs both planners and participants will increase the effectiveness of future programs linking laboratory-based scientists and classroom science teachers.

REFERENCES

Anderson, N.D. (1993). SCI-LINK: An innovative project linking research scientists and science teachers. *Journal of Science Teacher Education*, 4(2),44-50.

Atkin, J.M., & Atkin, A. (1989). *Improving science through local alliances.* Santa Cruz, CA: Network Publications.

Auger, F.K., & Odell, S.J. (1992). Three school-university partnerships for teacher development. *Journal of Teacher Education*, 43(4), 262-268.

Bennett, R.V., Ishler, M.F., & O'Loughlin, M. (1992). Effective collaboration in teacher education. *Action in Teacher Education*, 14(1), 52-56.

Bogdan, R.C., & Biklen, S.K. (1992). *Qualitative research for education: An introduction to theory and methods.* Boston, MA: Allyn and Bacon, Inc.

Borg, W.R., & Gall, M.D. (1989). *Educational research: An introduction.* White Plains, NY: Longman.

Bowers, J. (1994). Scientists and science education reform: Myths, methods, and madness. In Sigma Xi Forum Proceedings, *Scientists, educators, and National Standards: Action at the local level.* Research Triangle Park, NC: Edwards Brothers, Inc.

Bybee, R. D. (1997). *Achieving Scientific Literacy: From purposes to practices.* Portsmouth, NH: Heinemann.

Clark, R.W. (1988). School-university relationships: An interpretive review. In K.A. Sirotnik & J.I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

Daly, W.T., & Jassel, L. (1985). Continuous content updating: The Stockton connection. In W.T. Daly (Ed.), *College-school collaboration: Appraising the major approaches.* San Francisco, CA: Jossey-Bass Publishers.

DeBoer, G.E. (1991). *A history of ideas in science education.* New York, NY: Teachers College Press.

Dodge, B.J. (1993). *School-university partnerships and educational technology.* Syracuse, NY: Syracuse University, School of Education. (ED 358 840).

Erickson, F. (1986). Qualitative methods in research on teaching. In M.C. Wittrock (Ed.), *Handbook of research on teaching.* New York, NY: Macmillan.

Flick, L.B., Lederman N.G., & Lambert, E.A. (1996). Enhancing the value of business and education partnerships: Setting and meeting higher science education standards. In J. Rhoton & P. Bowers (Eds.), *Issues in Science Education.* Arlington, VA: National Science Teachers Association.

FCCSET (Federal Coordinating Council on Science, Education and Technology) Committee of Education and Human Resources. (1992). *By the year 2000: First in the world.* Washington, DC.

Frechtling, J. (2001). What evaluation tells us about professional development programs in mathematics and science. In C.R. Nesbit, J.D. Wallace, D.K. Pugalee, A-C. Miller, & W.J. DiBiase (Eds.), *Developing teacher leaders: Professional development in science and mathematics.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Frechtling, J. (1997). Best practice in action: Final report of the multi-agency study of teacher enhancement programs. Arlington, VA: National Science Foundation.

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-C. Miller, & W.J. DiBiase (Eds.), *Developing teacher leaders: Professional development in science and mathematics.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Frechtling, J. A., Sharp, L., Carey, & N., Vaden-Kiernan, N. (1995). *Teacher enhancement programs: A perspective on the last four decades.* Washington, DC: National Science Foundation.

Gilmer, P.J., & Davis, N. T. (1995). *Teachers' Experiences in Scientific Research: Effects on Beliefs and Practices.* Paper presented at the Annual Conference of the Association of Educators of Teachers of Science, Charleston, WV.

Glesne, C. & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction.* White Plains, NY: Longman Publishing Group.

Goodlad, J.I. (1993). School-university partnerships and partner schools. *Educational Policy*, 7(1), 24-39.

Goodlad, J. I. (1988). School-university partnerships for educational renewal: Rationale and concepts. In K.A. Sirotnik & J.I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

Gottfried, S.S., Brown, C.W., Markovits, P.S., & Changar, J.B. (1993). Scientific work experience programs for science teachers: A focus on research-related internships. In P. Rubba (Ed.), *Association for the education of teachers in science (AETS) 1992 yearbook: Exemplary programs in science teacher development.* ERIC Documentation Service.

Hays, I. (1994). An attractive remedy: Mathcing Scientists with Teachers. In Sigma Xi Forum Proceedings, *Scientists, educators, and National Standards: Action at the local level.* Research Triangle Park, NC: Edwards Brothers, Inc.

Hutchinson, S.A. (1986). Education and grounded theory. *Journal of Thought*, 21(3), 50-68.

