The Effects of Teacher Efficacy, School Climate, and Stages of Concern on the Implementation of a Physical Science Program.

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THE EFFECTS OF TEACHER EFFICACY, SCHOOL CLIMATE,
AND STAGES OF CONCERN ON THE IMPLEMENTATION
OF A PHYSICAL SCIENCE PROGRAM

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Administrative and Foundational Services

by

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M.Ed., Southeastern Louisiana University, 1979
May, 1995
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This dissertation is dedicated to the three men who fill my life with humor and love. First, I am grateful to my sons, Ben and Bret Thompson, for encouraging me when I was discouraged and for understanding when tuition fees came before athletic shoes. Many thanks are also extended to my best friend, David Duplessis, for his infinite patience throughout this process and the midnight cruises on Lake Maurepas that restored me.

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This study investigated the implementation of a physical science education innovation in a large, urban school system. The program began in the summer of 1993 with the selection of two teachers from each of seventeen elementary schools. Participants were selected by program staff from among a pool of applicants with an interest in science education.

The goals of the program included retraining teachers to implement hands-on, inquiry-based physical science and performance-based assessments. Teachers were provided with instructional materials, including science kits, and ongoing support and assistance from science and assessment specialists.

Specifically, the study examined the relationship between the independent variables, teacher efficacy, school climate, and stages of concern and the dependent variable, implementation, using three statistical procedures. First, pre- and post-test scores were compared to determine if teachers' concerns about the innovation differed over the course of the first year of implementation. Second, a correlation matrix was computed to examine the relationship between all variables included in the study. Finally, the independent variables were used as predictors of implementation variation in a multiple regression analysis.
The results of the analyses indicate that teachers' concerns about the innovation did shift in the predicted direction. Statistically significant relationships were found between the independent variables teacher efficacy and stages of concern, as well as efficacy and teacher ethnicity. The predictive value of the independent variables used in the regression analysis was not found to be statistically significant. It should be noted that the sample size available for study may have contributed to findings of statistical nonsignificance.

The findings of the study indicate that planners of educational reform should consider that teachers charged with the task of implementing programs are likely to experience several distinct concerns, which should be addressed specifically and appropriately. If schools are to improve, future research will need to continue to examine the many factors that influence implementation at all levels, including district, school, and classroom levels.
CHAPTER I
INTRODUCTION

Educational reform has been known by many names, restructuring in one decade and systemic change in another. Despite the label, education reforms, nevertheless, usually fall short of the expectations of both designers and supporters (Fullan, 1992; Ruscoe, 1991). Some research (Elmore, 1992) related to educational change has attempted to identify the most serious and persistent roadblocks to change, while other research highlights the characteristics of successful change in specific contexts (Cuban, 1992; Huberman & Miles, 1984). Despite this wealth of information, the key to widespread educational reform continues to appear elusive.

Implementation of change in any organization is rife with dilemmas. Louis and Miles (1990) find that the difference between successful or unsuccessful change implementation in schools was not in the number or kinds of problems that presented themselves, but in the responses that schools made to problems. Implementation requires persistence and probing, continuous monitoring and adaptation. Of the schools studied by Louis and Miles, little or no reform occurred where personnel engaged in "shallow coping" (p. 126), doing little to address problems and making only superficial changes.
Fullan (1993) suggests that the implementation of school change is a tangled process that requires an understanding of the manner in which many factors "interact and unfold" (p. 120). Thus, he argues that theories about changing, not change, should be the focus of researchers and decision-makers in efforts to bring about successful reform. Fullan (1982) explains that school improvement plans are subject to a process that begins with a change in behavior but is complete only when teachers fully change their beliefs, attitudes and understanding. He asserts that educational change depends on what teachers do and think.

Research examining personal motivation (Bandura, 1977) for attempting difficult tasks suggests that individuals' sense of efficacy, that is the "estimate that a given behavior will lead to certain outcomes" (p. 193), is a strong predictor of choices of and persistence in a given activity. Some studies suggest that teachers' sense of efficacy is determined by internal factors, such as locus of control and stress (Ashton et al., 1982) and by external factors that include training, socialization and organizational structures (Parkay, Olejnik, & Proller, 1988).

Teacher behaviors, beliefs and attitudes, specifically teachers' sense of efficacy, have been examined in relation to innovation implementation (Armor et al., 1974; Berman &
McLaughlin, 1977) and in relation to school climate (Ashton & Webb, 1986; Coladarci, 1986). Research suggests that where successful change has occurred in schools, the school climate and teachers' sense of efficacy are positive (Huberman & Miles, 1984).

A review of the innovations of the 1970's provided by Fullan (1993) identifies factors that emerged as important to successful implementation; among these is school climate, described as the way that characteristics of the work environment are perceived by the individuals who work in schools. Hopkins (1990) proposes that, although specific motivation from teachers is critical, an open, healthy, supportive school climate provides the general motivation in reform initiatives. Hopkins believes that "change in teacher behavior is the result of a dialectic between specific and general motivation" (p. 62). Hopkins asserts that psychological states of teachers, including feelings of self-worth and self-actualization provide individuals with the specific motivation to entertain and approach new ideas about education, but that organizational variables such as principal and collegial support, collaboration and experimentation are necessary general motivations to teachers involved in change.

The extreme difficulty of implementing reform can be attributed, in part, to the massive personal and organizational investments required to realize change.
(Shanker, 1990). Research (Huberman & Miles, 1984; Starko, 1989;) supports Bandura's motivation theory applied to the dilemma teachers encounter in the change process. When teachers do not expect that their actions will make a difference or doubt that they have the individual capacity to effect results, they are not likely to pay the personal price that change requires of them. As Fullan notes, alterations in teaching approaches has profound effects on teachers' "occupational identity, their sense of competence, and their self concept" (p. 33).

Many reforms have underestimated the amount of motivation and energy that were required by teachers and schools to enact well-intended policy, the result of which is a host of programs that were diluted or ultimately dismantled. McCaslin & Good (1992) report that "educational problems seem as acute as ever, and there is a growing realization that the reforms of the 1980's have not had much of an effect on American schooling" (p. 4). Should this trend continue, public support for education could continue to deteriorate; teachers could become increasingly disenchanted with efforts to reform; and outstanding leaders could decide that their energies are wasted on changes that do not last.

Theoretical Perspectives

The current study applied Bandura's motivational theory of self-efficacy in an examination of teachers
involved in the implementation of an innovative physical science program. Bandura (1977) proposes that individuals' expectations related to outcomes and efficacy provide motivation to act in uncertain or fear inducing situations. Two independent dimensions, outcome and efficacy, emerge to define expectations. Bandura suggests that individuals can believe that particular actions will lead to certain outcomes; however, individuals may or may not perceive that they themselves are capable of performing the actions necessary to arrive at anticipated outcomes. With this in mind, the nature of change as a highly personal process is reinforced. A strong focus on the individual response to change is at the core of a model selected for the present study.

The Concerns Based Adoption Model (Hord, Rutherford, Huling-Austin, & Hall, 1987) provides much of the research model for the present study. This change model, developed at the University of Texas, maintains several theoretical assumptions about the nature of change. First, change is viewed as a process and not an event. The implementation of educational innovations could require years of effort before intended results are realized.

Second, change is carried out by individuals. The activities necessary to effect change are conducted by people who are charged with implementing innovations and, accordingly, these individuals and their concerns should be
the focus of attention. The CBAM model proposes a developmental sequence of types or stages of concern through which persons charged with innovation implementation progress. Awareness of the specific stages of concern related to individuals at various points in time provides relevant information to persons who facilitate the change.

Third, change is a personal experience. Individuals do not respond uniformly to change efforts, demonstrating varying levels of acceptance, fear, energy, and expertise. Such responses require that intervention designs accommodate the unique needs of individuals involved in implementation.

Finally, the facilitation of change should focus on the innovations, individuals, and contexts. Persons affected by the implementation of innovations operate within particular organizational settings that are as unique as the people of which the organization is comprised.

The school represents the context, or level of organization, examined in the current study. Hoy and Clover (1986) propose that two types of social interaction, principal with teachers and teachers with colleagues, can be measured to determine the openness of a school climate.
1988) supports the concept that an open school climate enhances the success of change efforts.

Problem Statement

The intentions of school reformers are difficult to interpret in the reality of implementation. Although teachers in a well-developed program may receive training and technical support, implementation of the program can vary and, worse, fail to be sustained after training and support conclude. Some research (Hord, 1990) suggests that plans for innovation must consider the context in which change is to occur and the needs of individuals who will be involved with implementation.

If change facilitators are to effectively manage and support educational reforms or innovations, sources of variation that might impede either the goals of the reform or the change process must be identified and resolved. Some research indicates that support for or resistance to new ideas about education emerges from individual and organizational responses that possibly interact. In order to effectively manage change, recognition should be paid to those forces which are personal to teachers such as teacher efficacy and concerns about an innovation. At the same time, facilitators must keep in mind that the supporting structures of innovation implementation may well be defined by the climate at the school in which the teacher works.
The present study examined three variables that affect reform implementation: teachers' sense of efficacy, teachers' perception of school climate, and teachers' concerns about the change process. Specifically, the study focused on the first year implementation of a physical science program supported by the National Science Foundation and investigated whether the variables previously listed contribute to the differences that teachers exhibit in innovation implementation. The study also examined the relationship between these variables. Research and hypothesis development are guided by four questions related to innovation implementation:

1. How is innovation implementation affected by teachers' sense of efficacy, school climate, and stages of concern?
2. Do teachers selected for this research express different stages of concern at the beginning of innovation implementation than they do at the end of the first year of implementation?
3. Do teachers' expressed stages of concern over time support the developmental progression suggested by the Stages of Concern Model?
4. Do teachers included in a multiple case study manifest different innovation configurations of the physical science program, as proposed by the Concerns Based Adoption Model?
Definitions

Teachers' sense of efficacy has been defined by Armor (1976) as the extent to which a teacher believes he or she has the capacity to affect student performance. Research supports two independent dimensions of efficacy (Armor, 1976; Bandura, 1977; Berman & McLaughlin, 1977; Gibson & Dembo, 1984). The first dimension, sense of general teaching efficacy, is the extent to which a teacher believes that certain teaching behaviors can affect student outcomes. The second dimension examines a teacher's belief that she/he personally possesses the ability to perform the behaviors necessary to affect student outcomes positively.

School climate is defined by Hoy & Miskel (1987) as the "relatively enduring quality of the school environment that is experienced by participants, affects their behavior, and is based on their collective perception of behavior in schools" (p. 225). In this study, school climate was measured by the Organizational Climate Description Questionnaire-Revised for Elementary Schools (OCDQ-RE).

Concerns-Based Adoption Model is a theoretical structure, developed by the University of Texas Research and Development Center, which examines three aspects of change in the classroom: stages of concern, levels of use and innovation configuration. The model offers "a viable
framework for understanding, facilitating and evaluating change efforts" (Heck et al., 1981, p. 7).

Stages of Concern are identified in the Concerns Based Adoption Model as seven distinct categories of concern that express teachers' affective responses to change. The developers believe that teachers' concerns about an innovation "depend on one's closeness to and involvement with the innovation" (Hall et al., 1986, p. 5) and that concerns are not static but change over time. The complexity of implementation excludes the possibility of focusing on all aspects at one time. The program aspects that demand teachers' attention in the beginning of implementation are not likely to be the same as those that emerge later.

The stages are identified as Awareness, Informational, Personal, Management, Consequence, Collaboration and Refocusing. For this study, Stages of Concern are measured by responses to the Stages of Concern Questionnaire (SoCQ) and individual profiles have been completed for each teacher.

Implementation, identified and measured by the CBAM model as Levels of Use, is defined by Brewer and deLeon (1983) as "the social activity that follows upon, and is stimulated by, an authoritatively adopted policy mandate" (p. 256) representing a departure from previously existing arrangements. For this study, innovation implementation
will refer to the activities conducted by teachers in classrooms in response to new policy created for a physical science reform effort. Innovation implementation will be analyzed through an observation protocol known as the Innovation Configuration Matrix (ICM) and described in the next paragraph.

Innovation Configurations are identified in the Concerns-Based Adoption Model as operational patterns or multiple configurations "that result from implementation by different individuals in different contexts" (Heck et al., 1981, p. 1). For this study, the ICM was used to guide observations in classrooms and to review teacher logs and student portfolios that are maintained throughout the duration of the project. The ICM for the present study identifies eight key components of the project along a vertical axis and three observable behavioral responses to the components, ranging from "Ideal" to "Unacceptable" classroom configurations of the component along a horizontal axis. In this way, implementation of the physical science program can be seen as different patterns resulting from the way in which teachers in the study structure various parts of the innovation.

Significance of the Study

The failed attempts made in the past to alter school structure, governance and/or curricula are well documented (Huberman & Miles, 1984; McLaughlin, 1987).
Unfortunately, the factors that might have made implementation failure predictable were not foreseen. Rather, a retrospective investigation unveiled impediments to the change process after an innovation could not be salvaged and had to be dismantled.

History has proven that simply mandating a reform will not make it so. It is important to identify variables that contribute to individuals' reactions to reform efforts in order to provide successful intervention. Regardless of the level at which an innovation is introduced, important changes made in schools will ultimately affect the role and work situation of classroom teachers. Change is a highly personal process; thus, teachers are not uniformly affected by working conditions, student attitudes and behaviors, and time constraints that affect implementation.

Facilitation of innovation implementation requires consideration for the unique characteristics of teachers and schools that contribute to the degree and manner in which educational changes become classroom practice. This study examined some of the individual and organizational variables that affected the motivations of teachers embarking on the tedious journey of change.

The study was conducted as the change process was initiated in the first year of a five year innovation plan and, therefore, highlights the experiences and difficulties of change encountered in the early stages of
implementation. The context of the study is of particular interest because the plan incorporates many of the strategies that are advocated by current school restructuring efforts including shared decision-making, teacher peer mentoring, student directed learning strategies, and alternative forms of assessment.

**Delimitations and Limitations**

The current study of implementation was confined to an investigation of a single, unique innovation; therefore, some delimitations related to sampling procedures occurred. The schools involved in the study were not randomly selected. The population of students in the sixteen schools is represented by a larger number of white students than nonwhite students as compared to the school district as a whole. The school sample also includes a much larger proportion of rural schools and much smaller proportion of inner-city schools than is represented by the entire district. These discrepancies occurred when schools were selected based on the nomination of the teacher pairs submitted to the program selection committee.

As will be discussed more fully in Chapter III, pairs of teachers were selected for participation in this study based on certain characteristics such as the ability to serve as mentors and instructional leaders. Minimal emphasis was placed on schools to which teachers were assigned. Selected teachers have been recognized as
outstanding leaders in the science field and have volunteered to participate in the innovation; therefore, they cannot be considered a random sample of teachers, thus limiting the generalizability of the study results.

The analysis includes only teachers in elementary schools and, therefore, results may not be generalizable to other school levels (Purkey & Smith, 1983). The developers of the Concerns Based Adoption Model, however, do not distinguish differences between teachers' concerns about an innovation based on whether they are employed at an elementary or secondary school and no other research was found to support such differences. Teachers' sense of efficacy has been closely linked with situation specificity (Armor et al, 1976; Gibson & Dembo, 1984); thus, this design may help to reduce possible differences attributed to school level assignment.

The methodology used to collect data for the independent variables requires respondents to report their perceptions. While they were encouraged to answer as honestly as possible, some teachers may have unknowingly answered in ways which they believed were desirable or acceptable. This is of particular concern with items related to teachers' work with students, such as those found on the Teacher Efficacy Scale (TES). To provide additional support to findings from questionnaires,
structured interviews, and anonymous essays were used to examine the independent variables as well.

Finally, the researcher is an active participant in this project. This poses some concern for the sample teachers to be honest in their responses, especially with the TES and the Stages of Concern Questionnaire (SoCQ). To reduce anxiety or fear of reprisal, anonymity was provided to respondents when possible. Instruments were coded by number, when possible written responses were anonymous and about one fourth of the informal interviews conducted by other project specialists were related only by content of conversation, without revealing the respondent.

Two limitations of this study warrant discussion. There were only 32 teachers available for this study. They represent the entire population of teachers participating in the physical science program. This small sample size limited the statistical analysis of quantitative data and might have contributed to any findings of nonsignificance. The second limitation relates to instruments selected for use. The TES has been used to examine the teacher sense of efficacy in several studies (Coladarci, 1992; Dembo & Gibson, 1985; Gibson & Dembo, 1984). The scale, originally developed for a construct validation, had 30 items related to Teaching Efficacy and Personal Teaching Efficacy (Gibson & Dembo, 1984). The developers of the scale found 16 of the 30 items to have acceptable reliability coefficients in
factor analysis, which may have been the result of an insufficient sample size. Some studies (Woolfolk & Hoy, 1990) have used only the 16 items found to be reliable in the original Gibson & Dembo construct validation. This may have been the result of an insufficient sample size.

A few studies have found that the General Teaching Efficacy component of the scale has not provided the clarity that has been evident with the Personal Efficacy component. Of the literature reviewed, the General Teaching Efficacy reliability was consistently lower than the Personal Teaching Efficacy reliability. To date, however, there has been no other instrument as widely used to measure teacher efficacy than has the Teacher Efficacy Scale.

Summary of Chapters

This dissertation consists of six chapters. Chapter I has presented a statement of the problem, the theoretical framework, and research questions guiding the study. Chapter II provides a review of specific literature related to the independent and dependent variables. This includes teachers' sense of efficacy, school climate, stages of concern, and innovation implementation. A review of selected literature related to instrumentation and methodology used in the current study are provided in Chapter II as well. Chapter III presents the methodology used in this study. It describes the sample, the research
design, instrumentation used to measure independent and dependent variables, data collection procedures and data analysis.

Chapter IV presents the results of the data analysis related to the hypotheses proposed in Chapter I. Tables and graphs are used to display results when appropriate. Chapter V summarizes six teacher implementation configurations in a multiple case study. Chapter VI provides a discussion of the findings, conclusions, and recommendations for further study resulting from the data analysis.
CHAPTER II
LITERATURE REVIEW

Overview

Since the 1960's, sweeping changes of dramatic proportions have been introduced as reforms into American schools. Many of these were the result of increased federal interest in school improvement for specific populations of students, including the economically disadvantaged and the physically impaired. However, reform efforts have not been exclusively aimed at students identified as "at risk." Many of the program proposals, such as technology-supported learning, site-based management, alternative assessment and inquiry-based instruction, attempt to reshape the foundation of school institutions with which many parents and teachers are familiar.

Throughout the past four decades, researchers have attempted to identify and understand the reasons why some teachers and schools strongly resist change efforts. Deal (1990) explains that it is extremely troublesome to "navigate the difficult space between letting go of old patterns and grabbing on to new ones" (p. 12). Educational reform requires more than an isolated alteration or simple adjustment. Comprehensive change demands hard work,
determination and widespread support of individuals both within and outside of schools.

Well-conceived plans for change frequently become chaotic, frustrating experiences during implementation. Because educational change is so complex, Fullan (1992) says that a blueprint cannot be made and closely followed. Rather, a strategy can serve as a flexible tool that is responsive to changes in external pressures and the concerns of individuals charged with implementation.

The current study examined the correlation between the independent variables, teachers' sense of efficacy, organizational climate, stages of concern about an innovation, and the dependent variable, implementation of a physical science innovation in elementary schools. Literature presented in this chapter is organized around the three independent variables, teachers' sense of efficacy, organizational climate, and stages of concern, and the dependent variable, innovation implementation.

Teachers' Sense of Efficacy

Human behavior has been explained in the past as a result of cognitive processes. Individuals were believed to be motivated by certain stimuli that were associated with corresponding responses. Some researchers (Bandura, 1977), however, found it difficult to ignore the fact that the same stimuli did not always elicit identical responses from individuals. Questions about the effects of previous
experience on performance has led to a reconceptualization
of theories regarding individual motivation to act in
uncertain situations. Bandura (1977) suggests that
"cognitive processes mediate change but cognitive events
are induced and altered most readily by experience of
mastery arising from effective performance" (p. 191).

Bandura postulates that human motivation can be
attributed to efficacy, the perceived expectancy of
obtaining outcomes, which is more specifically portrayed by
an interaction between two independent dimensions of
efficacy. The first, outcome expectations, is the belief
that certain actions will result in certain outcomes. The
second dimension, efficacy expectations, is the extent to
which individuals believe they are capable of performing
the actions necessary to produce desired results. Human
expectations and motivation improve when individuals are
given opportunity to observe and model desired behaviors,
attempt to perform the behaviors, and then appraise their
behavior against the standard (Bandura, 1977). Bandura
contends that "both the anticipated satisfactions of
desired accomplishments and the negative appraisals of
insufficient performance thus provide incentives for
action" (p. 193).

This theoretical model suggests that human motivation
is highly individualized, stressing the personal nature of
fear, perceived threat, and encouragement provided through
anticipation of future success. Bandura's conceptualization implies that persons who have had considerable success in previous experiences may be more forebearing of negative self-appraisal or poor performance. Efficacy expectations are believed to vary in at least three ways and, because these variances are unique to individuals, treatments to improve efficacy must be personalized to accommodate differences. Efficacy can vary in magnitude, strength, and generality (Bandura, 1977). Magnitude refers to the level of task difficulty; thus, a teacher may have efficacy expectations for simple tasks, but not for difficult ones. Strength is related to the degree to which efficacy can be shaken by discomforting experiences. A veteran teacher with a strong sense of self-efficacy may not be easily discouraged by repeated failures to implement small group instruction, for example. Generality refers to a sense of efficacy that can be expected to extend beyond situation specific tasks. An example in this instance would be a teacher who feels capable of teaching gifted students, but would not feel effective in an inner-city school with a disadvantaged population.

Two Rand studies of the 1970's (Armor et al., 1976; Berman & McLaughlin et al., 1977) brought serious attention to teachers' sense of efficacy as an important variable in program implementation success and student outcomes. The first study, completed by Armor and others, was conducted
in the Los Angeles school district and involved implementation of a reading program in 20 schools. Specifically, the researchers wanted to know which of seven input variables were most significant in reading achievement gains for black and Hispanic students.

Of the seven variables selected for study, three were found to be significant, including teachers' sense of efficacy, student background factors, and students' previous years' reading test scores. Armor, et al., (1976) emphasized the finding that "the more efficacious a teacher felt, the more their students advanced in reading achievement" (p. 23). The authors did note that teachers' low sense of efficacy may have factually described working situations over which they had no control, imposed by the kind of school in which they had been assigned.