Jacullo-Noto, J. (1992). An urban schools/liberal arts college partnership for teacher development. *Journal of Teacher Education*, 43(4), 278-282.

Jones, R.V. (1993). *University-school partnerships: An organizational evaluation.* Paper presented at the Partners in Education: Practical Solutions through Partnerships Conference, Park City, UT.

Kaser, J.S., Bourexis, P.S., Loucks-Horsely, S, & Raizen, S.A. (1999). Enhancing program quality in science and mathematics. Thousand Oaks, CA: Corwin Press.

Klopfer, L.E., & Champagne, A.B. (1990). Ghosts of crisis past. *Science Education*, 74(2), 133-154.

Knight, S.L., Wiseman, D., & Smith, C.W. (1992). The reflectivity-activity dilemma in school-university partnerships. *Journal of Teacher Education*, 43(4), 269-277.

Kreuzer, H.W., Woodworth, D.L., & Kreuzer, K.N. (1994). *A research partnership between university scientists, high school teachers, and students.* Paper presented at the Sigma XI Education Forum Conference, Atlanta, GA.

Lasley, T.J., Matczynski, T.J., & Williams, J.A. (1992). Collaborative and noncollaborative partnership structures in teacher education. *Journal of Teacher Education*, 43(4), 257-261.

LeCompte, M.D., & Preissle, J. (1993). *Ethnography and qualitative design in educational research.* San Diego, CA: Academic Press, Inc.

Loucks_Horsely, S. (1997). Teacher change, staff development, and systemic change: Reflections from the eye of a paradigm shift. In S.N. Friel & G.W. Bright (Eds.), *Reflection our work: NSF teacher enhancement in mathematics K-6* (pp. 133-149). Lanham, MD: University Press of America.

Loucks-Horsley, S., Hewson, P.W., Love, H., & Stiles, K.E. (1998). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press, Inc.

Maeroff, G.I. (1983). *School and college partnerships in education.* Princeton, NJ: Princeton University Press.

Merriam, S.B. (1988). *Case study research in education: A qualitative approach.* San Francisco, CA: Jossey-Bass Publishers.

National Commission on Excellence in Education. (1983). *A nation at risk.* Washington, DC.

National Research Council (1996). *National science education standards.* Washington, DC: National Academy Press.

Parkay, F.W. (1986). A school/university partnership that foster inquiry-oriented staff development. *Phi Delta Kappan*, 67(6), 386-398.

Pellicer, L.O., & Anderson, L.W. (2001). Teacher leadership: A promising paradigm for improving instruction in science and mathematics. In C.R. Nesbit, J.D. Wallace, D.K. Pugalee, A-C. Miller, & W.J. DiBiase (Eds.), *Developing teacher leaders: Professional development in science and mathematics.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Peshkin, A. (1993). The goodness of qualitative research. *Educational Researcher*, 22(2), 23-29.

Podeschi, R., & Hackbarth, D. (1986). The cries for excellence: Echoes from the past. *The Educational Forum*, 50(4), 419-432.

Pugalee, D.K., Frykholm, J., & Shaka, F. (2001). Diversity, technology, and policy: key considerations in the development of teacher leadership. In C.R. Nesbit, J.D. Wallace, D.K. Pugalee, A-C. Miller, & W.J. DiBiase (Eds.), *Developing teacher leaders: Professional development in science and mathematics.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Punch, M. (1986). *The politics and ethics of fieldwork.* London, England: Sage Publications, Ltd.

Reed, P. (1988). *School/university collaboration.* Paper presented at the annual meeting of the Association of Teacher Educators. San Diego.

Schlechty, P.C., & Whitford, B.L. (1988). Shared problems and shared vision: Organic collaboration. In K.A. Sirotnik & J.I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

Seely, D. S. (1984). Educational partnership and the dilemmas of school reform. *Phi Delta Kappan*, 65(6), 383-388.

Sirotnik, K. A. (1988). The meaning and conduct of inquiry in school-university partnerships. In K.A. Sirotnik & J.I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

Sirotnik, K.A., & Goodlad, J.I. (1988). *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

Smith, M. L., & Glass, G.V. (1987). *Research and evaluation in education and the social sciences.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Smith, S.D. (1992). Professional partnerships and educational change: Effective collaboration over time. *Journal of Teacher Education*, 43(4), 243-256.

Spector, B. S., Strong, P. N., & King, J.R. (1996). Collaboration: What does it mean? In J. Rhoton & P. Bowers (Eds.), *Issues in Science Education.* Arlington, VA: National Science Teachers Association.

Sussman, A. (1993). *Science education partnerships: Manual for scientists and k-12 teachers.* San Francisco, CA: University of California.