Data collected to measure teachers' sense of efficacy were drawn from responses to two statements. The first, which correlates to Bandura's outcome expectancy (general teaching efficacy), asks teachers' degree of agreement to "When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his/her home environment." The second statement relates to efficacy expectancy (personal teaching efficacy) and asks for teachers' reaction to the proposition, "If I try really hard, I can get through to even the most difficult or unmotivated students." These items have been
used in several studies since they were first introduced in the Rand studies (Ashton & Webb, 1986; Berman & McLaughlin, 1977; Parkay, Olejnik, & Proller, 1988) and were later explored as two dimensions of teaching efficacy by Gibson and Dembo (1984).

The second of the Rand studies, conducted by Berman and McLaughlin, et al., (1977) examines the factors that determined successful implementation of federal programs. Using the two efficacy items appearing in the Armor, et al., (1976) study, Berman and McLaughlin found that the most important variable for predicting the effectiveness of innovation implementations was teachers' sense of efficacy.

Teacher behavior has been examined in several specific areas of interest, with results that support teachers' sense of efficacy as influential to program implementation. Starko (1989) has researched the role of teacher efficacy and student need in the strategies chosen by teachers of gifted and talented students. From a sample of 176 preservice teachers, 85 regular classroom teachers and 57 teachers of gifted and talented, the author found that efficacy was a strong predictor of use of an instructional strategy. Unfortunately, the Starko study reveals that students' need for an innovation was not a predictor of teachers' use of a strategy. Although teachers of the gifted and talented received inservice on strategies that were especially successful and responsive to the needs of
their students, implementation of such strategies occurred only among teachers who felt a high sense of efficacy as a result of usage.

Similar results have been found in an examination of teacher efficacy and science teaching. Riggs and Enochs (1989) suggest that many teachers do not treat science as an important component of instruction because of personal feelings of inadequacy in science content knowledge. The study proposed that teacher efficacy might account for the variation that elementary science teachers exhibit in the amount of time and type of activities that are observable in classrooms. Riggs and Enochs suggest that "an elementary teacher judges his/her ability to be lacking in science teaching (belief) and consequently develops a dislike for science teaching (attitude). The result is a teacher who avoids teaching science if at all possible (behavior)" (p. 4).

The authors developed an instrument that combined the Personal Science Teaching Efficacy Beliefs Scale and the Science Teaching Outcomes Expectancy Scale and provided support for its use as a valid and reliable tool for measuring elementary teachers' beliefs toward science teaching and learning. The model affirmed the existence of two dimensions of efficacy, personal and general, in agreement with previous research.
Sense of efficacy is believed to influence teachers' classroom behavior and student learning. In a multi-site research study supported by the National Institute of Education (NIE) completed in 1979 (Ashton & Webb, 1986), researchers determined that teachers' sense of efficacy differs and is reflected in job performance. Ashton & Webb report that "teachers’ efficacy expectations influence their thoughts and feelings, their choice of activities, the amount of effort they expend, the extent of their persistence in the face of obstacles" (p. 3). Teachers with low self-efficacy are preoccupied with their own feelings of hopelessness and inadequacies, perceiving their concerns as more serious than they actually are.

The NIE study also supports two independent dimensions of efficacy that mirror those proposed by Bandura (1977). The first of these dimensions, sense of teaching efficacy, is defined by Ashton and Webb (1986) as the belief that teaching can be effective for all students, while the second dimension, personal teaching efficacy, is the belief that a teacher can perform the activities necessary to be an effective teacher.

Some teacher behaviors that are believed to influence student learning include how teachers utilize instructional time and the manner in which question-and-feedback is delivered. In an effort to discover if teachers with high efficacy differed in patterns of behavior from teachers
with low efficacy, Gibson and Dembo (1984) observed the classrooms of eight teachers, four of whom were classified as having low efficacy and four classified as having high efficacy, based upon the composite score they received on the Teacher Efficacy Scale (TES) (Gibson & Dembo, 1984).

Teachers with high efficacy were found to spend more time in whole group instruction, monitoring and checking seatwork, and spent considerably more time in lesson preparation. Teachers' responses to wrong answers elicited from students were found to vary significantly among high and low efficacy teachers. There were no instances of criticism from high efficacy teachers when students volunteered incorrect responses; rather, these teachers probed students further in more persistent efforts to guide the student to the correct answer. Teachers classified as having a low sense of efficacy more frequently provided the right answer almost immediately, offered criticism, or redirected the question to another student.

The Gibson and Dembo study also found that the students of high efficacy teachers spent more time on task and that the teachers exhibited more "withitness" (p. 578). The high efficacy teachers seemed to be better able to cope with interruptions and were able to provide smoother coordination and quality of instruction to all students even when the teachers were working directly with small groups.
Teacher behaviors are believed to vary because of personal philosophies that influence pupil control ideology, motivation orientation, and bureaucratic orientation (Woolfolk & Hoy, 1990). Pupil control ideology, depicted along a continuum from custodial at one pole to humanistic at the opposite pole, refers to teachers' perceptions of controlling student behavior. Motivational orientation describes teachers' behavior in motivating students and in communicating information. The authors explain that teachers can minimize or maximize the autonomy given to students to find solutions to problems. Teachers who do not control situations too tightly, allowing students to think and act for themselves, encourage intrinsic motivation and effective problem solving. Bureaucratic orientation is defined as the "individual's commitment to the set of attitudes, values and behaviors that are characteristically encouraged by bureaucracies" (Woolfolk & Hoy, 1990, p. 84).

To determine a possible relationship between teachers' sense of efficacy and teacher beliefs about pupil control and bureaucratic orientation, Woolfolk and Hoy (1990) surveyed 182 prospective teachers using the TES (Gibson & Dembo, 1984), deleting fourteen of the items that did not meet acceptable reliability values in the Gibson and Dembo study. The researchers also added four items that were appropriate for preservice teachers. Other instrumentation
included the Pupil Control Ideology form (Willower et al., 1967), Problems in School Inventory (Deci et al., 1981) and the Work Environment Preference Schedule (Gordon, 1970).

Woolfolk and Hoy (1990) replicated Gibson and Dembo's (1984) two factor solution using principal axis factoring and found that the two factors were not correlated, confirming data reported in previous studies. Factor loadings for items were similar to the Gibson and Dembo results. These authors also examined whether the Personal Efficacy component of the scale was actually two dimensional, one dimension representing responsibility for positive outcomes and the other representing responsibility for negative outcomes. The results indicated that the Personal Efficacy component can be separated into these two related facets.

Woolfolk & Hoy (1990) report that two main effects were found when teachers' sense of efficacy was examined with bureaucratic orientation. They concluded that "teachers with low teaching efficacy are more bureaucratic than teachers with high teaching efficacy, but teachers with low personal efficacy have a less bureaucratic perspective than do those high in personal efficacy" (p. 86).

Bureaucratic orientation has implications for studies of teachers' sense of efficacy and the innovation implementation of the physical science program under
investigation in the present study. Teachers with a preference for bureaucracy might exhibit resistance to inquiry-based instruction that promotes the possibility of many approaches to problem solving and as many solutions. These teachers might prefer standardized routines with clearly stated rules of operation. Teachers with bureaucratic orientation may be less willing to encourage a student-directed approach to learning, as advocated by the physical science program, if they perceive their role in the structural hierarchy as directive.

The opportunity for teachers to successfully overcome implementation obstacles, such as the conflict between a bureaucratic orientation and new roles for teaching and learning, is important to the sustenance of high self-efficacy. Huberman and Miles (1984) found that the mastery of technical requirements of a program was an important motivational reinforcement for teachers involved in change. A nationwide sample of 146 school districts provided data indicating that as teachers experienced success in overcoming difficulties they developed a sense of "being on top of" (p. 155) or "having a good handle" (p. 155) on the changes of which they were charged.

Change strategies that do not lead to a sense of success or effectiveness in early stages of implementation contribute to teacher "burnout"; teachers' sense of efficacy wanes as they perceive insurmountable
difficulties. Huberman and Miles also determined that classroom practice changes usually precede cognitive understanding, which is necessary for eventual shifts of philosophies and attitudes. Purkey and Smith (1983) explain that in order for teachers to value new strategies and adopt them as their own, experiences should promote opportunity for small successes and the development of skills over time. This evolution, from experimentation to ownership, requires a commitment of time, patience, and continuous assistance.

In response to the necessity for ongoing support to teachers in the process of change, coaching or mentoring has been recommended as a useful strategy (Fullan, 1990; Joyce & Showers, 1988). Teacher mentoring can be a valuable tool for optimizing success in the implementation of educational change and supporting high efficacy among teachers. One project (Gersten, Woodward & Morvant, 1992) focused on observation and collaboration between mentors and other teachers to bring about changes in instructional strategies for reading. Recognizing the need to maintain a high level of teaching efficacy with experienced teachers, the project encouraged teachers to "select concrete, realistic and easy-to-implement practices" (p. 35) that would promote experimentation. Case studies provided in the research outlined the efforts of two teachers and their mentors in the project. Mentors helped teachers design
activities that would provide teachers with observable feedback about the performance of their students.

At the end of the year, one teacher noted "how hard it was to change and how overwhelming the process still is at times" (Gersten, Woodward, & Morvant, 1992, p. 36); however, her confidence in her ability to affect lower achieving students remained high. The researchers suggest that a mentor-protege relationship reduced the anxiety that often inhibits teachers from letting go of the old and grasping the new. They believe that systematic support and interactive feedback are important to successful implementation of new projects and to teachers' sense of efficacy.

The effects of leadership and supervision on teachers' sense of efficacy has received some attention in the literature. The Teacher Efficacy Scale (TES) (Gibson & Dembo, 1984) was revised by Coladarci (1991) and used to examine the relationship between special education teachers' sense of efficacy, frequency of supervisor's visits, and utility of supervision, defined as the degree to which supervision was perceived as helpful. Coladarci (1991) found that teachers who responded to the instrument had significant variation in their sense of personal teaching efficacy. Teachers' sense of efficacy did prove to be a significant predictor of the utility of supervision, but the study failed to determine a
relationship between teachers' sense of efficacy and frequency of supervision.

The relationship between teachers' sense of efficacy and other individual characteristics, such as gender and age, is inconclusive based on the literature currently available for review. Riggs and Enochs (1989) investigated possible differences in efficacy based on school assignment to rural or urban schools and attributable to teacher gender. Of the teachers included in the study, there were no significant differences in efficacy between teachers in rural or urban elementary schools. Male teachers reported higher personal teaching efficacy than did female teachers. The authors did not provide possible explanations for gender influence on teachers' sense of efficacy. Studies have suggested that males are more comfortable in the areas of math and science than are females, and this study was designed to examine teachers' sense of efficacy within the specific context of science education. Additional research is needed to explore the gender and efficacy relationship in other situations.

Educational reforms do not always come in the form of directives that provide specific redesigns for instruction. Some of the most recently proposed reforms, commonly referred to as restructuring, intended large-scale changes in governing structures and accountability procedures, which were believed to indirectly affect teacher classroom
behavior and student learning. This type of change introduces the question of a link between organizational or structural changes and teachers' sense of efficacy.

Among the many large city school districts that initiated restructuring was the Chicago school system. The city initiated a comprehensive restructuring effort, including the establishment of new programs, and drastically changed governing structures that legitimized the decentralization of power. The reform failed to produce the widespread educational improvement that developers anticipated. In an effort to understand why, teachers were questioned about their perceptions of school restructuring, the quality of instruction and possible improvements to education (Consortium on Chicago School Research, 1991). The survey included items that examined teachers' sense of efficacy related to program implementation. Items included "I am certain I make a difference in my students' lives" and "Many students I teach are not capable of learning material I am supposed to teach."

The report concluded that of the total number of teachers surveyed, most reported a high sense of efficacy. Teachers believed that students had the innate ability to achieve if they did not exhibit poor habits and attitudes that interfered with their opportunities for learning. Although efficacy was revealed to be strong, only half of
the teachers reported any change in teacher practice due to the reform. Classroom practice was most likely to have changed among teachers who reported a strong sense of efficacy and were involved in school governance. Many teachers expressed the belief that improvement would occur as a result of external changes rather than of practice.

Few studies have explored the possibility of a direct relationship between organizational variables such as school climate and teachers' sense of efficacy, although many studies refer to the situational specificity of efficacy (Armor et al., 1976; Gibson & Dembo, 1984; Starko, 1989). Hoy and Woolfolk (1993) supported the distinct differences between personal teaching efficacy and general teaching efficacy since "characteristics that explained personal teaching efficacy were different from the ones that explained general teaching efficacy" (p. 368). They also caution that the relationship between teachers' sense of efficacy, organizational and personal variables is complex and difficult to untangle.

The research of Hoy and Woolfolk (1993) provides an investigation of the two dimensions of teaching efficacy, general and personal, and several aspects of a positive school climate. Using a revised form of the TES (Gibson & Dembo, 1984) and the Organizational Health Inventory (OHI) (Hoy, Podgurski, & Tarter, 1991), the authors concluded
that there were significant relationships between some of the organizational variables and teacher efficacy.

Personal teaching efficacy was best predicted by two aspects of climate—principal influence and academic emphasis. Teachers perceive their ability to influence student performance to be greatest when goals are high but achievable, the climate is orderly and serious, and there is general respect for academic excellence. Teacher morale, on the other hand, did not predict personal teaching efficacy in the Hoy and Woolfolk (1983) study.

Two organizational variables, teacher morale and institutional integrity, predicted general teaching efficacy. The study indicated that in schools where the level of teachers' sense of efficacy is high, the amount of influence that parents impose on the school environment must be balanced with instructional strategies that reduce the effects of family on student achievement. While the lack of parent involvement in schools reduces community cooperation, negative forces of family and background are minimized when parents have limited involvement in school functions.

This finding is not meant to imply that increased parent involvement is detrimental. On the contrary, Hoy and Woolfolk explain that cooperative efforts between teachers and parents cannot be promoted without stimulating parent interest; however, the authors do recommend a
balance. High efficacy teachers are more likely to disregard the negative effects of poverty and dysfunctional families by creating an atmosphere of high expectations and determination in their classrooms, discounting the destructive forces of home.

A link between organizational variables and individuals' sense of efficacy has been explored by Fuller and others (1982). The research provides support for relating the structures of schools to teachers' sense of efficacy. These authors suggest, however, that a distinction must be made between personal, or performance efficacy as labeled by Fuller, et al. (1982), and organizational efficacy in order to accurately examine the characteristics of organizations that influence efficacy. While personal efficacy can be realized through actions that are conducted independent of interactions with colleagues, organizational efficacy can only be realized as individuals engage in efforts to influence others. Efforts to improve organizational efficacy must be considered in light of the impact such actions will have on individual efficacy.

Fuller, et al. (1982) suggest that organizational and individual efficacy are interdependent and plans for organizational change must consider the possibility that "the same structural variable may influence each type of efficacy [organizational and personal] in very different
directions" (p. 26). School reform efforts aim at reducing uncertainty and ambiguity in order to obtain predictable outcomes, for example, increased achievement test scores. Although the improved outcomes could serve to enhance organizational efficacy, the routinization of tasks leaves individuals with little personal responsibility for goal setting and determination of means to achieve desired outcomes, thus reducing individual efficacy.

Although an examination of organizational efficacy is not included in the present study, Fuller, et al. (1982) contribute insight into the interactive effects of school improvement goals, individual goals, and teacher efficacy. As in the example presented in the preceding paragraph, school improvement goals, however worthy or noble, could impinge on the individual goals of teachers and inhibit personal teaching efficacy. If teacher efficacy is important to program implementation, as the research suggests, school changes must be viewed in light of the possibility to enhance individual teacher goals as well as those of the organization.

The current study was designed to examine the relationship between teachers' sense of efficacy, the school as an organization and the influence of each on the implementation of an educational innovation. The organizational variable, school climate, was selected to
represent possible differences in the organizational setting of the teachers in the study.

School Climate

The recognition of school climate as an independent variable has become especially prominent with the growing body of effective schools research, which identifies climate as one of the common correlates present in successful schools. School climate is defined in many ways and this multitude of descriptions and frameworks has led to some confusion as to whether "we are all hunting the same beast" (Anderson, 1982, p. 376). Three theoretical perspectives provide frameworks for examining school climate.

The first of the climate models discussed, input-output theory, posits that a combination of school input variables such as time or money results in certain school outputs. When school outputs, such as student achievement scores, do not meet desired targets, input variables are changed; thus funds are increased or redistributed or timetables are redesigned.

The input-output view of climate was not selected for this study. It has been criticized as being "simplistic" (Anderson, 1982, p. 379) and does not explain the process that transforms inputs to outputs, which critics argue are complex and important to understanding climate.
The second framework, ecological theory, examines climate through procedures that secure and allocate resources and temporal and physical aspects of schools that influence schoolwide functions (Anderson, 1982). Often overshadowed by sociological theory, the ecological view of climate "has largely been used for research in classrooms and nonschool environments (Anderson, 1982, p. 382) and will not be employed in the current study.

The final and most widely used framework, sociological theory, describes climate as a result of social interaction among people. The climate model of Halpin and Croft (1963), which describes climates based on the perceptions of activities and interactions of teachers and administrators, serves as an example for sociological theory and provides the framework for the Hoy, Tarter, and Kottkamp (1991) model of climate that was used in the current study. Halpin and Croft's conceptualization of climate focuses on "the quality of faculty-principal relations" (Miskel & Ogawa, 1988, p. 291).

The emphasis on human relationships fits well with recent reform efforts that decentralize power and permit greater flexibility in organizational structure, communication, and roles. Many educational reforms have emphasized the need to restructure the relationships of individuals in schools in order to foster climates that facilitate improvement. Bureaucratic structures that are
designed to control information and power through a hierarchical framework are believed to inhibit the individual contributions of people in schools (Murphy, 1991). In recent years, many organizational structures have been redesigned to permit more creativity and flexibility for individuals, thereby redefining top-down control patterns into decentralized, power-sharing paradigms.

According to the model proposed by Hoy, Tarter, and Kottkamp (1991), open school climates are preferable to closed climates since open environments nurture trust and cooperation among school personnel. The model examines climate along two dimensions: principal openness and teacher openness.

Teacher-Administrator Relationship

The relationship between teachers and the administrator is a crucial element of school climate (Ellett & Walberg, 1979; Hoy, Tarter, & Kottkamp, 1991; Weber, 1971). Conceptualizations of organizational climates emphasize the importance of relationships between superordinates and subordinates (Halpin & Croft, 1963; Likert, 1961). Most theories about climate propose that school administrators are more effective when they do not hinder the work of teachers and when they support a collegial atmosphere of trust and risk-taking (Anderson, 1982). Principals often have near absolute authority to
approve teachers' participation in professional development, secure material support, provide time for teachers to interact with each other, and promote positive feelings between teachers, parents, and students.

Numerous studies support the need for open lines of communication between teachers and administrators if healthy climates are to be realized (Bell, 1979; Ellett & Walberg, 1979). To support such a climate, principals need to be "visible, approachable and open in discussion" (p. 449), according to Thomas (1976). Principals often control the flow of necessary information to teachers and provide a viable communication link between the school and its external environment (Kimpston & Sonnabend, 1975).

Peer Relationship

The second of the openness dimensions identified by Hoy, Tarter, and Kottkamp (1991) examines the interactions of teachers with colleagues. School climates are perceived as open when teachers frequently communicate and collaborate with each other. Sarason (1982) explains that within organizations "there are moral imperatives that dictate how people should structure their relationship to each other when their fates are intertwined" (p. 90).

Bureaucratic school structures typically foster an autonomy for teachers that isolates them from their colleagues. Crocker and Banfield (1986) report, however, that teachers prefer working in collegial environments even
when other environmental characteristics, such as large class size or physical facilities, are perceived as disadvantagious.

A school climate which supports opportunities for collegiality has been significantly correlated to the implementation of school change (Fullan & Pomfret, 1977; Wilson & Corbett, 1983). The frequency of collegial interaction, however, is not the sole determinant of teachers' relationships with each other. Collegiality that is contrived, mandated by administrators, appears to hold little value for the improvement of school climate or instruction (Hargreaves, 1991). Faculties must find mutual satisfaction in peer interactions by sharing and striving for common goals and having trust in each other. As Sweeney (1992) suggests, "trust is the glue that holds the school together" (p. 73).

It is difficult to balance the need for collegiality and autonomy within a school. People in any organization will, at times, perceive a need to find a quiet, isolated place in which to work on a difficult task or tackle an enormous workload. The same is true for teachers and, in the average school day, teachers are often inundated with interruptions that necessitate some time to close the door and get things done. Unfortunately, schools often promote excessive autonomy that more closely mirrors alienation.
Alienation is detrimental to teachers' relationships and to school effectiveness and is defined by Newmann, Rutter and Smith (1989) as "relationships of detachment, estrangement, fragmentation, isolation, and separation" (p. 222). The alienation of teachers in schools reduces three important components of effectiveness, teachers' sense of efficacy, sense of community and expectations. Despite the fact that isolation is most commonly viewed as a negative aspect of schools, Newman, Rutter, and Smith (1989) caution that individuals often require some isolation "because individuality and critical inquiry themselves require a certain separation or detachment from experience" (p. 222). Rather, the authors recommend that it is important to reduce the destructive aspects of alienation.

When schools work toward a sense of community, feelings of isolation are reduced and unity and cohesiveness is established. Teachers' perceptions of their ability to impact student learning and high expectations for student achievement are enhanced.

One of the strongest organizational variables found by Newman, Rutter, and Smith (1989) to contribute to reduced alienation was an orderly teaching environment. The authors suggest that when teachers have the opportunity to share technical information about their work, the effectiveness of teaching is improved. When teachers are
supportive of innovation, they are provided with a broadened range of strategies for use with students, thereby expanding opportunity for success.

The research conducted by Newman, Rutter, and Smith (1989) also concluded that there were reasonably strong relationships between sense of efficacy, sense of community, expectations, and some organizational features. Specifically, expectations were strongly correlated to student background. Consistent with previous research, teachers in the study conducted by Newman, Rutter, and Smith (1989) believe that they are more successful with white, non-disadvantaged students. Efficacy was correlated with order in schools, as were sense of community and expectations. Additionally, efficacy was related to consensus of staff, spirit of innovation, and teaching ability.

Effective school climates provide an atmosphere where teachers can enjoy their work and feel a sense of accomplishment. Smylie (1988) agrees that teachers' relationships with their peers is an especially important dimension of climate and suggests that teachers are more likely to engage in improvement efforts when colleagues are "tolerant and accepting of their individual goals and views even if those goals and views do not conform to prevailing opinion" (p. 9). This tolerance of views, identified by Smylie as openness of expression, will often lead teachers
to examine current practices, question effectiveness and experiment with new instructional techniques.

While openness of expression supports tolerance for a wide array of views within a school faculty, Sweeney (1992) argues that there are certain key beliefs and values that are important to the organizational climate (Sweeney, 1992). These beliefs and values, when widely shared, "positively influence how the teaching staff treats students, other staff members, and parents" (p. 71). Among those identified by the author are sense of efficacy, respect for the individual, self-esteem, control, achievement orientation, collegiality, trust and caring. The author suggests that school improvement efforts might benefit from an analysis of current school environment along these beliefs and values.

School climate has been found to affect teacher morale (Nidich & Nidich, 1986). Teacher goal consensus, one variable commonly identified among those that define school climate, was significantly related to teacher morale. When teachers are in agreement about the vision and direction of school work, feelings within the work environment are positive and warm.

Teacher-Student Relationship

Hoy, Tarter, and Kottkamp (1991) note that teachers' relationships with students are of paramount importance in the study of school climate. One variable commonly
associated with climate and student outcomes is that of teachers' expectations of students. Schools with a positive climate are populated by people who have high expectations for the quality of work and competence of individuals (Clark, Lotto, & Astuto, 1984). Concurrently, high expectations are most likely to be present when the climate fosters "order, structure, purposefulness, a humane atmosphere, and the use of appropriate instructional techniques" (Purkey & Smith, 1983, p. 440).

The relationship between school climate and effectiveness was found to be significant by Hoy, Tarter, and Kottkamp (1991). Their study determined that openness in principals' behavior was less important than was openness in teachers' behavior and, although all climate variables contributed to variance in school effectiveness, only "disengaged teacher behavior made a unique and significant contribution" (p. 146). The authors also noted that when effectiveness criteria are more broadly interpreted by faculty trust or teacher commitment, school climate is a strong explanatory variable for school effectiveness.

Open, healthy climates are considered important to the motivation of individuals involved in innovation implementation. The extent to which people expend effort and are persistent in the difficult process of change was examined by Kottkamp and Mulhern (1987). Their study
identified secondary schools with either an open or closed climate to determine if there were differences in expectancy motivation levels among teachers and if higher levels of motivation led to improved performance. Although the correlation between climate and expectancy was moderate, the authors propose that an open climate provides a "high level of functional flexibility, high task achievement and high social needs satisfaction" (p. 12).

School climate has been linked to teachers' levels of use of an innovation. Teachers employed in schools with positive, open school climates were found to use innovations much more than were teachers in schools with negative, closed climates (Hopkins, 1990). Innovation use, based on frequency of use, was reported to be four times higher for teachers in open climates. Reported levels of use in open climates was routine, as teachers demonstrated proficient, stable use of innovations with few changes. In contrast, teachers who worked in closed climates were still in planning stages of innovations and did not demonstrate actual implementation.

The Organizational Climate Description Questionnaire (OCDQ) (Halpin & Croft, 1963) is one of the most widely used instruments for measuring aspects of school climate. In an exhaustive literature review, Anderson (1982) found that the OCDQ had been used in over 100 studies of climate between 1963 and 1967. Thomas (1976) attributes the
advantages of the OCDQ to its practical application and administration. Thomas outlines two assumptions underlying the development of the OCDQ. First, teachers' collective perception of leader behavior is more important than actual leader behavior, and second, the essential determinant of effectiveness is the principal's ability to "create a climate in which he and other group members can initiate and consummate acts of leadership" (p. 446).

The OCDQ includes two subsets of behavior, teacher and principal, determined from responses to 64 individual items, to define a school's climate as 'open' or 'closed'. According to Thomas (1976), the open climate is characterized as "an energetic, lively organization which is moving toward its goal, and which provides satisfaction for the group members' social needs" (p. 448). In contrast, the closed climate "is characterized by a high degree of apathy on the part of all members of the organization" (p. 448).

Like the original OCDQ, revisions of the instrument, including the Organizational Climate Description Questionnaire-Revised for Elementary Schools (OCDQ-RE) (Hoy & Clover, 1986) and the Organizational Climate Description Questionnaire-Revised for Secondary Schools (OCDQ-RS) (Hoy & Clover, 1986), rely on collective perceptions to define climate. The OCDQ-RE reduces the original 64 items by 24 that exhibited low factor loadings. Additional items were
written to examine teacher-student variables. Pilot studies and factor analyses determined the 42 items to be included on the instrument. Principal and teacher dimensions of the instrument were redefined and climates were described as open, closed, engaged or disengaged.

The OCDQ-RE was selected in the current study to describe the climate of participating schools in order to measure the contribution of climate to predict variance in program implementation. The instrument was simple to administer and has proven to be a valid and reliable tool for measuring school climate.

Stages of Concern

Teachers who are engaged in innovation implementation often express many concerns about the change effort. Educational reform leaders have responded to teacher anxiety by offering professional development workshops, coaching, and mentoring. Such staff development efforts, however, have not always proven to reduce teachers' concerns. The Concerns Based Adoption Model (CBAM) (Hord et al., 1987) suggests that there are seven different categories of concern that teachers can or will experience.

The concept of a hierarchial framework for teachers' concerns was first conceived by Fuller and others (1973) through their experiences with preservice teachers. At the beginning of the teaching education program, individuals' concerns were of self (How does this affect me?). In time,
the focus shifted to concerns about task (How much time will this take to do?), and ultimately these preservice teachers became concerned about impact (How is this good for students?) as they neared exit from the teacher education program. The concerns felt by preservice teachers and practicing teachers were found to be important motivational factors for learning and, as Fuller suggests, any training that did not directly address expressed concerns was met with impatience.

Drawing on the work of Fuller, the CBAM model (Hall et al., 1986) proposes that individuals engaged in the implementation of innovations progress through "definite categories of innovation adopter concerns" (p. 4). There are seven stages of concern that include the following:

**Stage 0—Awareness**: Little concern about or involvement with the innovation is indicated.

**Stage 1—Informational**: A general awareness of the innovation and interest in learning more. The person is not worried about herself/himself in relation to the innovation but in general characteristics, requirements and effects of use.

**Stage 2—Personal**: Individual is uncertain about the demands of the innovation, his/her adequacy to meet demands, and his/her role in the innovation. Financial or status implications may be reflected.

**Stage 3—Management**: Individual focuses attention on the
processes and tasks of using the innovation and the best use of information and resources.

**Stage 4—Consequence:** Attention focuses on impact of the innovation on students in the teacher's immediate sphere of influence. The focus is on the relevance of the innovation for students and on evaluation of student outcomes.

**Stage 5—Collaboration:** The focus is on coordination and cooperation with others regarding use of the innovation.

**Stage 6—Refocusing:** The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individuals at this stage have definite ideas about how to change innovation.

Many persons involved with educational change have taken notice of the developmental nature of concern and the exigency for appropriate interventions to implementation obstructions. The often disappointing effects of inservice training have led to consideration of strategies that are aligned with individual teachers' needs and concerns.

Intervention strategies presented in staff development programs are believed to be mediated by organizational factors and by psychological states of teachers (Smylie, 1988). Typically, staff development is directed toward organizational change, involves groups rather than
individuals. While pressure from organizations and groups does serve to facilitate change, the individual's perception of his or her own ability to use new practices successfully in the interactive context of school and classroom contributes to receptivity to change.

In order to understand the feelings, frustrations and anxieties of teachers involved in retraining or continuing education, many change facilitators and instructors have used the Concerns Based Adoption Model (CBAM) (Hord et al., 1987) to gauge the concerns of teachers (Overbaugh & Reed, 1992; Scharmann & Harris, 1991). These studies have contributed to the understanding of how the stages of concern concept can be applied to the study of teacher training and innovation implementation.

Numerous studies have examined teachers' concerns in the context of various training programs. The research indicates that teachers' developmental progression through the stages proposed by the CBAM model is not assured by staff development or training, although some studies have provided evidence to support the developmental stages of concern.

Scharmann and Harris (1991) provide support for the developmental progression of teachers through the stages of concern using the Stages of Concern Questionnaire (SoCQ) (Hall, George, & Rutherford, 1986). The authors were interested in how a three week institute might change
science teachers' attitudes and concerns about the teaching of evolution theory. The institute provided content-knowledge and a student-centered peer discussion technique as a useful instructional strategy. Upon completion of the training, teachers revealed a more positive attitude toward the teaching of evolution and a moderately strong consideration for the peer discussion technique. Teachers anxiety level had been reduced and results of the SoCQ indicated that high concern at lower stages was diminished and had shifted to higher concerns at upper stages.

Bailey and Palsha (1992) examined the hierarchal framework for the stages of concern in the context of an inservice training for professionals assigned to a pre-school intervention program. The training approach required a shift from a focus on the child to one which extended the focus to include the entire family. This change required retraining for teaching skills, family assessment, communication with families, and writing family-focused goals.

Each of 142 professionals, including service providers, administrators, consultants, and social workers, was assigned to one of six workshops in three states. The SoCQ was administered prior to participation in the workshops. The authors contend that the fundamental assumptions of the Stages of Concern concept were supported by their research. Individuals did differ in their
concerns about an innovation in predictable variations upon completion of the workshops.

Yu and Bethel (1991) utilized the Stages of Concern Questionnaire, translated into Chinese, to determine the effect that science process skills training, using a laboratory-based approach, had on reducing concerns about "self" among preservice teachers in a science methods course. The researchers predicted that after laboratory-based training, preservice teachers in an experimental group would shift their focus of concern to "task" or "impact", while the preservice teachers in the control group receiving lectures without laboratory experiences did not change.

The data showed that anxiety about teaching laboratory activities did decrease for the experimental group; however, the data did not support the hypothesis related to stages of concern as concerns about "self" failed to decrease. The authors reported that the experimental group data indicated a slight, increasing pattern toward concerns about impact, although personal concerns remained high. This phenomenon illustrates how teachers may understand the mechanics of teaching strategies and still feel uncertain about their abilities to implement them in a realistic classroom setting.

Rogers and Mahler (1992) investigated the effects that different kinds of training might have on stages of concern
about an innovation. The researchers examined the implementation of technology education in two states, using the SoCQ to develop profiles for participating teachers. The researchers found that of the 80 teachers who returned the surveys, only 24% had accepted technology education, with teachers who received inservice training having a much greater acceptance rate than those who did not.

Inservice and preservice programs often include field experiences as a training component. An investigation into the effects of an undergraduate field experience for elementary math ascertained that concerns about math teaching had not shifted upon completion of the three week experience (Strawitz & Malone, 1986). The students' highest stage of concern was the same as it had been prior to participation in the course. The researchers considered that the students had already accumulated considerable field experiences prior to the course, which may have resulted in the lack of concern shift. Strawitz and Malone suggest that, while research supports the effectiveness of field experience in reducing preservice teacher concerns, field experiences may not have a cumulative effect.

Another explanation might be that field experiences are effective for some stages of concern, but not for others, especially those stages that are among the levels of collaboration and refocusing. For preservice teachers, a simulated three week experience may not provide
opportunities that reduce upper level concerns. To be effective, training and mentoring activities should consider the individual needs of the teachers for which they are designed, since strategies that are assessed to be effective in some situations are not necessarily appropriate in others.

The central question of the present study explored the ways in which concerns about an innovation influenced the implementation of a change program. Hiatt and Sandeen (1990) utilized the Stages of Concern to analyze implementation of a cooperative learning program. The study included eight elementary and seven secondary teachers, all of whom were implementing cooperative learning strategies in their classrooms after receiving training. Supplemental support was provided throughout the semester.

Researchers used interviews, observation and responses to the SoCQ to examine grouping structure, innovation utilization time, group interdependence, and task complexity. The administration of the SoCQ revealed a high level of concern at the informational stage, which was viewed as inconsistent with the experiences and training level of teachers. A high degree of concern at the awareness or informational stage is typical of non-users who have little or no prior knowledge about an innovation. A CBAM consultant explained that this might be an
indication that users were interested in any information that might help them in their struggle to implement, as opposed to non-users' need for initial information about an innovation. The consultant did not think that developers should be overly concerned.

Two consistently high stages of concern for the teachers in the Hiatt and Sandeen study were "consequences" and "collaboration". This finding was consistent with observations that teachers had very little trouble with management, as long as materials and plans were provided. Teachers appeared to choose activities that were related to student outcomes and appreciated opportunities to discuss grouping strategies with their peers.

Hiatt and Sandeen (1990) believe that the Stages of Concern format proved to be as useful to participants of the innovation as it was to the observers, providing teachers with a structure for reflecting on their own practice. Teachers remarked that "just being asked questions about their decisions caused them to reflect upon their decisions" (p. 15).

The unusual finding in this study, high stage one concerns for experienced users of the innovation, emphasizes the ambiguity of results in some cases. Once teachers have actually begun to use an innovation routinely, they are predicted to become more concerned about personal and managerial effects, according to the
CBAM model (Hord et. al, 1987) Interpretation of concerns profiles should include multiple data indicators, such as follow-up interviews with teachers who have completed the questionnaire.

Bailey and Palsha (1992) present some concern about the psychometric properties of the SoCQ. The authors collected data from workshop participants in a multi-state study of pre-school intervention training. Responses were grouped into seven raw scores and corresponding percentiles, as suggested by developers (Hall, George, & Rutherford, 1986). Factor analysis determined that there are more likely five developmental stages, rather than the seven originally proposed. Additional analyses eliminated Stage 1, "Informational", and Stage 6, "Refocusing", and then reduced the 35 item questionnaire to one consisting of 15 items, three for each of the five remaining stages. However, the study suggests that psychometric problems associated with the Stages of Concern Questionnaire document the need for "a reorganized and shortened version of the questionnaire" (p. 232). The recommendation of Bailey and Palsha (1992) warrants further research.

The decision to use the SoCQ in the current study, as published by Hall, George, and Rutherford (1986), was based on the considerable psychometric information provided by the developers. The authors cite confirming evidence from many studies in which reliability and validity values are
acceptable. The instrument continues to be used extensively in relation to education innovation and staff development.

The CBAM model for change supports the individuality of concerns about and responses to innovations. Because teachers do not all operate at the same stage of concern at a given point in time, they are not likely to implement programs uniformly. Each individual will transform planned change, based on unique understanding, knowledge and comfort levels, into classroom behavior, which will probably be different from one classroom to the next and from one school to the next.

Innovation Implementation

Implementation Studies

For nearly four decades, school systems have adopted multitudes of innovations, many of which were never fully implemented and equally as many that were not sustained (Cuban, 1992; Fullan & Pomfret, 1977; McLaughlin, 1978). Increased reform activity was spurred as a result of increased federal spending for educational improvement initiated after 1965 when legislative action was initiated to improve educational services to disadvantaged or poor children. Known as the Elementary and Secondary Education Act (ESEA), the mandate, created to break the poverty cycle, was outlined in sections or "titles" that identified specific areas to be remediated by increased federal
spending. With the development of large scale reform efforts through ESEA, opportunities to examine the implementation stage of policy became available and, therefore, considerable literature related to implementation resulted from this period.

McLaughlin (1978) examines the implementation of an effort to explain evaluative summaries that described this federal intervention as a failed national experiment. She suggests that the dismal results of some ESEA programs may have occurred because the program was never implemented as reformers had intended. Citing national level data, she notes "that most states and many LEA's have failed to implement their programs in full compliance with existing regulations, guidelines, and program criteria" (p. 165).

Highlighting four factors that are assumed to promote compliance, McLaughlin summarizes possible problems with implementation. The first compliance-promoting factor that was ignored was an inability to articulate common goals. Confusion about federal spending intent began in Washington, D.C., among legislators, and continued downward to local school personnel. While there was general agreement that disadvantaged children could benefit from federal spending, there was little agreement about how to attain the goal. The repercussion from this disagreement was vague and global definitions of need that could include "such disparate terms as student health and nutrition,"
clothing needs, cultural enrichment, socialization skills, and so on" (p. 167). This latitude precluded operational definitions that were specific enough to direct implementation activities or to measure program effectiveness.

The second factor identified by McLaughlin (1978) as critical to compliance was knowledge, which proved to be equally problematic. Knowledge about disadvantaged students and compensatory education was scarce in 1965; few local agencies had ever attempted to design compensatory programs. Federal guidelines did not offer a wealth of assistance. Initially, regulations and definitions for terminology were included in a handbook, but updates added in later publications and, to date, no single publication includes all the regulations, guidelines, and suggestions. Some local administrators felt that they were not able to spend the necessary time to plan effective strategies and interventions because they were too busy trying to interpret "the rules of the game" (McLaughlin, 1978, p. 171).

Provisions for incentives and authority are considered the other factors McLaughlin discusses for promoting compliance. Despite the fact that federal dollars were the primary incentive, the lack of oversight in local agency spending permitted continued funding without determination of proper program implementation. When local agencies did
provide reports to verify proper use of funds, they were often received by federal agencies after funding had already been renewed.

The Office of Education displayed an unwillingness to exert authority over local program and spending determinations, and state education agencies did not volunteer to assume the role. Thus, McLaughlin (1978) defines program authority as "an administrative vacuum in which the determination of ... policy is left to the very unit supposedly subject to oversight--the LEA" (p. 173).

Another particularly disappointing federal intervention was known as the Experimental Schools Program, initiated in the 1970's by the United States Office of Education. First year implementation began with the selection of three sites slated for comprehensive changes in curriculum, staffing, government, evaluation, and community involvement.

A case study of the Jefferson school district (Doyle, 1978) illustrates many of the problems common to participating schools. This school system, including two high schools, two junior high schools, and nine elementary schools, was in great need of money when the federal assistance was announced. Viewing the Experimental Schools project as an outstanding opportunity, the district submitted a proposal for comprehensive change; however, when policy changes were translated into actual procedures
for schools they were confusing and not widely accepted. Many individuals saw these changes as externally imposed.

Implementation was executed in piecemeal fashion. Individual schools adopted only those components of change that were appealing, which were often those paralleling current practice. A lack of coordination from the central office allowed for considerable discretion at the building level. Funds from the grant were not equitably distributed between schools; there was no clear definition for the role of the community in the support of change; and there was indecision about the federal role for project monitoring. Ultimately, evaluations revealed that governance, instruction, and community relations were much the same as they had been prior to implementation of the Experimental Schools Program.

Doyle (1978) believes that careful planning and realistic time frames could have provided successful strategies for managing unanticipated consequences of implementation. He argues that, in a rush to change, individuals and agencies often attempt to begin activities concurrent with planning them.

While Fullan and Miles (1992) suggests that plans for change can only serve as a guide, not a blueprint, he, nonetheless, does consider broad planning by leaders and teachers as a necessary condition for change. Considerable research supports the view that successful change requires
planning for the needs and resources that will be necessary to implement innovations (Berman & McLaughlin, 1978; Corbett, Dawson, & Firestone, 1984; Fullan, 1985; Louis & Miles, 1990).

An extensive field study conducted of 12 innovative programs that operated in 146 schools examined innovations for factors that contributed to or hindered successful implementation (Huberman & Miles, 1983). Programs were most effectively implemented in sites that provided adequate preparation for changes, including availability of resources, sufficient understanding of the innovation, and training for the skills necessary to complete activities.

Huberman and Miles (1983) emphasize a good fit between old and new programs as vitally important at the classroom level. Major changes were much harder to implement, as were programs that allowed little latitude for changes by users of the innovation. Observations of programs linked excessive record keeping, time demands, structural changes in program design, and lack of follow-through on initial design to unsuccessful implementation.

In some ways, the measurement of implementation can be as difficult as the process of implementation. Unlike federal funding, which often provides the money necessary to conduct program evaluations, many innovation plans do not allocate resources for either monitoring or summary
assessments. Studies of innovation implementation rely heavily on responses from teachers and staff who have been directly involved with the project.

Approaches to measuring implementation include foci on fidelity, quality, and degree of implementation. Fullan and Pomfret (1977) distinguish direct on-site observation as "the most rigorous measurement of behavioral fidelity or degree of implementation if the innovation is reasonably well specified" (p. 365). They issue a caution against reliance of individuals' reported use of an innovation since, without intent, responses are not always accurate and respondents' attitudes of acceptance may be unwittingly misleading. Fullan and Pomfret contend that, despite the difficulties inherent in studying implementation, some revelations from previous assessments justify serious consideration. Evaluations from previously implemented programs include timely recommendations about innovation planning, accountability designs, and methodological strategies that are most effective in assessment of program goals (Fullan, 1993). As Fullan suggests, many of the researchers who carefully studied the initiative of the 1960's have "literally grown up with the field" (p. 116).

Innovation Configurations

Research conducted by the University of Texas Research and Development Center explored the process of change and its effect on individuals involved in implementing change.
The result of their efforts was the development of a model known as the Concerns Based Adoption Model (CBAM) (Hall et al., 1986). This theoretical framework posits that innovations cannot be defined by the developers' intended design; rather, they must be described as they appear in actual use by those charged with implementation. Used in education reform research, the model provides a process for describing the degree and patterns of use that teachers exhibit in the implementation of school innovations. One method, developed as part of the Concerns Based Adoption Model, utilizes instruments known as Innovation Configurations to describe the way a teacher interprets and chooses to use changes in the classroom.

Hord and others (1986) explain that teachers begin to alter innovations almost immediately after they are introduced. These individual changes to program design, or innovation configurations, sometimes deviate to the extent that teachers' interpretations of innovations are not recognizable configurations of original intentions. When this happens, the implementation of innovations often fails to be sustained and teachers ultimately return to practices used prior to innovation implementation.

Investigations included in the literature explore sources of teacher influences in choosing strategies and practices. Crocker and Banfield (1986) view the operation of functional paradigms within social organizations as
particularly important to teachers' choice of action. Teachers as "members of a social organization can be considered to operate under a shared paradigm" (p. 806) and, therefore, interpretation of curriculum material is an interactive process. Program failure can sometimes be accounted for in terms of an innovation's incompatibility of program philosophy or components with teachers' collective views of current teaching practice.

Developers of the CBAM model caution that "teachers do not comply with the demands of even the most structured innovations" (Heck et al., 1981, p. 130) and do not believe that curriculum packages can prevent some variation from occurring. Use of Innovation Configurations provides persons involved with implementation opportunity to examine the actual patterns and levels of use of teachers.