Teitel, L. (1993). The state role in jump-starting school/university collaboration: A case study. *Educational Policy*, 7(1), 74-95.

Tucker, J.L. (1991). Global education partnerships between schools and universities. In K.A. Tye (Ed.), *Global Education.* Alexandria, VA: Association for Supervision and Curriculum Development.

Vierra, A., & Pollock, J. (1992). *Reading educational research.* Scottsdale, AZ: Gorsuch Scarisbrick, Publishers.

Vivian, J.R. (1985). Empowering teachers as colleagues: The Yale-New Haven Teachers Institute. In W.T. Daly (Ed.), *College-school collaboration: Appraising the major approaches.* San Francisco, CA: Jossey-Bass Publishers.

Williams, D.D. (1988). The Brigham Young University-public school partnership. In K.A. Sirotnik & J.I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns.* New York, NY: Teachers College Press.

APPENDICES

APPENDIX A

Federal Agencies in the Denver-Boulder Area

Bureau of Land Management
2850 Youngfield Street
Lakewood, CO 80215
Contact: Robert H. Robinson 239-3642

Bureau of Mines
Intermountain Field Operations Center
Bldg. 20, Denver Federal Center
Lakewood, CO 80225
Contact: Trudy A. Meyer 236-0428

U.S. Department of Energy
Rocky Flats Environmental Technology Site
PO Box 464
Golden, CO 80402-0464
Contact: Pat Randolff 966-3529

National Center for Atmospheric Research
PO Box 3000
Boulder, CO 80307-3000
Contact: Carol Fox McLaren 497-8109

National Geophysical Data Center
3100 Marine Ave.
Boulder, CO
Contact: John Kinemann 497-6900

Nation Institute of Standards and Technology
325 Broadway
Boulder, CO 80303
Contact: David Lee 497-7674

National Park Service - Rocky Mountain Regional Office
12795 W. Alameda Parkway
PO Box 25287
Lakewood, CO 80225
Contact: Robert Schiller 969-2652

APPENDIX A (Continued)

National Oceanic and Atmospheric Administration
325 Broadway
Boulder, CO 80303
Contact: Barbara McGehan 497-6224

U.S. Environmental Protection Agency
999 18th Street Suite 500
Denver, CO 80202
Contact: Cece Forget 312-6672

U.S. Geological Survey
Denver Federal Center
Lakewood, CO 80225
Contact: Barbara J. Ryan 236-5952

U.S. Fish and Wildlife Service
Denver Federal Center
Lakewood, CO 80228
Contact: Alan R. Fisher 236-8217

U.S. Forest Service
Rocky Mountain Region
11177 West 8th Avenue
Lakewood, CO 80225
Contact: Timothy E. Clark 275-5370

APPENDIX B

Research Letter - Program Administrators

Dear,

As the program administrator for a pre-college science education project at a federal laboratory, you may be interested in a research study that will begin this summer. I am a doctoral student in the Department of Science and Math Education at Oregon State University. In order to learn more about pre-college science education partnerships, I am conducting research that will attempt to document the experiences of the participants in partnerships between research scientists at federal research facilities and pre-college classroom science teachers. Specifically, the purpose of this research is to gain insight as to what are the best practices found in successful collaborations between scientists and pre-college science teachers.

I need at least two partnerships from different agencies in the Denver-Boulder Metropolitan area to participate in this study. Representatives of all constituent groups (i.e. teachers, scientists, program management) are needed for this study. Involvement from those in your program would be needed during the summer of 1996 and the 1996-97 academic year. I would need the names and addresses of the scientists and teachers participating in your program prior to the implementation of your program to determine their willingness to volunteer for this study.

The nature of this study is intended to be as unobtrusive as possible. Care will be taken not to impact your program in any way. I would like to be able to observe your science education partnership in action and be available for informal conversations. In addition, I would like to audio-tape interviews with selected individuals and also ask them to provide weekly journals documenting their experiences during the course of the partnership. Fieldnotes, interviews, and any comments made to me will be kept in strict confidence. Pseudonyms will be used for (insert agency name here) and all subjects when reporting any of the results of this research.

The benefit to (insert agency name) is the opportunity to have direct access to the results of research in an area that is central to the education efforts at (insert agency name here).

I will call you next week to determine your willingness to have your science education program participate in this study. In the meantime, if you have any questions, I can be reached at (303) 665-0767.

Sincerely,

APPENDIX C

Informed Consent Form

The research study is attempting to describe the experiences of individuals participating in pre-college science education partnerships that include scientists at a national research laboratory and classroom science teachers. The research will provide answers to such questions as, What are the practices associated with effective collaborations? What motivates individuals to participate in science education partnerships? Do the participants share a common vision for the outcome(s) of the partnership? Through the development of a thorough understanding of the interaction between laboratory-based scientists and classroom teachers, this research will provide valuable information needed to develop templates of best practices that can be exported to similar laboratory-based projects elsewhere. This research will enhance the efforts of future partnerships between national research laboratories and classroom science teachers.