Successful programs are the result of the way in which schools and school districts implement programs. Many science education reforms have been developed with federal sponsorship from the National Science Foundation. After many years of extensive funding, only a few science reform efforts have been disseminated beyond the original systems that implemented them.

James and Frank (1988) report that one of the most popular and widely acclaimed National Science Foundation projects could be found in only 12% of classrooms nationwide. To examine the way in which teachers actually
engaged strategies of the innovative science program, James and Frank (1988) developed an Innovation Configuration Matrix. Based on the assumption that "a majority of teachers begin by implementing only selected components of the innovation" (p. 149), the instrument identified those components of the program considered critical to actual implementation and permitted individual assessment of teachers' use of each component. Components were aligned along a vertical axis and contrasted against four observable behaviors that represented varying degrees of innovation implementation, from ideal variations to unacceptable variations. For example, one component was described as "Lesson parts normally used." The ideal implementation was represented by "Usually used" while the unacceptable implementation was represented by "Not at all used."

The research revealed that most teachers in the elementary science program implemented the program in an acceptable configuration since teachers' use was most often described by the variations in the two middle columns of the matrix. The Innovation Configuration, however, allowed program monitors to examine individual teachers' patterns of implementation as they selected their own use patterns for particular program components.

Heck and others (1981) agree that innovation configurations are valuable in examinations of specific
variations made by teachers. Using a configuration designed to provide insight into implementation of a Texas math innovation, program developers were able to identify those practices that had gained widespread use and those that were least used. Resistance to change in many circumstances was found to be the result of an innovation component that was difficult to implement or that was unappealing to the majority of teachers and specific interventions could be designed accordingly.

In another evaluation study, developers of a kindergarten through twelfth grade writing program designed an innovation configuration to assess the degree of implementation that could be observed in classrooms of language arts teachers (Heck et al., 1981). The program was developed to complement the normal language arts curriculum and suggested program activities and guidelines were clearly outlined in a source book for teachers. An initial workshop was conducted to explain how to use the source book and some follow-up workshops were provided as well.

The evaluation process began with the development of a checklist to derive the Innovation Configuration. Developers and teachers found the checklist difficult to conceive because of the flexible nature of the program as an add-on to an institutionalized curriculum. Program developers, however, reported that the development of the
Innovation Configuration was particularly helpful for them in clarifying the definitions and goals of the innovation. The difficulty in development of the instrument provided insight into the innovation's "potential to be ambiguous in practice" (Heck et al., 1981, p. 121). The data obtained from the innovation configuration were utilized to improve program implementation in the next school year.

The difficult development of an innovation configuration for the elementary school writing program (Heck et al., 1981) is a good example of a common problem in implementation research. Difficulties in assessing the implementation process are outlined by Fullan and Pomfret (1977) as the accuracy of the researcher's conceptualization of essential innovation characteristics; the way in which the characteristics are operationalized; the inclusion of appropriate organizational components; and the degree of implementation between nonorganizational and organizational innovation characteristics. The appeal of the innovation configuration might be attributed to the process that requires the identification and definition of program components and corresponding observable behaviors, which serve as indicators for degree of implementation for each component.

In summary, research on implementation can be found for programs initiated with federal funding from programs like those developed as part of the Elementary and
Secondary Education Act. Although, some outstanding recommendations have come from researchers of the 1960s and 1970s, institutionalized school structures and lack of understanding about the personal nature of change continue to confound effective implementation. The Concerns Based Adoption Model provides a method for defining programs and measuring implementation through innovation configuration, which helps to identify effective and ineffective program components and individual teacher interpretations of program policy.
CHAPTER III
METHODS AND PROCEDURES

Overview

The current study examined whether teachers' sense of efficacy, school climate, and stages of concern would affect the manner and extent to which teachers implement a physical science program in elementary schools. The study also investigated the relationship between these variables.

The chapter is divided into several sections that describe the design of the study. The first section provides a description of the program innovation and population selected for the study. Methodology and data collection procedures are described next. These sections include a discussion of the instruments used to measure teachers' sense of efficacy, school climate, stage of concern and classroom implementation of the innovation.

Also described in the chapter is the method used for interviewing the science teachers who were involved in the physical science innovation to confirm responses from the Stages of Concern Questionnaire (SoCQ). Procedures are outlined for document analysis of two components of the physical science reform, known as student portfolios and teacher reflection logs, and the chapter concludes with hypotheses and methods of analysis for each.
Description of the Innovation

The present study was conducted in a large school district comprised of 102 urban, suburban, and rural schools. The district has been highly involved in a district-wide reform that created school advisory councils at every school and school-based enhancement programs such as preschool programs, computer-focused curricula and extended day programs. At the time the present study was conducted, support for the reform effort had waned and the program was in jeopardy of being dismantled by the school board. These circumstances leave administrators and faculties unsure about how to proceed with decision-making structures and program development. Some schools have lost valuable resource allocations for programs due to a change in school board priorities. There is an atmosphere of ambiguity about the future direction of the school system.

With optimistic disregard for the uncertainty in school system direction, many instructional supervisors, principals and teachers have continued to press for educational reforms. In August 1992, a school district team submitted a proposal to the National Science Foundation that would restructure science education in kindergarten through third grade over a five year period. The program was implemented in the summer of 1993 with 17 elementary schools, two teachers per school, who were selected by the staff members assigned to the project. By the fourth year
of the five year funding cycle (1996), all 60 elementary schools in the district will be included. In order to effect this comprehensive change, the training and support for the first cadre of teachers should result in innovation implementation that closely matches program intentions and impediments to change must be identified and addressed.

The goals of the project include retraining teachers to implement both hands-on, activity-based physical science and alternative forms of classroom assessment. A detailed list of objectives and a discussion of each objective is provided below.

**Knowledge Base.** Some research (Riggs & Enochs, 1989) suggests that teachers are hesitant to teach science because they do not have a sufficient knowledge base, especially in the area of physical science. In two three-week summer institutes, teachers selected for the project are provided with the opportunity to study nine physical science concepts and scientific habits of mind, in concert with appropriate pedagogy.

**Ongoing Training and Support.** In order to effect change, training and support should be ongoing and continuous (Hord, 1992; Tye, 1992). Technical assistance, mentoring and modeling are provided through specialists assigned to work directly with the teachers. There are three instructional specialists who work with the teachers weekly and an assessment specialist who visits teachers
once or twice a month; however, teachers can specifically request additional assistance with an activity or assessment whenever needed.

Materials for instruction. Science is frequently neglected because teachers do not have sufficient materials to engage students in lab activities or experiments. The project provides teachers with the necessary equipment to engage students in thoughtful hands-on activities. Material availability is made possible through the establishment of a Science Resource Center, which houses commercially developed science kits at all grade levels, K-6, for check-out of six weeks. Kits are delivered and picked up by specialists and part-time employees.

Alternative assessment. Student assessment has received much attention in the last several years. Research (Wiggins, 1989; Wolfe, 1989) suggests that thoughtful assessment strategies should be closely aligned with instruction. Therefore, teachers are trained and encouraged to use alternative forms of assessment to evaluate students, classroom activities, and program effectiveness. An assessment specialist provides technical assistance in the development of performance-based assessments that evaluate students' understanding of concepts and processes taught through kits or teacher-made units. Portfolios, purposeful collections of students' work products, are an important component of the project
and the assessment specialist meets with teachers to reflect on works found in them.

Teacher mentoring. When reforms are perceived as mandated from the top, teachers may not experience a sense of ownership or commitment to proposed changes (Murphy, 1991). To reduce possible resistance to change, the project employs a mentor teaching strategy by selecting a cadre of teachers who volunteer to serve as teacher trainers. At the end of two years, these science mentor teachers will be asked to assist in the training of additional teachers at other schools in the district.

The objectives of the project are particularly appropriate and timely for examining individual and organizational variables that affect innovation implementation since school systems throughout the country are struggling to implement many of the same strategies. The present study was conducted in the first year of implementation of the elementary science innovation. The teachers have attended the first of two summer institutes, and the course content focused on four of the nine physical science concepts: magnets, sound, color/light and matter and its changes. Teachers also attended monthly meetings, day-long seminars, designed to further teachers' knowledge in the four physical science areas, to provide assistance in lesson planning and assessment, dialog opportunities
among mentor teachers, and an opportunity for teachers to express suggestions or concerns.

The program's teacher selection process began with a letter of application which was extended to all schools in the district. In the letter were described the scope, content and intent of the project. Principals were asked to formally nominate a pair of teachers from their schools who were teaching in kindergarten through third grade. This teacher pair submitted an application that required a list of their qualifications as mentors, including years of experience, professional development history, leadership roles, and education levels. Their philosophy of science teaching must have included a commitment to a discovery, hands-on approach. A panel of five readers, including project staff, rated the application components and the 16 teacher pairs with the highest scores were selected from a total of 28 schools that applied.

Population

The schools and teachers chosen for this study were selected as a result of their voluntary participation in an elementary school physical science reform effort. Although first year implementation included seventeen schools, one school was not included in the study because they have asked to be excluded from future program activities.
Methodology and Data Collection

As the primary interest of the current study is the individual responses of teachers to innovation implementation, the unit of analysis for the measure of teacher efficacy, school climate, stages of concern and innovation implementation is the individual classroom teacher. Data collection included the administration of three instruments, unstructured interviews and documentary analysis.

Measure of Teacher Efficacy

The Teacher Efficacy Scale (TES) (Gibson & Dembo, 1984) is a 30-item instrument that corresponds to and supports the two-component model of efficacy theorized by Bandura (1977). The efficacy expectancy component, identified as Factor 1, Personal Teaching Efficacy, includes 14 items, including teachers' responses to "When a student does better than usual, many times it is because I exerted a little extra effort." The outcome expectancy component, identified as Factor 2, General Teaching Efficacy, includes 16 items, among which is "The amount that a student can learn is primarily related to family background."

The authors sought to develop an instrument that would measure teacher efficacy and to provide evidence for construct validity. Research procedures consisted of three phases: factor analysis of a 30 item instrument known as
the Teacher Efficacy Scale, a multitrait-multimethod analysis investigated the convergence of teacher efficacy over verbal ability and teacher flexibility, and classroom observation data for high efficacy and low efficacy teachers were collected for teachers' use of time and question-and-answer feedback. Gibson and Dembo recommend that future research investigate the relationship between efficacy and situational, organizational, and observable classroom practices.

Results from the initial research conducted by Gibson and Dembo (1984) found only 16 of the items to have reliability values of .45 or higher, and the researchers excluded the other 14 items from subsequent analyses. The lower reliability coefficients may have been due to a sample size too small to provide statistical power to the research design (Keppel & Zedeck, 1989).

The traits of verbal ability, flexibility and efficacy passed the criteria for convergent validity, indicating that teacher efficacy describes a unique teacher attribute with the power to account for differences in teacher behaviors (Gibson & Dembo, 1984). Factor analysis supported the existence of two independent dimensions of efficacy, corresponding to the efficacy components proposed by Bandura (1977). The Gibson and Dembo study also determined that the scale was valid for measuring the construct of teacher efficacy by identifying teachers as
having high or low efficacy based on resulting scores. The study (Gibson & Dembo, 1984) then examined the extent to which teacher classroom behavior varied between the high and low efficacy groups.

The TES, revised to include only the 16 items found reliable in the Gibson and Dembo study (1984), has been used in subsequent research (Tracz & Gibson, 1986; Woolfolk & Hoy, 1990). Pigge and Marso (1993) reported a reliability coefficient of .75 for the General Teaching Efficacy scale and .78 for the Personal Teaching Efficacy scale. In a study of the relationship between teachers' sense of efficacy and school climate, Hoy and Woolfolk (1993) chose to limit the TES to the ten items that had the highest factor loadings in the earlier research. The authors reported a reliability coefficient of .77 for personal teaching efficacy and .72 for general teaching efficacy; thus, reliability did not significantly improve by reducing the scale from 16 items to 10. Therefore, the instrument selected for this study included the sixteen items that were found reliable in the Gibson and Dembo study.

Measure of School Climate

The Organizational Climate Description Questionnaire-Revised for Elementary Schools (OCDQ-RE) (Hoy and Clover, 1986) is a revised form of the 64-item Organizational Climate Description Questionnaire (OCDQ) (Halpin & Croft, 1963), one of "the most widely known conceptualizations and
measurements of the organizational climate of schools" (Miskel & Ogawa, 1988). The theoretical framework for the instrument highlights the importance of leadership behaviors within the context of the organization and relationships of leaders and group members belonging to the organization.

Despite the extensive use of the OCDQ to measure school climate, criticism about the usefulness of six climate distinctions and an inadequacy for describing climates of urban and large secondary schools (Anderson, 1982; Miskel & Ogawa, 1988; Rentz, 1970) led Hoy & Clover (1986) to research and revise the instrument. The revised climate instrument, the OCDQ-RE is shorter, 42-items as compared to the original 64. The six subsets defined by the OCDQ-RE are derived from two general factors. The first factor, openness of teacher interaction, can be described in one of three ways, establishing classifications for teachers' perceptions of other teachers: collegial, intimate or disengaged. The second factor, openness of principal leadership, can also be described in one of three ways, establishing classifications for teachers' perceptions of their principal: supportive, directive or restrictive.

Hoy and Clover (1986) measured reliability of each of the six subscales on the instrument, which correspond with the six subsets of openness. The coefficients for the
three subscales of principal dimensions were determined as .95 Supportive, .89 Directive, and .80 Restrictive and teacher dimension reliability coefficients for subscales were reported as .90 Collegial, .86 Intimate, and .75 Disengaged. Based on these data, and data from other studies (Hoy & Miskel, 1987; Hoy, Tarter, & Kottkamp, 1991), the OCDQ-RE has been established as a reliable and valid instrument for measuring school climate.

The instrument asks teachers to rate their perceptions of their principal and other teachers in the school, using a four point Likert-type scale. Teachers are asked to choose from "Rarely occurs" to "Very frequently occurs". Items 6, 31 and 37 require reverse coding. Scores finally determine schools to have one of four possible climates, "Open", "Engaged", "Closed", or "Disengaged". The TES and the OCDQ-RE were administered to all teachers in the 16 participating schools.

Measure of Stages of Concern

The Stages of Concern Questionnaire (SoCQ) (Hall, George, & Rutherford, 1986) was developed for use with the Concerns Based Adoption Model. There are 35 items expressing such concerns as "I am completely occupied with other things" or "I am concerned about evaluating my impact on students". A seven point Likert-type scale is used, with a value of "0" indicating that the concern is "Irrelevant", a value of "1" indicating that the concern is
"Not true of me now," mid-range values indicate the extent to which the concern is "true of me now" and a value of "7" indicating that the concern is "Very true of me now".

Initial attempts to measure the stages included open-ended questions, forced rankings, interviews and adjective checklists. The quick-scoring, 35 item checklist was used in 11 education innovation studies over two years and instrument validity research was conducted in several of the studies. According to Hall, George, and Rutherford (1986), coefficients for internal reliability for each of the seven stages range from .64 (Stage 0) to .83 (Stage 2). Coefficients for test-retest reliability for each of the stages ranges from .65 (Stage 0) to .86 (Stage 1). Investigations of validity were problematic, but the authors report that "a series of validity studies were conducted, all of which provided increased confidence that the SoCQ measures the hypothesized Stages of Concern" (Hall, George, & Rutherford, 1986, p. 20).

Participant Interviews

Research (Hall, George, & Rutherford, 1986) has suggested that data from the administration and analysis of the SoCQ should be augmented by teacher interview data. In the present study, science specialists, assigned to provide technical assistance and personal support to teachers, met in conferences with teachers throughout the school year. These conferences consisted of lessons related to the
physical science topics germane to the program, discussion about future lessons, reflections of previous lessons and personal concerns of teachers. Information was recorded in specialists' log and retrieved for this study. The specialists used their knowledge of stages of concern to provide appropriate support to teachers.

Teachers were given the opportunity to express concerns about the innovation in January anonymously in writing. At the end of the first year of implementation, teachers were once again provided the opportunity to express, in writing, the concerns they had about the innovation. This activity was designed to provide a relatively risk-free opportunity for teachers to express concerns.

Innovation Configuration Matrix

The Innovation Configuration Matrix (ICM) was developed as an observation protocol specifically for this study; however, innovation configurations have been used in numerous studies to examine teacher implementation of various programs (Crandall et al., 1981; George & Hord, 1980; Gray, 1974; Heck et al., 1981), including a similar science education program (James & Francq, 1988). Innovation Configurations can be used in various forms other than observation protocols including self-reporting checklists and interviews.
Prior to drafting the ICM, the developers of the physical science project identified eight critical components of the desired change as outlined in the original National Science Foundation proposal. These included use of science kits, amount of physical science being taught, balance between process and content, role of student, role of teacher, integration of science and other subject areas, use of small groups, and development of performance-based assessments. For each component, three configurations of implementation are described and identified as ideal, acceptable, and unacceptable. Each category of configuration defines one of three ways in which teachers might interpret and implement the innovation component.

Ideal configurations describe the observable behaviors that are anticipated as a result of the innovation program training and mentoring. Recognizing, however, that most teachers will choose to vary the ideal activities to accommodate their own purposes and constraints, acceptable configurations represent observable behaviors that modify program intentions without compromising innovation standards. Unacceptable configurations are observable classroom behaviors that describe traditional forms of science teaching, and reflect little application of program training and mentoring to actual classroom practice.
The ideal configuration of each component was aligned in the left-hand column, the acceptable configuration of the component was aligned in the middle column and the unacceptable configuration of the component was aligned in the right-hand column. Observations of teachers during science lessons were conducted, teacher reflection logs were scanned, and a random sample of student portfolios were analyzed in each classroom before a decision was made about the actual configuration of each of the critical components.

Because program training and mentoring has been confined to the 17 schools included in the present study, there were no schools available in which to pilot the ICM. Procedures to determine construct validity and reliability were conducted and are explained later in this chapter.

Case Studies

The Innovation Configuration Matrix (ICM) was used to organize and guide observation data that were subsequently used in case study analyses of six teachers selected from the three possible levels of implementation, classified as Level III, for ideal configurations; Level II, acceptable configurations; and Level I, unacceptable configurations. For each level, one teacher, representing the major case, and another teacher, representing the minor case, were presented for comparison and contrast. Major case studies include information related to all eight components of the
ICM, while the minor cases are illustrated by selected innovation components for comparison and contrast of teachers at the particular level of implementation.

The eight innovation components were used as dimensions of contrast, guiding the categorization of observations of teacher behavior related to science instruction. Observations in the latter part of the year became selective, attempting to restrict the focus of the research in order to identify and classify small differences (Spradley, 1979). This type of componential analysis provided for the organization of implementation behavior "onto a paradigm" (Spradley, 1979, p. 84) that is represented in the current study as a table of dimensions of contrast. This table is included in Chapter 5 with the case studies.

**Document Analysis**

Two integral components of the physical science program include student portfolios and teacher reflection logs. Throughout the year, teachers and students engage in purposeful collections of science products that demonstrate students' understanding and ability to apply process and content learning to science activities. These collections are stored in science portfolios and include laboratory observations, data collection, graphs, written or transcribed explanations of phenomena, journal entries, video tapes and/or experiment results.
Portfolios are used as part of program evaluation to determine the quality and diversity of student experiences that were provided throughout the year. Inservice training conducted for teachers in the summer included discussion about the quality and utility of these portfolios. Teachers were encouraged to use them as diagnostic tools, to share them with parents, and to allow students to reflect on past performances. For this study, portfolios were used to provide evidence for actual implementation practices in the analysis of intended and actual program outcomes determined by the ICM.

Weekly, teachers are asked to reflect on one particular science lesson or incident and record their thoughts in a notebook known as the teacher reflection log. The log format asks teachers to consider positive outcomes or incidents, ways in which they could improve on an activity, and to identify concerns or needs that they have at the time. Teachers are encouraged to keep artifacts from activities and to freely respond in addition to, or in place of, the form that is provided in the notebook. The reflection log form is sectioned for comments related to particular science lessons, success stories, difficulties, and provides a checklist of concerns about materials, technical support, time, and student concerns.

The teachers' reflection log is also used in program evaluation. Inservice conducted for teachers in the summer
focused on the usefulness of reflection to teacher practice and practical logistics such as when to reflect and the kind of information that might be included were discussed. For the purposes of this study, teacher reflection logs are used to provide evidence for actual implementation practices in the analysis of intended and actual program components, determined by the ICM. Information from reflection logs and portfolios was triangulated with classroom observation data to provide cross-validation for the classifications of ideal, acceptable, and unacceptable teacher behaviors along each of the eight program components included in the matrix.

Hypotheses and Procedures

To examine relationships posed in the research questions outlined in Chapter 1, hypotheses were developed and tested. These hypotheses, the statistical procedures used, and operational definitions are described in the following section. Of primary concern in this study were the effects of teachers' sense of efficacy, stages of concern and school climate on innovation implementation.

For this study, it was necessary to develop an instrument to measure specific components of the program design in order to examine the patterns, or configurations, of implementation used by individual teachers. Thus, it was important to establish some reliability and validity of
the instrument. The first hypothesis was designed to address this issue, as follows:

Hypothesis 1: The Innovation Configuration Matrix is a valid and reliable procedure for measuring teachers' implementation of the physical science program.

To determine construct validity, the instrument was presented to each of three program staff members, science specialists, assigned to work and conference with the teachers throughout the year, with a checklist. Specialists were asked to read each of the 24 cells created by crossing eight program components with three variations of observable behaviors, labeled as "Ideal", "Acceptable", and "Unacceptable." If specialists agreed that the component and the behavior were accurately described, they were to indicate agreement by checking "Yes." If they did not agree with the description of the component or the behavior, they could disagree by checking "No" or could indicate that "With Modification" suggested by them, the cell descriptions could be improved.

To determine reliability, specialists were then asked to rate the teachers' implementation of the physical science program using the ICM. For each of eight program components, specialists identified and checked the description that most nearly matched teachers' actual classroom implementation behavior. Since specialists were
assigned a portion of the total teachers involved in the project, they rated only those teachers with whom they worked directly. These ratings were compared to the rating of the researcher, providing two ratings for each teacher.

An agreement ratio was also computed between the researcher and each of the three specialists. To analyze the degree of agreement between ICM scores provided by specialists and ICM scores provided by the researcher, the total number of agreeing cell scores was divided by the total number of cell scores possible (8 cell scores X number of teachers rated).

Of primary concern in the present study was whether teachers participating in an innovative physical science program exhibited discrete implementation responses as a result of differences in their sense of efficacy. With this in mind, the current study advanced the following hypothesis:

**Hypothesis 2:** Teachers' sense of efficacy, school climate, and stages of concern are correlated with the innovation implementation of a physical science program.

Statistical analysis selected to test this hypothesis was a multiple linear regression. Total scores for the TES, the OCDQ-RE, and the SoCQ were entered as predictor variables on the dependent variable, total score on the ICM. The procedure was selected because it is known to be
useful in summarizing data as well as for studying relationships among variables (Norusis, 1993).

**Computation of Scores**

First, a score was determined for the three independent variables as follows. To determine individual scores for efficacy, responses from each of the 30 items included on the questionnaire were added together, reverse coding all personal efficacy items. Organizational climate was computed by, first, calculating standardized scores for each of the six subscales (Directive, Restrictive, Supportive, Collegial, Disengaged, and Intimate). The Directive, Restrictive, and Supportive subscales were used to determine a score for Principal Openness, and the Collegial, Disengaged, and Intimate subscales were used to determine a score for Teacher Openness. The two Openness scores were added together to get a total climate score, as outlined by Hoy and others (1991). Stages of Concern posttest data were also included in the analysis. For the regression analysis, a total score was computed by adding item responses from the 35 items on the instrument.

To compute a score for the dependent variable, innovation implementation, the Innovation Configuration Matrix data were quantified. By crossing eight program components, along a vertical axis, with three variations of observable behavior for each component, along a horizontal axis, 24 cells are created. Teachers' actual
implementations of program components were compared to the behaviors described by each cell. Component behavior identified as "Ideal" was awarded three points; behavior identified as "Acceptable" was awarded two points; and behavior identified as "Unacceptable" was awarded one point. Therefore, if a teacher's implementation of the physical science program closely matched the "Ideal" behavior described in eight cells, the teacher was awarded a total of 24 possible points.

Analysis of Data Using MRC

Using SPSS for Windows, a correlation matrix was calculated to examine possible relationships between all variables, following which, the three scores computed for the independent variables were analyzed with the score computed for the dependent variable using multiple regression with stepwise analysis. Since the sample size was small (n=31), mean substitution was used to handle cases with missing values for some variables.

This study also investigated whether the physical science teachers expressed different stages of concern at the beginning of innovation implementation than at the end of the first year of implementation. Specifically, the CBAM model proposes that teachers will progress through seven stages of concern in a developmental fashion. If the data support the model, teachers' concern about the physical science program should yield evidence of a
developmental progression through stages. Hypothesis 3 stated below was developed to test this proposition.

Hypothesis 3: Teachers' concerns will progress from a high concern at the bottom end of the Stages of Concern scale to a high concern at the upper end of the scale by the end of the project year.

To compare stages of concern at two points in time, the 34 program teachers were asked to complete the SoCQ in October, at the beginning of implementation and again in May, eight months after implementation began. Profiles were developed from both sets of responses for each of the teachers, using procedures discussed in "Guidelines for Interpretation of the SoC Questionnaire Data" found in Measuring Stages of Concern About the Innovation (Hall, George, & Rutherford, 1986) and are summarized briefly below. Once raw scores have been converted to percentile scores, using the procedures outlined by developers, the percentiles are plotted onto a graph. The vertical axis of the graph represents the relative intensity of the concern, as represented by the percentile score provided by the table. The horizontal axis represents the seven stages of concern. Individual graphs are completed to provide a profile for each respondent. Figure 3.1 exemplifies the profile of a nonuser, illustrating the pattern created by a high degree of concern at the bottom end of the stages.
Figure 3.2, on the other hand, represents the typical profile of a program user who expresses a high degree of management concerns.

The profiles identify the stages of concern with the greatest intensity, and the pattern that is produced by plotting the value for each stage of concern is compared to those provided by the developers for interpretation. Profiles for the first and second administration were compared to determine if teachers' concerns demonstrated higher level concerns at the end of the first year of implementation.

In the initiation stage of innovation implementation, teachers are expected to express concerns about lack of information or understanding and the personal effects that will result with proposed changes. Questions about implementation include "How does this innovation actually work?" or "How much more work is this going to be for me?" The present study proposes that when teachers' concerns are greatest in the areas of awareness and personal concerns (Stages 1 and 2), they are likely to be unsure of what to expect as a result of changes in classroom practice, reducing feelings of personal efficacy.

As teachers' concerns shift from informational or personal ones to concerns about how they can encourage others to try innovative strategies and how the innovation
Figure 3.1
Stages of Concern Profile: Nonuser/Awareness Concerns
Figure 3.2
Stages of Concern Profile: Management Concerns

RELATIVE INTENSITY

0 20 40 60 80 100

0 1 2 3 4

SOC STAGES

MANAGEMENT
CONSEQUENCE
COLLABORATION
REFOCUSING

INFORMATIONAL
PERSONAL
AWARENESS
can be refined to better suit students' needs (Stages 5 and 6), concerns about innovation now focus away from the teachers.

Concerns at the upper end of the scale focus on students and collaboration with peers. These concerns may be indicated by statements such as "This method is quite effective for my students, so how can I encourage other second grade teachers to try it?" or "What would happen if I restructured my cooperative groups from four students to two in order to reduce time students waste quarreling?" At this point, teachers' confidence may be greater, reflecting a willingness to engage or experiment with the strategies.

Interviews with teachers were conducted during their conference periods with specialists; at monthly meetings; or during class visits. Concerns expressed by teachers in interviews were categorized using the seven stages of concern identified in CBAM and this information was used to corroborate the scores obtained on the SoCQ (Hall, George, & Rutherford, 1986).

The written records of interviews were analyzed qualitatively using a procedure described by Miles and Huberman (1984). Codes were created for each stage of concern and are described as 0-AWARE, 1-INFO, 2-PERS, 3-MAN, 4-CONS, 5-COLL, 6-REFOC. Using the codes, data were scrutinized in segments, or codeable units, to determine the focus of teachers concerns, and data segments were
labeled and indexed. This method was used by Fuller (1973) in the examination of concerns of preservice teachers. In the current study, once the data were classified by concern, data segments were reexamined for patterns and confirming evidence.

Summary

The current chapter described the instruments and methods that were used to define the variables and this information is presented in Table 3.1. Hypotheses were presented with explanations for testing procedures. Results of data analysis are presented in Chapters IV and V.
Table 3.1  
**Summary of Instruments/Methods**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Instruments/Methods</th>
<th>Unit of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td><strong>Teacher Efficacy Scale</strong> (Gibson &amp; Dembo, 1984)</td>
<td>Teacher</td>
</tr>
<tr>
<td>Climate</td>
<td><strong>Organizational Climate Description Questionnaire-Revised Elementary</strong> (Hoy &amp; Clover, 1986)</td>
<td>Teacher</td>
</tr>
<tr>
<td>Stages of Concern</td>
<td><strong>Stages of Concern Questionnaire</strong> (Hall, George, &amp; Rutherford, 1986)</td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Unstructured Interviews</td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Anonymous Essay Response</td>
<td>Teacher</td>
</tr>
<tr>
<td>Innovation Implementation</td>
<td><strong>Innovation Configuration Matrix</strong></td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>Teacher; Students</td>
</tr>
<tr>
<td></td>
<td>Document Analysis</td>
<td>Teacher; Students</td>
</tr>
</tbody>
</table>
CHAPTER IV

RESULTS

The current chapter presents the results of a study designed to examine the first year implementation of an innovative physical science program. Teachers' sense of efficacy, school climate, and teachers' expressed stages of concern were analyzed for correlation with individual teachers' innovation configurations, a measure of actual classroom implementation. The first section reports descriptive statistics for each of the four variables, and the second section presents the statistical findings of a multiple regression analysis. The final section includes quantitative and qualitative data related to the stages of concern of teachers in the program.

Descriptive Statistics

The first step in the quantitative analysis was to compute descriptive statistics for the independent variables, teacher efficacy, school climate, and stages of concern, and the dependent variable, innovation implementation. Included in this description are the means, standard deviations, and ranges of scores for each variable. The data are displayed in Table 4.1.

Teacher Efficacy

In the spring semester of the first year of implementation, teachers were asked to complete the Teacher Efficacy Scale (TES). This instrument measures two
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (n = 31)</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>68.48</td>
<td>69</td>
<td>8.11</td>
<td>55.00</td>
<td>88.00</td>
</tr>
<tr>
<td>Climate</td>
<td>1068.97</td>
<td>1055</td>
<td>219.24</td>
<td>634.39</td>
<td>1434.09</td>
</tr>
<tr>
<td>Concern</td>
<td>124.07</td>
<td>126</td>
<td>36.71</td>
<td>59.00</td>
<td>185.00</td>
</tr>
<tr>
<td>Innov. Conf.</td>
<td>18.50</td>
<td>18</td>
<td>4.14</td>
<td>9.00</td>
<td>24.00</td>
</tr>
</tbody>
</table>
dimensions of efficacy, as proposed by Bandura (1977). The first dimension, general teaching efficacy, examines teachers' perceptions related to what effect teaching has on students despite other factors that might influence learning, such as socioeconomic levels, parent education levels, and student attitudes. The second dimension, personal teaching efficacy, addresses the extent to which teachers' believe themselves able to perform certain skills and behaviors that influence learning.

Since available literature suggests a relationship between teacher efficacy and implementation of education innovation, a total efficacy score derived from administration of the TES was a predictor variable in a multiple regression analysis. Additionally, a median efficacy score for efficacy was computed to be 69 (see Table 4.1). This median value was used to separate the teachers into two subsets, high and low efficacy teachers, for the qualitative analysis, which follows in Chapter 5.

School Climate

School climate has been examined in relation to implementation of educational reform. The theory proposed by Hoy, Tarter, and Kottkamp (1991) suggests that open climates provide an environment for supporting and promoting opportunities for change. Two dimensions of climate, reported as principal openness and teacher openness, are measured here to determine how principals
and teachers are perceived to interact with each other as they create and carry out school policies, procedures, and practices. To examine the contribution of school climate to variations in innovation implementation, school climate was operationalized by computing a total score for the Organizational Climate Description Questionnaire-RE, derived from summing scores from two dimensions, principal and teacher openness.

Stages of Concern

The process of change has been conceptualized as a developmental progression through a series of concerns and reactions to implementation (Hall, George, & Rutherford, 1986). It is expected that teachers will express the greatest concerns around the initial stages of awareness and information in the early periods of implementation, and with appropriate intervention over time, teachers' concerns will shift to concerns about consequences for students and collaboration with others. For inclusion in the multiple regression analysis, a total concern score was computed. Additional information and analysis related to Stages of Concern are included in the last section of this chapter.

Innovation Implementation

Teachers were rated on eight components of the physical science program using the Innovation Configuration Matrix (ICM). To determine inter-rater reliability of the instrument, science specialists were asked to rate the
teachers using the ICM and the scores were analyzed with the scores of the researcher using Pearson Product Moment Correlation Coefficient. The correlation, \( r = .94 \), supports the reliability of the ICM to measure program implementation.

Two ratings were determined for each science mentor teacher, including the ratings provided by the researcher and the rating provided by the science specialist assigned to work with the teacher. Since three specialists are specifically assigned to a portion of the teachers sampled in the study, the ratings provided by specialists were a compilation of scores from three individuals. To examine the agreement of ratings between the researcher and each of the specialists, an agreement ratio was calculated by dividing the number of component scores that showed rater agreement by the total number of component scores. For example, one specialist is assigned to work with twelve teachers. She rated each of these teachers on eight components, resulting in a total of 96 component scores. To obtain an agreement value of .85, the specialist and the researcher must agree on 82 implementation components. The ratios computed between the three specialists and the researcher for the present study were quite similar, with values of .83, .83, and .86. These values indicate a high level of agreement (Borg & Gall, 1983) between raters.
Total scores for teachers' innovation configurations were computed by summing the cell scores. For each of eight program components, a teacher could receive a minimum of one point, indicating that the innovation configuration of the teacher most nearly matched the behavior described by the cell for Level I implementation, or a maximum of three points, indicating that the teacher's innovation configuration most nearly matched the behavior described by the cell for Level III implementation (see appendix). Therefore, a perfect score of 24 would indicate that the teacher's innovation implementation configurations match all eight cells described for Level III implementation.

The eight components identified in the ICM are presented in Table 4.2. Also displayed are the percentages of teachers who were rated for each of three levels of implementation: "Level 3" represents ideal implementation, "Level 2" acceptable implementation, and "Level 1", unacceptable implementation.

Multiple Regression Analysis

Before running the multiple regression model, a correlation matrix was developed for the three independent variables, teacher efficacy, school climate, and stages of concern, and the dependent variable, innovation configuration. As the information included in Table 4.3 indicates, a statistically significant correlation
Table 4.2

Percent of Teachers Scoring at Three Levels of Implementation

<table>
<thead>
<tr>
<th>Innovation Component</th>
<th>Implementation Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. Use of Kits</td>
<td>34%</td>
</tr>
<tr>
<td>2. Balance between life, earth, physical science</td>
<td>75%</td>
</tr>
<tr>
<td>3. Balance between process skills and science content</td>
<td>53%</td>
</tr>
<tr>
<td>4. Role of teacher becomes facilitative</td>
<td>47%</td>
</tr>
<tr>
<td>5. Role of student becomes active, self-directed</td>
<td>47%</td>
</tr>
<tr>
<td>6. Science is integrated with other subjects</td>
<td>37%</td>
</tr>
<tr>
<td>7. Use of cooperative groups</td>
<td>44%</td>
</tr>
<tr>
<td>8. Use of performance assessment</td>
<td>9%</td>
</tr>
</tbody>
</table>
Table 4.3

Correlation Matrix for Variables Included in Regression

<table>
<thead>
<tr>
<th></th>
<th>Efficacy</th>
<th>Climate</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innov.Conf.</td>
<td>Efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate</td>
<td>-.076</td>
<td>p = .341</td>
<td></td>
</tr>
<tr>
<td>Concern</td>
<td>.4399</td>
<td>-.1638</td>
<td>-.1335</td>
</tr>
<tr>
<td>Innov.Conf.</td>
<td>.1505</td>
<td>.1362</td>
<td>-.1335</td>
</tr>
</tbody>
</table>

p = .209  p = .233  p = .241
(r = .44; p < .05) was found between teacher efficacy and stages of concern.

The three independent variables were entered as predictors of the dependent variable, innovation implementation, in a multiple regression analysis and the results are presented in Table 4.4. The predictive value of the variables was not found to be statistically significant, as the R Square value indicates that a small 8% of the variation in implementation could be attributed to the independent variables selected for study. It should be noted that the small sample size available for the study might be too small to provide sufficient power for statistical tests. The small proportion of variance explained by the independent variables does not imply practical significance in any case.

Analysis of Stages of Concern Data

Quantitative Analysis

The data indicated that there was a shift in teachers' concerns in the predicted direction. This shift is illustrated in Table 4.5. The graph compares pre- and post-implementation percentages of teachers for stages of highest concern. Survey results from the first administration of the Stages of Concern Questionnaire (SoCQ) indicate that 33% of teachers had concerns at Stage 0, compared with 4% who expressed concerns at Stage 6. At the end of the year, 42% express concerns at Stage 5. Of
**Table 4.4**

**Multiple Regression Analysis**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>.1249</td>
<td>.1012</td>
<td>.2447</td>
<td>1.234</td>
<td>.2274</td>
</tr>
<tr>
<td>Climate</td>
<td>.0023</td>
<td>.0035</td>
<td>.1205</td>
<td>.657</td>
<td>.5163</td>
</tr>
<tr>
<td>Concern</td>
<td>-.0245</td>
<td>.0229</td>
<td>-.2136</td>
<td>-1.068</td>
<td>.2948</td>
</tr>
<tr>
<td>Constant</td>
<td>10.5815</td>
<td>7.6302</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.5

Pre-/Post-Implementation Differences in Stages of Concern

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pre</th>
<th>Post</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>33%</td>
<td>13%</td>
<td>Decrease</td>
</tr>
<tr>
<td>Stage 1</td>
<td>8%</td>
<td>7%</td>
<td>Decrease</td>
</tr>
<tr>
<td>Stage 2</td>
<td>13%</td>
<td>21%</td>
<td>Increase</td>
</tr>
<tr>
<td>Stage 3</td>
<td>13%</td>
<td>10%</td>
<td>Decrease</td>
</tr>
<tr>
<td>Stage 4</td>
<td>7%</td>
<td>5%</td>
<td>Decrease</td>
</tr>
<tr>
<td>Stage 5</td>
<td>25%</td>
<td>42%</td>
<td>Increase</td>
</tr>
<tr>
<td>Stage 6</td>
<td>4%</td>
<td>4%</td>
<td>No change</td>
</tr>
</tbody>
</table>
the 26 teachers who completed surveys in October and June, 13 respondents had shifted to a higher stage of concern, while 11 respondents had not changed, and one expressed concern at a lower level. Of the eleven respondents who did not change, six had expressed their greatest concerns related to collaboration, or Stage 5, in the beginning of implementation.

It is not surprising that the stage associated with concern about collaboration with others is important to the teachers in the program under study. These teachers are expected to be science mentor teachers and will be a crucial component for the successful implementation of future activities. In the first two years of the project, however, teachers are not expected to train other teachers or serve in any mentoring activities. Therefore, first-year training did not address mentoring concerns, as program developers focused on professional development related to science content knowledge, instruction and assessment of students.

As is seen in the table, teachers did not express great concern for student consequences, Stage 4, at either time of administration, although teachers frequently mentioned performance-based student assessment as a particularly difficult component of the program. Performance assessment will be discussed more specifically in the final chapter of the study.
Qualitative Analysis

To corroborate the empirical study of the developmental progression of stages of concern, 218 segments of information obtained from interviews, teachers' reflection logs, and an open-ended writing exercise were coded, chronologically arranged, and analyzed using the seven stages of concern identified by the Concerns-Based Adoption Model (Hall, George, & Rutherford, 1986). Data indicate that in the earliest phases of the project, teachers expressed confusion due to insufficient information about program components and commitments. Some teachers admitted that they had access to only a few details from their principals upon entrance to the project. As one teacher explained, "I didn't know what to expect when I signed up." Another teacher explains, "I have gotten frustrated at times because of the unknown—For example, science portfolios, classroom expectations, and general information about the project."

Some of the confusion and frustration at the beginning of the year came about as teachers realized they had underestimated the investment of time and work that was required to implement the project. "I didn't realize it would be so time consuming." A second grade teacher commented, "I knew [the program] would require a lot of hard work, but not as much work as I find myself having to do." Only occasionally did teachers mention unexpected
positive consequences in the first few months of implementation. As one teacher commented, "It has been a great deal of work, maybe more than I anticipated, but the rewards have also been greater than I had expected."

At the beginning of the second semester, teachers' comments, in general were more positive, but continue to reflect a personal focus. Participants explained to their specialists that they had become more comfortable with the program than they were initially and had begun to recognize personal and professional reward. One teacher explained, "I'm more confident teaching science" and another teacher remarked, "This program has really sparked a new interest that I really enjoy." At midterm, about 15% of teachers remained uneasy about their participation in the program and negative remarks also take on a more personal vein, such as, "When I'm at school, I feel all alone in this program" or "It's very stressful."

Midway through the first year of implementation, the greatest concern of teachers appears to be time, a Stage 3 (Management) concern. Repeatedly, teachers reported how difficult it was to devote attention to science kit teaching and to monthly staff development meetings. One teacher's comment was representative of many others when she reported, "It's hard to devote the required time necessary to ensure that the science is being done well."
Another wrote, "I've been fast on my feet this year...but that is stressful."

As has been mentioned, teachers did not appear to focus on the effects of program on students during the first year of implementation. Of the segments studied from the first semester, only seven comments were related directly to student impact. Five of these were positive, including one related to attitudes. "The excitement that is going on with the children is a positive thing."

Another comment, from a kindergarten teacher, described a perception of academic benefit. "It has really gotten to the depth of what is really needed for children." One teacher expressed concern about the appropriateness of the physical science content. "Some of these concepts are too advanced for my students."

Later in the year, however, teachers began to relate the program to students more frequently, especially when they speak of students who often have limited success in other major subject areas. The last entries in reflection logs became very focused on students' reactions and responses to science lessons, a departure from earlier concerns about such logistics as the lessons themselves, time restraints, or faulty materials. Teachers' descriptions of science lessons frequently included references to student performance. Comments included, "I'm shocked at how the lower achievers excel in this type
of learning," and "The activity was non-threatening and it gave the children the opportunity to learn from each other."

Interestingly, many comments included mention of students who do not typically perform well in other academic areas. One third grade teacher revealed, "Students were very successful [with this activity]. All the students completed a circuit. Most of my students that were below grade level were the first to complete the circuit."

Although teachers did not discuss consequences for students directly, comments about the development of performance-based assessment indicated this component of the program was quite difficult for teachers. Throughout the year, assessment was mentioned as confusing, elusive, and even frightening. As one teacher acknowledged, "It’s what we were all afraid of in the beginning." The range of comments included, "I need help with portfolios. I don’t know how to decide what to put in them," to "I sometimes think of good activities to use as assessments, but then I don’t know how to score them. Other times, I’m just giving them (students) recall again."

The low percentage of concern with student consequences seems somewhat contradictory in light of the frequency with which teachers discussed problems with assessment. Based on the data from interviews and
reflection logs, it appears that teachers' concerns about consequences of the program's impact on students is a very different issue than teachers' concerns about how to design assessments for students.

In the middle of the first year of implementation and continuing through May, peer collaboration was frequently cited as an important component of the program by many teachers. In interviews, when teachers speak of advantages of program participation, references were made to the bonding that occurred among participating mentor teachers, particularly with high concern at Stage 5 (Collaboration). As one teacher explained, "The network of teachers provides a strong base for each of us to grow." When another teacher was asked about the strength of the program she replied, "Working with people who have a common interest and desire to forge on." The collaboration that teachers spoke of has extended into areas other than science. The first grade teachers, representing seven schools, told specialists they met in the summer at the close of the first year of the project to plan the scope and sequence of their mathematics instruction for the upcoming year (in addition to designing grade level plans for using science kits). Similarly, other teachers report calling each other frequently to discuss a newly adopted reading series that is difficult to implement.
At the end of the first year, 21% of teachers remained greatly concerned about how program components affected them personally. Throughout the year, three teachers voiced dissatisfaction with the lack of freedom to choose science units and determine when units would be taught. One teacher dropped out of the program in frustration. At the beginning of the year, this teacher’s stage of concern profile was unique because concerns were extremely high, over 90%, at every stage of concern, indicating a warning to facilitators that the respondent had a high degree of concern about the program in several areas. Throughout the year, she voiced strong opposition to many program components. The teacher, respected by her peers for her strong understanding of science content, reported that the program was restrictive and would not contribute to her professional growth. She once wrote, "I expected that we would be treated as responsible mature adults, rather than as junior high school students".