Participation will be during the summer sessions of 1996 and for the 1996-97 academic year. Each participant will be asked to participate in up to three audio-taped interviews at different points in the study. The researcher will be observing the activities of the partnership on a regular basis and will be available for informal conversation throughout the period of study. Participants will be asked to communicate with the researcher on a regular basis either through electronic mail or journal entries. In addition, the researcher may contact each participant through a combination of personal visits, phone calls, or electronic mail and ask for responses to specific areas of interest or topics that have arisen in previous correspondence. Discussion with the researcher will provide an opportunity for participants to engage in discussion with someone who is also interested in improving partnerships between scientists and pre-college science teachers.

The researcher will be the only person with access to all data collected (interview tapes, transcriptions, electronic mail files, and field notes). Interview tapes and original field notes will be stored in a locked file cabinet in the researcher's office. Transcriptions from interview tapes and field notes will be transferred to a password protected diskette that will be stored in a locked file cabinet in the researcher's office. Electronic mail will be accessed at least twice daily with files transferred to a password protected diskette stored in a locked file cabinet in the researcher's office. Pseudonyms will be used for all subjects, the research facility, the schools and school districts when reporting any of the results of this research.

Participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled. The subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Questions about the research, personal rights, or research-related injuries should be directed to: Dr. Norman G. Lederman at (541) 737-1819.

APPENDIX D

Overview of Programs A and B

Program A

- Partnership between a single, urban school district and a research laboratory

  30 miles away (Lab A)
  Research Focus: Atmospheric and solar science
- Three weeks during summer (2 weeks in June and 1 week in August)
- Six follow- on days scheduled
- 'Traditional" workshop format - scientist participation via lectures, activities, and field trips
- No formal recruitment process - of the 24 teachers, only one fit the targeted audience (middle school science)
- No clear program goals
- Clearly communicated that teachers were expected to develop a standards-based lesson plan to share with other teachers
- Portions of the workshop were held in substandard facilities
- No formal evaluation

Program B

- Partnership between individual teachers from six nearby school districts and a centrally located research laboratory (Lab B)
  Research Focus: Renewable and alternative energy development and application
- Three weeks during summer (consecutively in June/early July)
- Five follow-on days scheduled
- Dual format-
  Research internship - scientist/teacher
  Teacher development institute - pedagogy
- Formal application process - of the 28 teachers, most fit the targeted audience (middle school science)
- Goals discussed early
- No clear guidelines as to teacher output
- Optimal physical facilities
- Formal evaluation

APPENDIX E

Letter to Teachers

Dear,

You have been identified as a participant in the Program B summer teacher program. As you know, a key element in Program B is the joining of classroom teachers and laboratory scientists. As a participant in Program B, you are in a program that has the potential to make a significant impact on future partnerships between scientists and classroom teachers.

I am a doctoral student in the Department of Science and Mathematics Education at Oregon State University. In order to learn more about K-12 science education partnerships, the research I will be conducting will attempt to document your experiences as a participant in a partnership between national laboratory scientists and K-12 teachers. The point of the research is to determine if the goals and objectives of partnership programs have been met and if so, what practices seem to contribute to the success, and if not, what can be identified as barriers to success. The data generated through this research may prove useful in capturing a more complete understanding of partnerships between K-12 teachers and research scientists.

Representatives of all constituent groups (i.e. teachers, scientists, program administrators) are needed for this study. I need only a few representatives from each group and will choose randomly from those willing to participate. If you do agree to participate, your involvement would be for the time you are involved in the partnership this summer (1996) and during the 1996-97 academic year. Your involvement will include at least one (and up to three) 30 minute taped interviews. In addition, you will be asked to engage in regular correspondence with the researcher during the summer and following academic year. Correspondence can take the form of electronic mail or journal exchanges. Comments to me will be kept strictly confidential and participants will, of course, remain anonymous as this research is reported. Pseudonyms will be used for all institutions involved and all subjects when reporting any of the results of this research.

Your participation is voluntary, refusal to participate will involve no penalty or loss of benefits. Please contact me with any questions you may have. I can be reached at:

Sandra Henderson
182 West Elm Street
Louisville, CO 80027
(303) 665-0767
e-mail sandrah@meeker.ucar.edu

If you are interested in participating, please return the enclosed, postage-paid card. Be sure to include a way that I can contact you. Thank you for considering involvement in this research project.