Hord (1992) proposes that leadership for change "cares deeply about and for individuals in the system, providing the human interface in personalized ways that stem not only from the mind but from the heart as well" (p. 78). The Stages of Concern model suggests that the provision of materials and content knowledge will not insure change. The model recommends attention to the varied and shifting needs of individuals throughout the implementation process.
The data provided by interviews and analysis of documents are consistent with some of the patterns that emerged from responses on the Stages of Concern questionnaire. In the first year of implementation, teachers' expressed Stages of Concern have progressed in the predicted manner proposed by the Concerns Based Adoption Model. In Chapter 5, case studies of six teachers' innovation implementation configurations are presented, and explanatory themes are developed to summarize the data obtained from the case study data base.
CHAPTER V
CASE STUDIES OF SELECTED TEACHERS

Overview

In Chapter 4, teachers' sense of efficacy, school climate, and teachers' expressed stages of concern were examined in relation to innovation implementation of a physical science program. The results of statistical analyses and a discussion of major findings were presented. The current chapter examined six teachers included in the sample of the 32 mentor teachers directly involved with implementation of the physical science innovation. The chapter begins with methodology for identifying, recording, and analyzing qualitative data for the case studies. A discussion of teacher selection for cases follows methodology. The six cases are presented together and are summarized to conclude the chapter.

Methodology

The present chapter was designed as a multiple case study for the purpose of describing actual classroom implementation responses to the physical science program. Multiple sources of information were triangulated to support the validity of results (Yin, 1989). Spradley (1979) recommends the inclusion of four primary sources of data, described as notes, narratives, documents, and
tabular material, three of which were used to construct the case study data base developed for the current chapter.

The eight program components described by the Innovation Configuration Matrix (ICM) served as dimensions of contrast for constructing case studies, in addition to quantitative data for teacher efficacy and school climate. The dimensions of contrast are as follows: use of science kits; increased emphasis on physical science topics; role of teacher; role of student; integration of science and other subject areas; use of small groups; development of performance-based assessment; level of teacher efficacy (high or low) based on a median split of total efficacy scores; and classification of school climate (open, engaged, closed, or disengaged).

Case study notes ensued from several activities: 1) observations of teachers in the classroom and as participants in group meetings (a minimum of 5 classroom observations and 6 group meetings); 2) informal interviews with teachers (minimum of 5); and 3) formal and informal interviews with three of the four science specialists (minimum of 10).

Classroom observations were conducted throughout the year in science teachers' classrooms, using the ICM as an observation protocol to focus observations on the contrast of teachers' implementation behavior. Field notes were recorded and included a general description of the lesson,
directions, questions, and actions taken by teachers and students.

Interviews were conducted during regularly scheduled conference times. Since the researcher was able to make frequent visits to the sites, many additional opportunities were available to record teachers' interactions with other teachers and responses to various program activities.

Four types of documents were reviewed for the present study. Included are teachers' reflection logs, students' science portfolios, monthly meeting evaluations, and science kit circulation records, although logs and portfolios were not provided by one teacher in the study. All documents were reviewed at the close of the first year of implementation.

Finally, narratives were retrieved from two sources, a parent survey and a written, open-ended question exercise administered to teachers in December, 1993. As with observation notes, data obtained from narratives and documents were examined and analyzed using the dimensions of contrast previously described. Table 5.1 displays the average time spent on data collection and analysis for each of the data base components for the six teachers included in the case study (additional time was spent collecting and analysing data for all mentor teachers participating in the project).
Table 5.1

Case Study Data Base: Sources and Hours Logged

<table>
<thead>
<tr>
<th>Case Study Activity</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Study Observations:</td>
<td>44</td>
</tr>
<tr>
<td>Teacher Interviews</td>
<td>18</td>
</tr>
<tr>
<td>Specialist Interviews</td>
<td>35</td>
</tr>
<tr>
<td>Review of Teacher Log (one log was unavailable)</td>
<td>9</td>
</tr>
<tr>
<td>Review of Student Portfolios (one class set unavailable)</td>
<td>20</td>
</tr>
<tr>
<td>Science Kit Circulation Records</td>
<td>2</td>
</tr>
<tr>
<td>Monthly Meeting Evaluations</td>
<td>10</td>
</tr>
<tr>
<td>Parent Narratives</td>
<td>15</td>
</tr>
<tr>
<td>Teachers’ Written Responses</td>
<td>15</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>168</strong></td>
</tr>
</tbody>
</table>
Selection of Teachers

The science teachers were classified as having one of three levels of implementation based on the results of the Innovation Configuration Matrix (ICM). Teachers identified as having achieved Level III implementation were assigned "Ideal" ratings in at least five of eight program components included on the matrix. Teachers who had achieved Level II implementation were assigned ratings of "Acceptable" on at least five of eight components, and teachers who were classified as having Level I implementation were assigned ratings of "Unacceptable" on at least five of eight components.

Six teachers were selected for inclusion in the case studies: for each of the three innovation configuration levels, a major case and a minor case was developed. Major cases included information for all dimensions of contrast, while minor cases used particular dimensions that provide corroborating and contrasting implementation responses among individual teachers and between groups. Pseudonyms have been utilized for all teachers and schools included in the studies, and genders have been altered in order to preserve confidentiality. Specific information for major and minor cases levels is presented in Table 5.2.
### Table 5.2

**Innovation Configuration Dimensions of Contrast**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Level III</th>
<th>Level II</th>
<th>Level I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
</tr>
<tr>
<td>Kits</td>
<td>I</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Balance</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Process/Content</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Role of Teacher</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Role of Student</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Integration</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Use of groups</td>
<td>I</td>
<td>A</td>
<td>I</td>
</tr>
<tr>
<td>Assessment</td>
<td>I</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Efficacy</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Climate</td>
<td>O</td>
<td>O</td>
<td>C</td>
</tr>
</tbody>
</table>

**Key to Symbols**

- I - Ideal Configuration
- A - Acceptable Configuration
- U - Unacceptable Configuration
- H - High Score for Efficacy
- L - Low Score for Efficacy
- O - Open School Climate
- E - Engaged School Climate
- D - Disengaged School Climate
- C - Closed School Climate
Table 5.3

Teachers' Use of Science Kits

<table>
<thead>
<tr>
<th>No. of Kits Used</th>
<th>Science Discipline Represented</th>
<th>Description of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 4 of 4</td>
<td>Life/Physical</td>
<td>Used kits fully.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>other subjects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helped with revision of kit. Designed assessment for kit.</td>
</tr>
<tr>
<td>T2 2 of 4</td>
<td>Life/Physical</td>
<td>Used kits fully.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>other subjects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provided valuable input to group assessment design.</td>
</tr>
<tr>
<td>T3 2 of 4</td>
<td>Physical</td>
<td>Used one kit fully.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selected lessons from other kit. No integration. Did not feel training was sufficient.</td>
</tr>
</tbody>
</table>

(table con’d.)
<table>
<thead>
<tr>
<th>T4</th>
<th>2 of 4</th>
<th>Life</th>
<th>Used kits as supplement to teacher-made units. Not much integration with other subjects. Frequently reported she did not need kits.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5</td>
<td>1 of 4</td>
<td>Physical</td>
<td>Used kit fully. No integration with other subjects. Pleased with worksheets provided.</td>
</tr>
<tr>
<td>T6</td>
<td>1 of 4</td>
<td>Life</td>
<td>Used kit fully. Kit use corresponds with first use of student journals.</td>
</tr>
</tbody>
</table>
The Cases

Level III: Mrs. Ward (Teacher 1)

Parker School is nestled in a quiet middle class subdivision in a rural area of the parish. The facility is not new (there has been no building activity in this school system for twenty years), but it is in much better condition than many other system schools. The majority of students in the school are white and from lower middle class, predominantly blue collar families. The parent involvement at the school is unusually high, due in part to the outstanding administrator of the school. At the time of the present study, there was little teacher turnover.

Mrs. Ward is one of a cohort of excellent teachers, yet she commands attention even among them. The science specialist assigned to work with Mrs. Ward reports that, "other teachers often seek her advise." Her planning reflects the serious dedication, the strong science knowledge base, the high sense of efficacy, and the distinct pleasure in her art that is the essence of this teacher. Children learn in her classroom. One parent proclaims that her son "comes home all excited about whatever they are studying that day. We as parents have enjoyed watching him learn." Another parent explains that her child "has taught me things that I wasn’t aware of."

Mrs. Ward has used all the science kits available to her at her grade level and has developed a few mini-kits of
her own. She has expressed her enthusiasm for the kits to "anyone who will listen," reports the science specialist and Mrs. Ward explains that her only complaint about kit teaching is that "there aren't enough of them and they're not in my classroom all year!"

Students in this class work in groups every day. These groups rotate through various science stations that are each designed to develop understanding of a single science concept. During one week, students learned about color by mixing colors of jello, separating secondary colors through chromatography, and looking at colored newspaper photographs through magnifying lenses. As they journey through the various experiences, they are required to record the new things that they learn in journals.

The physical science program encourages teachers to integrate science with other subject areas such as math and language. Although Mrs. Ward teaches in a departmentalized program, she is responsible for math and science for two classes and it is sometimes difficult to distinguish which subject is actually being taught. Science topics are frequently used as thematic approaches to teaching, and boundaries between subjects are obscured. Astronomy lessons include trips to the Starlab, charts for recording the number of days that occur in each phase of the moon, a large black bulletin board with twinkling lights arranged on it to model the night sky, and children bringing pillows
and teddy bears to school so that they can lie on the floor, look up into the "sky" and listen to Mrs. Ward reading *Ira Sleeps Over*.

One commitment that schools were obliged to make upon application to the physical science program was teachers' full-time access to computers. Mrs. Ward utilizes computers as one of the stations in the science center rotation. Although Mrs. Ward had one new computer, she scavenged additional models that were old but, according to her, "still did the job."

Mrs. Ward was the first mentor teacher in the physical science program to express a desire to design a performance assessment. With the assistance of the assessment specialist, she administered a hands-on test of magnets. Mrs. Ward expressed shock when she discovered that some children really did not understand the properties of magnets, although they seemed to articulate information about magnets quite well in class discussions.

Mrs. Ward's principal reports that everyone in school heard about the assessment experience. Mrs. Ward has attempted to try other innovative kinds of assessments including journals, exhibitions, and projects. Students' journals clearly demonstrate the progress that they make over the course of the school year. One child's mother was overwhelmed by the difference in her son's journal. In October, he was unable to write anything legible, but by
March this child could recount an experience with a balls and ramps unit, writing, "When the ramp is high, the ball rolls fast but when the ramp is flatter, the ball rolls real slow."

Several of the science journals were included in the class science portfolios. The entries of the students' portfolios are regular, at least one per month, and serve as evidence of the diverse hands-on experiences afforded to students. Included in addition to journal excerpts are drawings, graphs, artifacts from experiments and computer print-outs. Physical science topics represent more than one third of the total science topics covered throughout the year. Much of the work included in the portfolios required students to express themselves in writing. Inventive spelling was encouraged, as Mrs. Ward once explained to them, "Just do the best you can. Don't be too worried about how to spell words. Write what you observed or did."

Mrs. Ward does not always feel as if she has been totally successful. For example, she described her effort to build a checklist for an exhibition, noting "I thought I had covered all the bases, thinking of everything that the kids might explain to the other kids. But the kids talked about so many good things that I didn't expect! I was frantically trying to rethink my checklist so that it would capture the great stuff that I was hearing from the
students." Nonetheless, evidence suggests that Mrs. Ward believes she knows more about her students' academic growth and what they understand about science concepts as a result of the new methods presented through the physical science project. In one entry in Mrs. Ward's reflection log she wrote, "Without this type of assessment, I would have never found this out," and "It (the activity) let me know specifically what each student was thinking."

Mrs. Ward's reflection log provides additional evidence of her high level of enthusiasm for science teaching. She recorded several instances related to the positive attitudes of her students. One day, for example, Mrs. Ward explained, "This is going to be such a wonderful experience for them--and me!" Another entry relates, "The excitement among the children was unbelievable." There are no negative comments about students included in her reflection log. This pattern of positive attitudes about students supports the finding that Mrs. Ward was identified as a teacher with a strong sense of teaching efficacy.

At the beginning of program implementation, Mrs. Ward's expressed stage of concern was Stage 5 (Collaboration). Since she reported already using a hands-on, discovery science approach with her students prior to her inclusion in the program, Mrs. Ward was not worried about implementation of the instructional component of the program. She explained that her greatest concern was her
commitment to be a mentor to other teachers, since she frequently was called upon at her own school. At the end of the year, her stage of concern was the same.

Of the 11 teachers who did not demonstrate a shift in stage of concern after first-year implementation, six were teachers who had expressed concern at Stage 5 at the beginning of implementation. Training for the mentoring role was not to begin until the second summer institute, since no mentoring duties were required in the first year of implementation. Because teachers' concerns about their future roles as mentors was not addressed in the first year of program training, it is understandable that teachers' high concerns about this aspect would remain unchanged.

Mrs. Ward represents a group of ten teachers who were identified as having Level III, or Ideal, innovation configurations. Mrs. Sage, the second of the teachers in the case studies, is presented as the minor case at this level.

**Level III: Mrs. Sage (Teacher 2)**

Eight of ten teachers who were identified as having Level III innovation configurations reported having a strong interest in science prior to volunteering for the physical science program. Most of these teacher have stated that they had already adopted many of the instructional techniques stressed in the program; however, this is not the case with Mrs. Sage; on the contrary, she
admits that her interest in the program was a result of her inexperience with science and a need to become more proficient in science teaching.

Mrs. Sage teaches in Holt Elementary, built on a tree-lined street of a middle class suburb. The school has received numerous awards and accolades for the many innovations that the principal and faculty have implemented. Hallways at the school are lined with student artwork and other products as well as newspaper clippings highlighting the school. Thus, the observer had some indication of the school's activities and purposes before interviews or classroom observations began. The quantitative data obtained through the OCDQ-RE revealed the school climate as open.

Mrs. Sage shares her students and her classroom with another teacher. Mrs. Sage teaches math and science in the morning and leaves the class in the afternoon to conduct a special language lab while her partner teacher takes over the class for other subject areas. This arrangement requires considerable planning and cooperation, but Mrs. Sage always appears to be pleasant and unhurried, according to specialists and the principal.

Although Mrs. Sage stated that she did not have experience teaching science, she is no novice to many of the strategies included in the science program. Students work in cooperative groups and in center groups routinely.
The students are all assigned various responsibilities and they were observed to take them seriously. Mrs. Sage uses a soft, soothing voice and a ever-present smile to explain the day's activities to her students. Children are given several minutes to ask questions, to make recommendations, or to voice opposition to plans and student input influences future lesson plans.

Teachers' use of kits varied among and between levels of implementation, as can be seen in Table 5.3. Mrs. Sage checked out two of the four science kits available to her. She admitted feeling insecure at times with her science teaching because of what she felt were weaknesses in content understanding. Science specialists also reported Mrs. Sage did not teach science as frequently or as regularly as other mentor teachers. On some occasions, the class spent the entire morning in social living centers or language extensions that were not related to the science unit.

The three science specialists all agreed that Mrs. Sage's efforts to implement the science program were successful. The specialists also agreed that Mrs. Sage displayed considerable changes from previous science teaching. Before participation in the program, activity-based science lessons were primarily used as center activities, which required no data collection, prediction or careful observation. Lesson content varied from week to
week. However, Mrs. Sage quickly began to integrate such science process skills into more extensive science units through the assistance of the science specialist assigned to her.

Science specialists attributed her progress to her commitment to the proposed changes. The specialists reported that she "welcomed suggestions and was always willing to try things." One specialist reported that upon entrance to the school's front door, Mrs. Sage greeted her warmly by saying, "Do you know how glad we always are to see you here?"

Mrs. Sage was very receptive to performance-based assessment. Teachers at Holt had utilized portfolio assessment and some math assessment prior to participation in the physical science program, and the state department of education relaxed, or waived, policy requiring teachers to report student progress through assignment of letter grades. Because of her prior experience with student portfolios, Mrs. Sage was able to serve as a strong advocate for portfolio assessment among other science mentor teachers.

**Level II: Mrs. Bell (Teacher 3)**

Mrs. Bell has taught for several years in an old inner city school, Garden Street Elementary, that was built on the intersection of two streets that are frequent locations for drug trafficking and violent crimes. Mrs. Bell has
been offered opportunities to leave this campus for schools with more supportive parent organizations and greater fund raising capacity. She remains, according to her account, because she knows she is effective and believes these students need her. Many teachers have left before her for newer classrooms, safer neighborhoods and wealthier students, but Mrs. Bell steadfastly refuses to transfer.

Ninety-two percent of the students at Garden Street School are eligible for free lunch. The school is in a deteriorating condition, there is very little playground space, sidewalks are cracked, the paint is peeling, and the office has an unpleasant odor. The school's principal has worked for the school system for over 30 years and is anticipating her retirement. The teachers report that she is rarely seen in classrooms, makes commitments she cannot always keep, and requires only enough order from students to keep the school from attracting negative attention from the press. The results of the climate survey indicated that the school's climate was classified as closed.

The atmosphere does not carry over to Mrs. Bell's classroom. Students are orderly, excited, and respectful. Simple household items (eggcartons, cereal boxes, plastic containers), plants, and make-shift science equipment fill tables and stations. Here students work together cooperatively to determine how the level of liquid in bottles affects the pitch of sound that is created when the
bottle is struck. No time is wasted here because students know that their observations of phenomena, collection of data, and interpretations are the only things that should concern them. Mrs. Bell's students have discovered that more than one explanation is acceptable, but all answers must be defensible and the result of honest effort.

"These students, who might normally demonstrate anger and defiance, are treated with great respect and are guided by high expectations," explains the specialist assigned to work with Mrs. Bell. In turn, students respond with their best efforts and take great interest in their work, which often requires them to personally reflect on learning experiences. Mrs. Bell has made it clear that she needs to know what they are thinking and oral or written language ability is second to the ideas that drive their words. Mrs. Bell's students also respond in journals, but entries are not regular.

One assumption made by designers of the program was that, given sufficient materials of instruction and technical support, teachers would be willing to make changes in the way they taught science. Of the 34 teachers included in the first year of the project, 11, or one-third, used all of the kits that were available to them. Mrs. Bell is among two-thirds of teachers who have used only half of the science kits that are designated for her grade level. Mrs. Bell admits that she is somewhat
intimidated by the comprehensive kit lessons. Like several other teachers in the science project, she is accustomed to improvising with meager supplies and creative activities that have stressed process skills over science concepts, as teachers were often unable to build or procure comprehensive, sequentially-developed units.

Mrs. Bell has expressed a sincere desire to become more knowledgeable and secure with all of the kits at her grade level and believes that kit teaching has the potential to greatly enhance her science program. Mrs. Bell explained that most of her enjoyment with the program comes from learning new things. "I like learning new ideas. New ideas are what keep me going."

A parent survey designed and distributed by program staff was well-received by Mrs. Bell's parents. She expressed surprise by the number of responses that were returned. One particularly unique aspect of the responses was that 93% of parents indicated that their children had been given homework that involved experimentation. One parent highlighted the home-school connection by explaining that her son, "loves science...he even comes home and tries to teach his little five year old brother different things that he's learned."

There was only occasional evidence of integration of subject matter from observations. Mrs. Bell's students write frequently in science, but there is little use of
graphic organizers or ties to language or math lessons. Lesson plans reflect very distinct time periods for each subject that is taught. Although science lessons are well-prepared and students demonstrate concentrated time on tasks, they are nonetheless, isolated science lessons.

Mrs. Bell has a very old computer in her room; however, no student was observed using it during any of six observations. Prior to program implementation, the school principal made a commitment to provide a computer for science mentor teachers' classrooms. The aging computers were not made available until February and most new software cannot be supported by the model. While some older computer programs are available to all district teachers, there was no evidence from observations, portfolios, or reflection logs that the computer was utilized by Mrs. Bell's students.

Mrs. Bell knows her students well. She watches them as she facilitates their activities. Because she does not need to dominate the science lesson, she quietly walks around groups, listens to student interactions, and examines work carefully. Her assessment is performance based, but also rather informal. Much of what Mrs. Bell learns about her students is stored into her memory. She does refer to students frequently in her reflection log, noting when one particular child has trouble with a concept or when an experiment did not work well because of improper
equipment. She discovered and noted on one occasion that the difficulty students had in completing an assignment was probably the result of students' lack of understanding of the terms that were used in the lesson, and she resolved to reteach the lesson in a way that considered the students' every day language. There is no evidence to indicate that Mrs. Bell has tried to design formal performance-based tests and, according to the specialists, has not asked for the specialists' help in this area.

The portfolios of Mrs. Bell's student support the evidence obtained from observations. Many student products are the result of group work, they almost all require students to write an description or explanation of a phenomenon, and some reflect a flexibility that allow students to attend to a problem in an open-ended manner. Only one portfolio entry required students to gather and organize data. Physical science was balanced well with life science topics. While entries covered the span of the entire school year, there were only eight student pieces in the portfolio and showed little diversity in purpose or process skill focus. Most entries were observation records of results of a group experiment. There were formal end-of-unit assessment tasks included among entries, but exercises required a recall of facts and had no performance component.
Entries in Mrs. Bell’s reflection log do not provide the same quality of evidence that observations do. Most log entries are quite brief and describe procedural difficulties in lessons such as, "I felt students were confused by the word" or "Students were able to observe the vibrations." The entries do, however, reveal the sensitivity that Mrs. Bell demonstrates as she teaches children who live in the inner city. She recognizes that students’ limited experience with their world is something she must consider as she designs or adjusts lesson plans. She explains, "I had pictures of things that my students had never seen such as a hot plate or a lightening bug" and "My students were very amazed to find out that the battery had a bump and a positive and negative sign." Identified as a mentor teacher with a strong sense of efficacy, she speaks positively of students and there is no evidence that she ever attributes failure to work effort, behavior, or inattention.

Mrs. Bell does not voice feelings of insecurity or negative concern. She is often very quiet throughout teacher workshops. She is not detached from participant interaction, however. Rather, she expresses a patience with the change process that many teachers do not possess. During a discussion, she is frequently the teacher who suddenly smiles and says, "Hey, we’re going to get it. It’s going to all work out."
At the beginning of the year, Mrs. Bell concern at the Stage 0 (Awareness) level. Her responses indicated that she had general concerns about the project and was anxious to know more about it. At the end of the year, Mrs. Bell’s concern remain high at Stage 1 (Informational), although she rarely voiced concern of any kind. These findings were difficult to interpret from the directions provided by the developers; however, Mrs. Bell explained that personal events in her life at the time were stressful.

Mrs. Bell represents several teachers in the program who were unaccustomed to support and access to materials for instruction. Mrs. Hart, the second teacher studied at Level II implementation, serves as a contrasting case to Mrs. Bell for the abundance of materials and funds that she has secured independently.

**Level II: Mrs. Hart (Teacher 4)**

Mrs. Hart, a second teacher selected for the case study at Level II (Acceptable Configuration), works at Dunlop Elementary. Like Mrs. Bell, this teacher works in a school with meager resources. Of the students at Dunlop, nearly 80% are eligible for free lunch. Unlike Mrs. Bell, however, Mrs. Hart does not lack resources or materials. Either through grants or personal finances, Mrs. Hart has accumulated a wealth of materials for science teaching. She has engaged similar methods to pay for attendance at
conferences, professional development seminars, and higher education classes.

The materials observed in the classroom were impressive. They include some very expensive items such as incubators, elaborate aquariums, and booths with artificial light sources for plant growth. There are three computers in the classroom and a private phone line so that one computer can be online with national networks.

At no time were students observed using any of these materials. There were signs of use in some fashion since there were eggs in the incubator, animals in the aquarium, and plants growing in the booth, but it is unclear if or how children were allowed to manipulate or utilize equipment. According to the science specialist, Mrs. Hart demonstrated most activities for the children as they watched. This phenomenon was observed during one lesson in which the computers were utilized. The teacher sat at the keyboard and explained what was happening on the screen as the students sat on the floor and watched.

Possibly because Mrs. Hart has secured considerable supplies for her science units prior to inclusion in the physical science program, Mrs. Hart does not express much need for the science kits that are available to her. While she did check out two of the four kits at her grade level, she admits that she picks and chooses from lessons and
materials to support her teacher-made units, rather than to follow the sequential order outlined in the kit manual.

Mrs. Hart used small groups during several science lessons; however, these groups were not provided with time to work on problems or experiments independently. The tasks were broken down into small steps, which were controlled and paced by Mrs. Hart. During observations, children in groups did not always remain on task because they became distracted as they waited for other groups to finish. Other students got up to retrieve hall passes and left for the restrooms as Mrs. Hart continued to direct procedures for the rest of the class.

Mrs. Hart frequently asked probing questions, encouraged all students to make predictions, and was very positive in her responses to all student answers. During one particular lesson, a student refused to accept an explanation constructed from a class experiment. Mrs. Hart offered the student an opportunity to conduct his own experiment with her assistance. In this way, Mrs. Hart modeled a scientific attitude that is greatly encouraged by the physical science program and the current science education reform.

Mrs. Hart also demonstrates a strong understanding of science concepts. Information used in lessons was observed to be accurate, interesting, and developmentally appropriate for her students. The science specialist
remarked, "She could be a wonderful teacher. She presents such good inservice for other teachers, but she doesn't seem to be able to let go of her students. I don't see many teaching moments. Students are often bored and there are always students writing lines in her class."

Science lessons were rarely observed to be integrated in any way with other subject areas. Nor did artifacts on class bulletin boards, homework assignments, or student journals indicate any integration. This might be due, in part, to the traditional approach that Mrs. Hart uses in other subject areas. Student complete spelling assignments that included writing the words ten times each, using each word in a sentence, and completing "Part C" in the spelling book. Math assignments included directions for completing various exercises on pages in the math textbook.

There were no observations from class activities or artifacts to indicate that any kind of science assessment, other than letter grades for report cards, was utilized in Mrs. Hart's class. Mrs. Hart did not turn in a reflection log or portfolios for review at the end of the project period. When specialists asked to see portfolios, she replied that they had been left at home. During one brief review of portfolios made earlier in the year, the specialist noted that only one assignment had been filed, which pertained to recall of facts. Mrs. Hart reflected that she "did not get off on the right start" with
portfolios and did not feel that the contents were valuable. She did ask for the assessment specialist’s assistance with portfolios at the end of the year.

Contrasts within levels of implementation were most prominent at Level II. Only three teachers were identified as having Level I implementation, and contrasts within this level are less obvious. As will be seen by the final two cases, teachers at Level I have quite different behaviors from the teachers at Level III.

Level I: Mrs. Campbell (Teacher 5)

Mrs. Campbell teaches at Powter Elementary in one of the fastest growing areas of the city. Many of the families are white, middle class and the percentage of free lunch applicants is low compared to most schools in the district. The school facility is one of the most recently built schools in the system, has a large number of computers and most classrooms have easy access to a wide variety of audiovisual equipment, from tape recorders to televisions and video players. A review of observation notes, interviews, and artifacts discloses no use of available technology; rather, Mrs. Campbell relied heavily on the textbook through most of the year.

Mrs. Campbell’s understanding of science is adequate, according to the physics teacher who works with the teachers in the summer program. She actively participates in discussions with other science teachers and seems to
have a good understanding of the framework promoted by the physical science project. Classroom observations reveal, however, that Mrs. Campbell does not choose to implement much of the program in her own science class. Throughout most of the observations made in the classroom, students sat quietly in rows humped over the science textbook. Sometimes students were taking turns reading the chapter aloud to the class.

During one class, when Mrs. Campbell attempted to conduct an activity-based lesson, the lack of use of many program components was obvious. Mrs. Campbell spent over 30 minutes trying to group students and supply them with simple materials, such as water, rulers, crayons, and papertowels. Another 15 minutes was required for giving directions on individuals’ assignments in groups, how to record data, how to actually do the task and a long list of things that the teacher did not want students to do. The children had begun to fidget, talk to each other, play with the rulers and colors, and look at the clock by the time they were given the signal to begin the experiment. The children were left with only ten minutes to complete a task that required at least 30 minutes and they were dismissed after having done only one of four steps.

The specialist discussed some of the difficulties that she had observed throughout Mrs. Campbell’s lesson, made some suggestions for making the lesson more manageable and
asked that the lesson be completed the next day. Unfortunately, the lesson was never completed since Mrs. Campbell was afraid that the class would fall behind in the chapters of their science book and not finish on schedule.

Mrs. Campbell taught one kit of the four available at her grade level at the end of the year. The science specialist believes that this might have been a turning point for the teacher. Entries in Mrs. Campbell's reflection log support a shift, as the nature of her remarks made about students and lessons changes, as will be discussed later.

Of the 14 parents surveyed from Mrs. Campbell's class, three provided comments about experiments, two of which related to activities conducted by the science specialist. One comment also supports a possible shift in focus toward the end of the year, as the parent explains, "Nathan has had a difficult time understanding concepts in science this year. It seems to be one of his more challenging subjects. However, in the last few weeks, he has experienced more success and has shown a little more interest."

Mrs. Campbell completes every chapter with a traditional recall test that includes no performance-based activities. She has expressed having difficulty understanding how she should focus her assessment on the processes or approaches used in science to solve problems. Recently she asked the assessment specialist, "But what if
they get the right answer anyway, without doing anything? Shouldn’t they still get full credit?"

Several examples of student work included in student portfolios were traditional fill-in-the-blank and matching exercises. Students received negative feedback, and in some cases lost points, for sloppy coloring or handwriting. Students were rarely given opportunities to express ideas in writing or oral reports.

Mrs. Campbell has been quite honest about her opinion that "book learning" is important. Many of the entries included in her reflection log refer to students' memorization of vocabulary and facts. She seldom reflected on how the lesson could have been improved. Instead, Mrs. Campbell shifts most of the failure of a lesson on the students, observing that "students took too long to complete the assignment," or "Students did not label the parts properly." Mrs. Campbell has been identified as a teacher with a low sense of teaching efficacy, and she frequently remarks that her class is "low" and that she has "many students below grade level." However, the last few entries in her log are more positive of students and less reproaching, such as "Kids loved using rain gauges," or "Should have had them predict first."

One particular school policy concerns the physical science staff that works with Mrs. Campbell. The Powter School administrator requires a yearly plan of all units
for science and social studies by grade level at the beginning of each school year. This practice makes the physical science program difficult for both of the Powter School mentor teachers in areas such as kit teaching, which promotes comprehensive study of fewer topics instead of trying to teach many topics for brief periods of time. Mentor teachers' peers are not comfortable with many physical science topics and do not wish to include them in yearly grade-level timelines, even though mentor teachers are urged to include them. The principal, however, supports activity-based science and strongly advocates the use of computer technology to support instruction.

While many mentor teachers seek the advice and support of staff members to discuss implementation difficulties with administrators, Mrs. Campbell usually does not, according to the specialist. The specialist also believes that the full-year planning is not the biggest roadblock to implementation; rather, the specialist feels that the traditional use of the textbook, not required by the administrator, precludes all other activities in Mrs. Campbell's class. Another teacher at Powter participates in the physical science program and, while she, too, is required to submit a plan for the school year, she and the specialists have devised methods to integrate science kits and other program components into her plan without significant conflict.
At the beginning of the year, Mrs. Campbell's highest stage of concern was identified at Stage 3 (Management). She expressed confusion about how she could fulfill program requirements without making substantial changes in her teaching practice. When she found student portfolios were virtually empty of products or work pieces by midterm, she requested permission to submit her traditional chapter tests as evidence that she had taught physical science. She explained that, while she did do some experiments, she believed the study of terms and vocabulary were critical to students' understanding of science.

At the end of the school year, Mrs. Campbell expresses stages of concern at Stage 2 (Personal) and Stage 4 (Consequences). She has recently begun to consider changes and wonders what this commitment will require of her and what ramifications it will have on her students. She worries that not memorizing the facts might leave them ill prepared for the future.

Mrs. Campbell's preference for learning factual information is shared by the final case presented, Mrs. Young. Innovation configurations of the two teachers selected at this level are similar, although a few unique events and implementation roadblocks are presented for contrast.
Mrs. Young teaches at Bridgestreet Elementary, a large rural school located in a remote area of the school district. Like Mrs. Campbell, she was observed to have traditional approaches to teaching. The students were seated in long rows, unsuitable for group work, and the classroom arrangement clustered students into a tight space, which left little room for moving about. Although Mrs. Young occasionally provided opportunities for students to work in groups toward the end of the year, the primary purpose for the group was to share materials. Whole group instruction and, in some instances, small group activities were designed almost entirely around textbooks and dittoed pages.

Science specialists reported a unique problem in the Bridgestreet School. Mrs. Young and the other science mentor teacher did not appear to like each other. The relationship between Mrs. Young and the other mentor teacher eventually disintegrated to the point that they no longer spoke to each other. Messages from the science specialists could not even be relayed between them. The animosity between the mentors made the science specialists' jobs especially difficult since conferences were often set up to include both teachers at one time.

According to the specialists, Mrs. Young was not receptive to recommendations made by specialists or by the
other mentor teacher. She would insist that school policy would conflict with the innovation, students were too disruptive to try new things, or students were just not ready for the kinds of tasks recommended by the program.

Mrs. Young was identified as having a high sense of teacher efficacy; however, during grade level meetings of program mentor teachers, she frequently mentioned that her students weren't capable of doing some of the performance-based tasks that other teachers were attempting. She commented that her students came from poor families, that they had little access to technology, and that parent involvement at the school was minimal. These statements seemed to be in conflict with the items that represented efficacy on various instruments used to measure the construct.

Mrs. Young checked out two of the four kits available to her, but one was sent back with the packages unopened and all material unused. Toward the end of the year, however, Mrs. Young received a kit that she found exciting. Mrs. Young explained that, "the kit activities were developmentally appropriate for the students and they were interested and excited." This excitement seemed to serve as a catalyst for Mrs. Young to try some of the innovative practices that the specialists encouraged her to use. Students wrote in journals for the first time, they graphed
information, and some language and art were integrated into science lessons.

There were several instances of assessment activity observed in Mrs. Young's class, but they were traditional, consisting of reading and responding to true/false statements or multiple choice items. One test included in the portfolios consisted of ten numbered blanks, on which students had recorded a letter from "a" to "d". No heading or directions were printed on the student form, so there was no way of knowing the content or topic of the test. Mrs. Young explained that she felt compelled to have "one letter grade per week" for her students in all subject areas.

Summary

Teachers' innovation configurations were unique illustrations of implementation behavior. The portraits of individual program interpretations confirmed that, although teachers received the same training and assistance from the physical science program activities and staff, responses to the change initiative highlight the personal nature of change as described by Hord et al. (1987).

The innovation configurations can, however, be examined for emerging themes or "cultural meanings that occur in almost every social situation" (Spradley, 1979, p. 69). These cultural meanings provide support for possible
explanations of teachers' implementation behavior recorded in the present study.

The primary focus of the case study research was to identify the attributes and actions of teachers whose implementation most nearly matched the intentions of the primary physical science program, in order to contrast such attributes and actions with teachers whose implementation fell short of program developers' expectations. The following conclusions result from the examination of the data and are intended to contribute explanations useful for future change efforts.

1. Although all teachers found alternative assessment to be one of the most difficult aspects of the program, Level III teachers were more likely to have designed end-of-unit, performance-based assessments and all ten Level III teachers received ratings of "Ideal" or "Acceptable" implementation for this component. None of the three teachers demonstrating Level I implementation had attempted to design or use any kind of performance task for assessment purposes. Assessment strategies for the case study teachers are outlined in Table 5.4.

The difficult nature of this dimension was alluded to early in the first year of implementation when teachers reported assessment as the topic for which they were least prepared upon completion of the summer institute (Teddlie, 1994). The assessment specialist recognized teachers'
hesitancy to use performance assessment in several instances throughout the year. While her offers of assistance were routinely rejected, Level III teachers were more likely to ask for her assistance.

The difficulty with performance assessment appears to be attributable to the lack of experience that teachers had with new kinds of assessment specifically and any kind of assessment design in general. Testing programs have discouraged design of assessments other than those used routinely by the commercial test industry. Many group sessions were required before teachers began to demonstrate some comfort with technical assessment issues.

2. Level III teachers were more likely to adopt the new role of teacher more routinely than Level I teachers. Classroom observations revealed that Level III teachers were more likely to provide students with frequent opportunities to explore, discuss phenomena in small groups, and make predictions than teachers in Level I classrooms. Teachers in Level I classrooms were frequently observed dominating communication and lesson pace by lecturing or demonstrating activities for students. Interestingly, seven of the ten Level III teachers were assigned to kindergarten or first grade classes. It is possible that these teachers are less likely to be dependent on textbooks since their young students have limited or no reading skills. Kindergarten teachers in
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<th>Response to Performance Assessment</th>
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<td>T1</td>
<td>Was the first to try performance-based assessment. Designed activities, interviews, and exhibitions as tests.</td>
<td>Frequently requested input from specialist. Asked for help with test design, requested assistance with administration, and requested video-taping.</td>
<td>Student portfolios included variety of products. Used science journals, artwork, data collection, and experimentation.</td>
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<td>T2</td>
<td>Began assessment by using journals and some observation records. Later in the year, conducted performance-based tests.</td>
<td>Asked for assistance early in the year. Specialist was welcomed but not routinely consulted or called upon.</td>
<td>Portfolios included variety of products. Unique to this class were models for some complex concepts.</td>
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<td>T3</td>
<td>Performance tests not observed, although teacher frequently observed students in groups. No formal checklists. Used some traditional testing to get grades.</td>
<td>Rarely asked for assistance. Always indicated that she was doing well and had no problem with assessment.</td>
<td>Portfolios included several writing samples and group work data sheets. Did not include wide range of products.</td>
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<td>T4</td>
<td>Teacher indicated she used performance tests; however, none were observed or available for review.</td>
<td>Indicated that she did not need help. Specialist was not used to assist with test design or administration.</td>
<td>There were no portfolios available for this class. Teacher explained that they would be of no value.</td>
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<td>T5</td>
<td>Teacher used a traditional testing approach. Designed pencil-paper tests.</td>
<td>Teacher requested assistance with portfolios on two occasions. She wanted permission to put pencil-paper chapter tests in portfolio.</td>
<td>Student portfolios reflected strong dependence on textbooks. Most of the year, students filled in blanks and colored ditto pictures. Some performance-based worksheets included at end of year.</td>
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<tr>
<td>T6</td>
<td>Teacher used a traditional testing approach. Designed pencil-paper tests.</td>
<td>Teacher declined assistance on several instances.</td>
<td>Portfolios included student products that were difficult to interpret, such as blank spaces with letters. At end of the year, a journal is used and filed in portfolio.</td>
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the school district under study use report cards that focus on developmental skills rather than subject specific grading.

3. Teachers identified as having Level III implementation were more likely to report that they had used, or experimented with, many of the techniques encouraged by the physical science program prior to their participation in the program. The components, mostly frequently cited by teachers as familiar included use of small groups, use of computers, and use of hands-on activities. On the other hand, Level I teachers utilized many traditional practices such as reliance on textbooks, whole class instruction, and emphasis on memorization of factual material.

4. Teachers identified as having Level III implementation were more likely to emphasize the importance of process skills as they taught science content to students. These teachers were often observed to stress precision in measurement and observation, use of data collection procedures, and use of graphic organizers to make data interpretation easier. In contrast, Level I teachers were more likely to stress memorization of content or subject matter.

5. The wide variation in kit use, even among Level III teachers, suggests that provision of and easy access to materials of instruction were not sufficient incentives for promoting desired changes. Although teachers' comments
about the science kits were generally positive, only 34% of teachers used all four kits available at grade level. A single explanation did not emerge from the data; rather, five possible explanations are supported by the data including the following:

A. The few teachers who had attained large stores of materials wanted to continue to use them to support teacher-developed units.

B. Some of the teachers who previously had access to only meager materials, employing what one teacher called "junkyard science instruction" wanted to continue to teach favored units, even if teachers had to scavenge for plastic bottles, aluminum cans, and toilet paper tubes.

C. Some teachers indicated feeling overwhelmed by some activities in the kits with which they did not feel comfortable teaching. Teachers indicated that the half-day training provided for each kit was not always sufficient.

D. Some teachers indicated that they could not devote six weeks to a single science topic without sacrificing other science or social study units.

E. Even though kits were usually reserved at the grade level recommended by manufacturers, some teachers felt that topics like electricity and forces were too difficult for elementary students, regardless of how they were presented.

All of these explanations might be related to some extent by proposing that teachers in the physical science
project tended to select science topics with which they were familiar and avoided topics with which they were not comfortable. Without additional input from teachers, however, this explanation may oversimplify the reluctance of teachers to use kits.

6. Teachers at all levels of implementation included physical science topics in their curricula to some degree. While it is difficult to make generalizations about Level I teachers, represented by only three teachers, two of the three teachers were observed teaching physical science topics on more than one occasion.

Research indicates that physical science topics are largely ignored by elementary teachers; thus, one of the primary goals of the physical science program was to increase the inclusion of physical science in such classrooms. The qualitative data indicated that this objective was successfully met at all levels of implementation. The physics training provided to teachers in the summer institute, which provided developmentally-appropriate activities for use with students, and the yearlong demonstration lessons provided by science specialists in classrooms appeared to sufficiently support this program goal.

7. The teacher efficacy score did not differentiate teachers' responses to implementation. Two of the three teachers who demonstrated Level I implementation
configurations had scores above the median score on the TES. However, the qualitative data indicate that the measure of efficacy in this study may be affected by the race of teacher and teachers' reluctance to respond to items on the instrument objectively. The concerns of the researcher about teacher efficacy measures are discussed more fully in Chapter VI.

8. Although school climate did not have a statistically significant correlation with innovation configuration in the quantitative analysis, it was noted that 80% of teachers rated as having Level III implementation were employed in schools identified as having open climates. This pattern was not repeated in Level II or Level I group data; however, the practical significance of this finding is limited by the small sample of teachers included in the groups.
CHAPTER VI
DISCUSSION

Overview

Of interest in the current study were the individual implementation responses of teachers to an innovative physical science program developed for elementary schools. The Concerns Based Adoption Model (Hord et al., 1987), which proposes that change is a process that should focus on individuals' unique responses, provided much of the framework of the present study. Data were collected and analyzed to determine to what extent individual teachers' first year implementations were affected by teachers' sense of efficacy, school climate, and stages of concern.

Results of the study indicate that, after one year, a majority of the teachers have implemented several of the instructional components included in the science education reform. Specific changes and the degree to which these components were implemented varied considerably among the thirty-one teachers included in the study sample. A discussion of the principal findings related to the quantitative and qualitative data analyses, as well as recommendations for future research, are presented in this chapter.
Principal Findings

Innovation Implementation

The first hypothesis proposed that the Innovation Configuration Matrix (ICM) would be a reliable and valid procedure for studying implementation. This hypothesis was supported by the data. The program staff and the researcher were in agreement on the observation ratings of teachers' innovation configurations in science classes, and each teacher's response to the physical science program was uniquely illustrated by the ICM. The information from the matrix provided opportunity for examining patterns of implementation for the group, and it organized information about each teacher for comparison in case study analysis.

One dominant pattern that emerged from the implementation aspect of the study suggested that teachers who demonstrated implementation most nearly matching program goals were teachers who reported using the suggested strategies (activity-based instruction, cooperative grouping, integration of subjects) prior to their involvement in the physical science program. The teachers who demonstrated the least acceptable level of implementation, Level I, were identified early in the year by program staff as the teachers who used traditional whole group/textbook instruction and, therefore, had the most changes to make. This was illustrated in the case study analysis.
Teachers face considerable challenges as they begin to implement significant changes. It stands to reason that decision-making in the classroom may follow an incremental process, such as the one proposed by Lindblom (1959) for policymakers. Lindblom noted that, incrementalism, as applied to problem-solving, describes a practical approach that limits solutions to those that require minimal change to the status quo. If the list of solutions does not fit the problem, then the problem is often revised to fit one of the solutions.

To find simple, manageable solutions to problems imposed by sweeping changes, teachers may redesign program components in such a fashion as to make them more compatible with their previous practice. Thus, for a teacher who has not used small groups for instruction at all, using small groups simply for the purpose of sharing materials is an incremental step toward using cooperative grouping strategies for more comprehensive purposes. Change as a process might require, then, the patience to allow teachers to make many small steps toward substantial changes.

Eight program components were included in the observation protocol, paralleling eight implementation goals specified by the physical science program. Of the eight components considered for review, implementation of performance-based assessment strategies appeared to be the
most difficult to implement. Interestingly, teachers did not indicate high levels of concern about student consequences, as described by Stage 4 of the Concerns Based Adoption Model. Teachers frequently reported a confidence in the appropriateness of activity-based instruction for students and, for that reason, they did not anticipate serious negative consequences for students as a result of implemented changes.

The absence of performance-based assessment implementation, therefore, appeared to be related more to overcoming technical aspects of assessment design. Teachers reported being very frustrated with how to test students, as one teacher explained, "It's (performance assessment) what we're all afraid of." While assessment was one aspect of the project that teachers reported being the least prepared for, many teachers abstained from requesting assistance from program staff. One second grade teacher explained, "We don't even know what to ask." In the second year of implementation, program staff recently reported that teachers are experimenting much more with assessment. Increased assessment activity among teachers could be the result of training and support that was provided throughout the year and into the summer, in which teachers worked in collaborative grade-level groups to design unit tests.
Another particularly difficult aspect of change for teachers was the reformulation of the teacher's role from director or leader of learning to a role of facilitator. Many teachers found it difficult to watch students explore without explanation. Teachers expressed fear that students would not "get it" if they did not provide some form of lecture or teacher-led discussion. The focus on student learning tended to emphasize "covering the material," as some teachers explained. Some teachers expressed the belief that exposing students to information, provided by the teacher rather than as a result of students' experiences, was acceptable and assured that students received the correct information. At the beginning of the project, several teachers indicated that students in early grades were too young to really understand such topics as forces or motion at any level. Instead, the responsibility of teachers, according to them, was only to provide learning experiences that might help students understand such concepts later.

One contributor to the difficulty in teacher role transition may be the design of teacher accountability for student outcomes in earlier reforms. The teachers included in the study have previously been required to follow a state-mandated science curriculum guide and were sometimes required by school administrators to document times and dates of instruction for each topic included. This
practice did not consider how well students understood science information or whether they could apply newly acquired knowledge to other contexts; rather, the concern was largely related to whether teachers provided ample opportunity for students to be exposed to the material.

**Teacher Efficacy and Climate**

The second hypothesis of the study stated that a relationship would be found to exist between three independent variables, teachers' sense of efficacy, school climate, stages of concern and the dependent variable, innovation implementation. For determination, the independent variables were entered as predictors of the dependent variable in a multiple regression model. The data analysis did not support the hypothesis. Collectively, these variables accounted for 8% of the variation in teachers' responses to implementation. A lack of statistical significance may have been due, in part, to the small population of teachers available for this study. Other considerations merit some discussion. First, both the teacher efficacy and the school climate variables are multiple dimension variables. A larger sample size would have provided better opportunity to examine these dimensions separately. Second, a positive correlation was found to exist between race of teacher and the total teacher efficacy score ($r = .40$). In general, African American teachers responded in a more efficacious manner to
the instrument than did their European American counterparts. This correlation may have confounded the analysis.

Information retrieved from interviews, teacher reflection logs, and written responses to open-ended questions indicate that many teachers had definite expectations of students for science achievement, and these expectations were largely drawn from what was known about students' achievement in other subject areas. Teachers often expressed astonishment when students identified as "low" were able to complete activity-based science tasks successfully. Reflection logs were filled with stories about students who were able to construct circuits or draw conclusions about light from prism activities, especially when students exceeded expectations. One teacher wrote, "There were some low students who contributed more than I expected them to." Another teacher remarked, "A few low level students did not remember different word descriptors." The tendency to label students as low, without consideration of individual strengths and weaknesses, was common among teachers identified as having low efficacy.

Other data from these sources, however, called into question the validity of the efficacy instrument that might warrant further investigation. Of the thirty-one teachers who were used in the sample, three were found to have a
very low implementation level, Level I. Two of these teachers, one white and one black, were determined to have total efficacy scores above the group median; however, the data collected from interviews and written responses of these teachers were not typical of high efficacy teachers. On the contrary, the two teachers frequently suggested that the low achievement of their students prohibited changes. They frequently identified their students as "poor" and their classes as "quite low." This finding suggests that teachers may anticipate how they should respond to the Teacher Efficacy Scale items, given the emphasis currently placed on the philosophy that all children are able to learn. Such items as "Teachers are not a very powerful influence on student achievement when all factors are considered," might be hard for teachers to agree with openly.

The relationship between school climate and innovation implementation was not found to be significant in this study; although, the small magnitude of the relationship might be attributed to a small sample. It should be noted, however, that the teachers participating in the project received regular, on-going assistance and support from program staff and from each other. This networking and support from specialists is typical of support that has been identified by Hord, Stiegelbauer, and Hall (1984) as second change facilitation. While Hord (1992) suggests
that principals are the primary facilitators of change, she acknowledges that leadership for change often is provided by "more informal but collegial arrangements" (p. 28) with second change facilitators: central office staff, content specialists, or consultants. The program staff, serving as facilitators of change, frequently met with teachers to plan, monitor, coach, and provide resources. Many modifications were made to the program based on the feedback accumulated from interaction between specialists and teachers. In this way, a supportive environment was established that was external to the school setting. It is possible that teachers who operate in closed or disengaged climates may have received some compensatory support from this source.

**Stages of Concern**

The third hypothesis proposed that data collected in the study would support the developmental progression of teachers through the Stages of Concern, as described by the Concerns Based Adoption Model. The analysis of teachers' pre-implementation and post-implementation scores from the Stages of Concern Questionnaire, coupled with the information gleaned from qualitative analysis, supports the hypothesis. The majority of teachers did express different concerns at the end of the first year of implementation than they did at the beginning of implementation, and differences were generally found to have shifted from high
concerns at the lower stages of the concerns model to high concerns at the upper stages of the concerns model as predicted. Both the qualitative and quantitative data support the Stages of Concern model (Hall, George, & Rutherford, 1986).

At the beginning of implementation, teachers expressed a need for information about the physical science program. The feeling of ambiguity about the program components surprised the program staff, as a number of briefing meetings had been held with principals and teachers prior to implementation. Program staff also reported that teachers did raise a number of challenges that had not been anticipated by the program developers. Unanticipated difficulties included a lack of coordination between lesson planning done by program specialists with units initiated by the teachers and scheduling uninterrupted conference times on the school site. As might be expected, most of the concerns related to information about how the physical science program would fit into teachers' current classroom day, competing for time and resources with other programs and responsibilities.

Teachers expressed high concerns about collaboration at the end of the first year of implementation. This is not surprising given that, during the second year, teachers will provide coaching and mentoring to another teacher new to the program. Because the science staff believed that
content knowledge and instructional practice should be the primary focus for professional development in the first year, training for future mentoring has just begun at the beginning of the second year.

Conclusion and Recommendations

The study of the first year implementation of the physical science program supports school change as a multifaceted, highly personal process. Clearly, every teacher did not respond to uniform training, materials, or human support in the same way. Each individual brought previous experiences and beliefs into the reform effort that influenced implementation configurations. For this reason, future research should continue to examine the attitudes and belief structures of teachers charged with implementing school reform.

While the Teacher Efficacy Scale has been used extensively to measure teachers' sense of efficacy, its structure has been altered by many users (Hoy & Woolfolk, 1993; Starko, 1989) to exclude some of the original items and include some other items, such as the two items used in the Rand study (Armor et. al. 1977). Future research should continue to explore measures of efficacy, taking into consideration that it may be difficult for teachers to respond frankly if they are admonished by administrators or official policy to disregard family background and cultural barriers. The differences in responses between African
American teachers and European American teachers also merits further investigation.

Although school climate did not contribute significantly to the variation of implementation in this study, the context in which school change is conducted cannot be overlooked. Teachers in the program frequently expressed the importance of having a strong, supportive science staff, whether they worked in an open or a closed environment. Science specialists reported receiving phone calls frequently from teachers at their home in the evening. They recounted many instances of making special trips to schools just to provide a butterfly tower, a set of magnets, or a helping hand for a class field trip to the planetarium. Although, a few teachers indicated that science specialists were intrusive, the on-going assistance provided by specialists was received positively by the majority of teachers in the study.

The networking of the science mentor teachers was considered to be one of the most important outcomes for science mentor teachers. In the second year of implementation, teachers have begun to report just how much they have learned to depend on each other for support and guidance. This networking does not just occur among teachers on one campus; rather, teachers frequently meet and call each other from different schools.
The support provided by specialists and teacher networking may be an especially important change facilitation factor. Paul (1977) describes this type of facilitative interaction as "communication networks between sources of innovations and users via an intermediary facilitating role either in the form of a linking agent or a linking agency" (p. 26-27). Many reforms have included the redesign of the role of central office staff from one of dictator to facilitator and "in this role central offices act as service providers" (Murphy, 1991, p. 24). Since sources of support for teachers can come in many forms and fashions, future research might continue to examine the influence of second change facilitation and interactions that could possibly occur between such assistance and principal support.

The utilization of the Concerns-Based Adoption components, particularly stages of concern and implementation configurations, offered a manageable procedure for examining the personal responses of teachers to school change. For this study, the Innovation Configuration Matrix (ICM) was used as an observation protocol that examined the current behavior of teachers and did not account for previous instructional practices. In light of the observation that teachers seemed to respond to change incrementally, future research might consider using
the ICM in longitudinal studies as a means for charting past and current classroom practice.

The findings related to assessment are of timely interest as educators find themselves engaged in great debate about how to design and measure student outcomes equitably. Initially, one would expect that teachers would be extremely anxious about how change will affect their students. In this study, this was not found to be the case. Teachers' statements implied a kind of faith in the reform, if not to bring about substantial student gains, to at least do no particular harm. It must be pointed out that this study was conducted with elementary school teachers, who, in this school district, do not have to be as concerned about test results as secondary teachers who must prepare students for a state-mandated exit exam. Proponents of assessment reform might want to consider that many teachers have depended on externally-supplied tests, either from testing services or textbook companies, and may have very little experience with evaluation design issues.

Based on observations of this program and other systemic change efforts being conducted across the United States, the inclusion of on-going, concern-specific support and a continuous review and modification process is intended to directly address the nature of change as an ambiguous and erratic journey. Radical change should not be expected to occur in one school year, nor should
proposed changes be assumed to be uniformly interpreted by the individuals charged with implementation. If schools are to improve, future research will need to continue to examine the many factors that influence implementation at all levels, including district, school, and classroom levels.
REFERENCES


APPENDICES
A: Teacher Efficacy Scale

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate numeral beside each statement. Your responses will be kept completely confidential.

1. When a student does better than usual, many times it is because I exerted a little extra effort.  
   1 2 3 4 5 6

2. The hours in my class have little influence on students compared to the influence of their home environment.  
   1 2 3 4 5 6

3. If parents comment to me that their child behaves much better at school than he/she does at home, it would probably be because I have some specific techniques of managing his/her behavior which they may lack.  
   1 2 3 4 5 6

4. The amount that a student can learn is primarily related to family background.  
   1 2 3 4 5 6

5. If a teacher has adequate skills and motivation, he/she can get through to the most difficult students.  
   1 2 3 4 5 6

6. If students aren’t disciplined at home, they aren’t likely to accept any discipline.  
   1 2 3 4 5 6

7. I have enough training to deal with almost any learning problem.  
   1 2 3 4 5 6

8. My teacher training program and/or experience has given me the necessary skills to be an effective teacher.  
   1 2 3 4 5 6
9. Many teachers are stymied in their attempts to help students by lack of support from the community 1 2 3 4 5 6

10. Some students need to be placed in slower groups so they are not subjected to unrealistic expectations. 1 2 3 4 5 6

11. Individual differences among teachers account for the wide variations in student achievement. 1 2 3 4 5 6

12. When a student is having difficulty with an assignment, I am usually able to adjust to his/her level. 1 2 3 4 5 6

13. If one of my new students cannot remain on task for a particular assignment, there is little that I could do to increase his/her attention until he/she is ready. 1 2 3 4 5 6

14. When a student gets a better grade than he usually gets, it is usually because I found better ways of teaching that student. 1 2 3 4 5 6

15. When I really try, I can get through to most difficult students. 1 2 3 4 5 6

16. A teacher is very limited in what he/she can achieve because a students’ home environment is a large influence on his/her achievement. 1 2 3 4 5 6

17. Teachers are not a very powerful influence on student achievement when all factors are considered. 1 2 3 4 5 6

18. If students are particularly disruptive one day, I ask myself what I have been doing differently. 1 2 3 4 5 6

19. When the grades of my students improve, it is usually because I found more effective teaching approaches. 1 2 3 4 5 6
20. If my principal suggested that I change some of my class curriculum, I would feel confident that I have the necessary skills to implement the unfamiliar curriculum.

21. If a student masters a new math concept quickly, this might be because I knew the necessary steps in teaching that concept.

22. Parent conferences can help a teacher judge how much to expect from a student by giving the teacher an idea of the parents' values toward education, discipline, etc.

23. If parents would do more with their children, I could do more.

24. If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.

25. If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him quickly.

26. School rules and policies hinder my doing the job I was hired to do.

27. The influences of a student's home experiences can be overcome by good teaching.

28. When a child progresses after being placed in a slower group, it is usually because the teacher has had a chance to give him/her extra attention.

29. If one of my students couldn't do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty.
30. Even a teacher with good teaching abilities may not reach many students.
DIRECTIONS: THE FOLLOWING ARE STATEMENTS ABOUT YOUR SCHOOL. PLEASE INDICATE THE EXTENT TO WHICH EACH STATEMENT CHARACTERIZES YOUR SCHOOL BY CIRCLING THE APPROPRIATE RESPONSE.

RO = RARELY OCCURS;
O = OFTEN OCCURS;
SO = SOMETIMES OCCURS;
VFO = VERY FREQUENTLY OCCURS

1. The teachers accomplish their work with vim, vigor, and pleasure
   RO SO O VFO

2. Teachers' closest friends are other faculty members at this school
   RO SO O VFO

3. Faculty meetings are useless
   RO SO O VFO

4. The principal goes out of his/her way to help teachers
   RO SO O VFO

5. The principal rules with an iron fist
   RO SO O VFO

6. Teachers leave school immediately after school is over
   RO SO O VFO

7. Teachers invite faculty members to visit them at home
   RO SO O VFO

8. There is a minority group of teachers who always oppose the majority
   RO SO O VFO

9. The principal uses constructive criticism
   RO SO O VFO

10. The principal checks the sign-in sheet every morning
    RO SO O VFO

11. Routine duties interfere with the job of teaching
    RO SO O VFO

12. Most of the teachers here accept the faults of their colleagues
    RO SO O VFO

13. Teachers know the family background of other faculty members
    RO SO O VFO

14. Teachers exert group pressure on non-conforming faculty members
    RO SO O VFO

15. The principal explains his/her reasons for criticism to teachers
    RO SO O VFO

16. The principal listens to and accepts teachers' suggestions
    RO SO O VFO

17. The principal schedules the work for the teachers
    RO SO O VFO

18. Teachers have too many committee requirements
    RO SO O VFO

19. Teachers help and support each other
    RO SO O VFO

20. Teachers have fun socializing together during school time
    RO SO O VFO

21. Teachers ramble when they talk at faculty meetings
    RO SO O VFO

22. The principal looks out for the personal welfare of teachers
    RO SO O VFO

23. The principal treats teachers as equals
24. The principal corrects teachers' mistakes
25. Administrative paperwork is burdensome at this school
26. Teachers are proud of their school
27. Teachers have parties for each other
28. The principal compliments teachers
29. The principal is easy to understand
30. The principal closely checks classroom (teacher) activities
31. Clerical support reduces teachers' paperwork
32. New teachers are readily accepted by colleagues
33. Teachers socialize with each other on a regular basis
34. The principal supervises teachers closely
35. The principal checks lesson plans
36. Teachers are burdened with busy work
37. Teachers socialize together in small, select groups
38. Teachers provide strong social support for colleagues
39. The principal is autocratic
40. Teachers respect the professional competence of their colleagues
41. The principal monitors everything teachers do
42. The principal goes out of his/her way to show appreciation to teachers
<table>
<thead>
<tr>
<th>Program Component</th>
<th>Ideal</th>
<th>Acceptable</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use of grade level kits</td>
<td>Used all kits available at grade level.</td>
<td>Used 2-3 kits at grade level.</td>
<td>Used 0-1 kit at grade level.</td>
</tr>
<tr>
<td>2. Balance between life, earth, and physical science</td>
<td>Time spent on physical science equal to time spent on life, earth science (30% of units)</td>
<td>More time spent on life, earth science topics than on physical science topics (10-30% of units)</td>
<td>Not much physical science taught. (0-10% of science units)</td>
</tr>
<tr>
<td>3. Balance between process (skills) and content (subject matter)</td>
<td>Lessons reflect process (skills of measurement, observation, recording) and content (concept mapping, verbal and written responses)</td>
<td>Process emphasis often exceeds content emphasis (Less than 50% of lesson observations use concept building experiences)</td>
<td>Major emphasis is on factual learning, covering or memorizing subject matter.</td>
</tr>
<tr>
<td>4. Role of teacher</td>
<td>Teacher is facilitator. Provides opportunities for wide range of experiences; allows students to assume responsibilities; does not rely on teacher demonstrations, lectures.</td>
<td>Teacher often assumes leadership/director role. There is some exploration and some group work, but teacher still spends considerable time talking to students or leading them step-by-step.</td>
<td>Teacher usually directs entire lesson. Spends most of the time lecturing.</td>
</tr>
</tbody>
</table>

C: Innovation Configuration Matrix
<table>
<thead>
<tr>
<th>Program Component</th>
<th>Ideal</th>
<th>Acceptable</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Role of student</td>
<td>Students are actively engaged in hands-on science; given time for exploration; reflect on their experiences and observations; record data (At least 65% of activities or time)</td>
<td>Students do some hands-on science and some workbook or textbook activities. Do not get much time to reflect or evaluate.</td>
<td>Students are very passive. Very little hands-on (less than 25% of activities or time) Students spend most of their time listening.</td>
</tr>
<tr>
<td>6. Integration of science with other subject areas.</td>
<td>Science is integrated with several subject areas regularly (at least 50% of lessons)</td>
<td>Science is integrated occasionally with one or two subject areas (11% to 49% of lessons)</td>
<td>Science is rarely integrated with other subject areas (10% or less of lessons)</td>
</tr>
<tr>
<td>7. Use of cooperative groups.</td>
<td>Small groups are used purposefully at least weekly. Groups must solve a problem or show some task requiring interdependence.</td>
<td>Small groups are used sometimes for exploration or small groups are used to share materials (less than weekly)</td>
<td>Small groups are seldom used. (Less than month)</td>
</tr>
<tr>
<td>4. Use of performance-based assessment</td>
<td>Most assessments require manipulation of tools or materials; use reference to lab experiences; or require direct observation of performance. Teacher uses checklists during student observations; good use of portfolios.</td>
<td>Some assessments require manipulation. Some are recall or drill. Teacher seldom uses formal observations of students. Portfolios contain some evidence of hands-on activities.</td>
<td>Assessments are traditional, not hands-on OR there is little assessment of any kind.</td>
</tr>
</tbody>
</table>
D: Validation of ICM

Attached you will find the Innovation Configuration Matrix that was developed to monitor implementation of the Primarily Physical Science Project. There are eight program components outlined that are derived from the project requirements as proposed to the National Science Foundation. Beside each of these components are three descriptions of possible teacher behaviors or "usages" that are labeled as "Ideal", "Acceptable", or "Unacceptable" configurations.

Please check "Yes" if you agree that the description for usage of this component is accurate; check "No" if you disagree with the description; and check "W/Modification" if you partially agree with the description. Provide information about how these usage descriptions can be improved wherever necessary.

1. Use of Kits

Ideal: ___Yes ___ W/Modification ___No
Acceptable: ___Yes ___ W/Modification ___No
Unacceptable: ___Yes ___ W/Modification ___No

2. Balance between physical, life and earth

Ideal: ___Yes ___ W/Modification ___No
Acceptable: ___Yes ___ W/Modification ___No
Unacceptable: ___Yes ___ W/Modification ___No

3. Balance between process and content

Ideal: ___Yes ___ W/Modification ___No
Acceptable: ___Yes ___ W/Modification ___No
Unacceptable: ___Yes ___ W/Modification ___No

4. Role of teacher

Ideal: ___Yes ___ W/Modification ___No
Acceptable: ___Yes ___ W/Modification ___No
Unacceptable: ___Yes ___ W/Modification ___No

5. Role of student

Ideal: ___Yes ___ W/Modification ___No
Acceptable: ___Yes ___ W/Modification ___No
Unacceptable: ___Yes ___ W/Modification ___No
6. Integration of science with other subjects

**Ideal:**
- Yes ___
- W/Modification ___
- No ___

**Acceptable:**
- Yes ___
- W/Modification ___
- No ___

**Unacceptable:**
- Yes ___
- W/Modification ___
- No ___

7. Use of cooperative groups

**Ideal:**
- Yes ___
- W/Modification ___
- No ___

**Acceptable:**
- Yes ___
- W/Modification ___
- No ___

**Unacceptable:**
- Yes ___
- W/Modification ___
- No ___

8. Use of performance assessment

**Ideal:**
- Yes ___
- W/Modification ___
- No ___

**Acceptable:**
- Yes ___
- W/Modification ___
- No ___

**Unacceptable:**
- Yes ___
- W/Modification ___
- No ___
VITA

Jennifer Baird resides in Baton Rouge, Louisiana where she is currently employed as the assessment specialist for an elementary science program sponsored by the National Science Foundation, local industry, and the school district. As a state licensed Level A program evaluator, she provides consultation to other education programs and school districts.

Ms. Baird taught elementary school for ten years before she became involved in numerous educational reform efforts. She has written several grants proposing education initiatives, designed performance-based assessment strategies, and studied controlled-choice plans as a vehicle for reform and desegregation. Ms. Baird has volunteered services to several agencies including Girl Scouts of America, YWCA, and Partnerships in Education.
Candidate: Jennifer B. Baird

Major Field: Administration and Supervision

Title of Dissertation: The Effects of Teacher Efficacy, School Climate, and Stages of Concern on the Implementation of a Physical Science Program

Approved:

[Signatures]

Major Professor and Chairman
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination: February 24, 1995