1995

Teacher Efficacy and the Use of Specific Instructional Practices by Seventh- and Eighth-Grade Science Teachers in the United States

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TEACHER EFFICACY AND THE USE OF SPECIFIC INSTRUCTIONAL PRACTICES BY SEVENTH- AND EIGHTH-GRADE SCIENCE TEACHERS IN THE UNITED STATES

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Larry Dale Burton

July 1995

UMI Number: 9600304

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To my wife, Pam,
and my children, Danielle and Jeremy,
who have contributed generously
to the fulfillment of my dreams

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ABSTRACT OF GRADUATE STUDENT RESEARCH

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Name of researcher: Larry Dale Burton

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Date completed: July 1995

Problem

Current reform efforts in science education are constructivist in nature and call for major changes in the way science has been taught in the schools. Teacher efficacy, a measure of perceived instructional empowerment, is one variable which has been linked to teacher change and general classroom innovation. However, the specific relationship between efficacy and innovative science instruction had not been examined.

Method

This descriptive study employed a correlational design utilizing cross-sectional survey methodology. Data were collected via a three-part survey instrument. The purpose of this design was to gather descriptive data on science education in seventh- and eighth-grade classes in the United States and to correlate reported use of instructional practices with teacher efficacy scores and selected context variables.

Study participants totaled 285 from an original national sample of 543, for a net return rate of 52.5%. The data from these respondents were presented through descriptive statistics, Spearman rho correlation, and chi square.

Results

Data were presented concerning the reported use of specific instructional practices in seventh- and eighth-grade science education in the United States. Discussion and lecture were the two most commonly used instructional methods. Results show use of hands-on lab activities increased 4%, while use of lecture has decreased almost 6% since 1977.

Hypothesis testing resulted in the rejection of both of the study's null hypotheses. Significant relationships were found between 34 specific instructional practices and teacher efficacy. The number and size of correlation coefficients were greater between efficacy and constructivist practices than between efficacy and traditional, absorption-type practices, although all correlations were weak.

Fifty-three statistically significant correlations were found between use of specific instructional practices and years of teaching and between specific instructional practices and perceived qualifications to teach science classes.

Conclusions

While these correlations were statistically significant, they were typically small. The descriptive data suggested the use of a variety of teaching practices by science teachers in the seventh- and eighth-grade classroom. The large number of small yet significant correlations supports this conceptualization. External validity of this sample was supported through a comparison of demographic features with Weiss's (1994) national probability sample.

CHAPTER 1

THE PROBLEM

Introduction

At the Secretary of Education's Second Conference on Mathematics and Science (McKinney, 1993), four themes emerged for educational reform. These were the need for national standards, the improvement of mathematics and science teaching, the improvement of instructional materials, and the need for systemic change.

Systemic change or reform is defined as "transforming all parts of the education system at the same time to achieve high standards of student performance" (McKinney, 1993, p. 1). The conference presenters stressed the need for national standards in science education to guide reformation efforts at all levels: local, state and national. Lifelong professional development plans for teachers were cited as a vital need if systemic reform is to occur.

There are four current initiatives promoting educational reform in science. None of these projects is exclusive of the others, rather, each is complementary. These four initiatives are the Science, Technology, and Society (STS) movement; the National Science Teachers Association (NSTA)

Project on Scope, Sequence, and Coordination (SS&C); development of national standards by the National Committee on Science Education Standards and Assessment; and *Project 2061* (McCormack, 1992).

While each of these reform movements has its own unique characteristics, it is possible to identify several common attributes. With few exceptions these goals are held in common:

1. an integrated, thematic approach that emphasizes connections within science and with "other" subject areas
2. relevance of science education to daily life
3. teaching for understanding, which includes in-depth treatment of core concepts rather than superficial treatment of many topics
4. use of hands-on, constructivist learning activities
5. inclusion of important societal topics
6. integration of technology, and
7. inclusion of higher-order thinking and decision-making skills (American Association for the Advancement of Science [AAAS], 1989, 1992; Ahlgren, 1993; Ahlgren & Rutherford, 1993; McCormack, 1992; McKinney, 1993).

In the pursuit of reform in science education, use must be made of the literature of school reform and innovation. Teacher efficacy has been identified as an important contributor to the implementation of educational innovation. Teacher efficacy refers to a teacher's beliefs concerning the effectiveness of teaching in general and their personal teaching abilities specifically. In a study of over 400 federally funded innovative programs, teacher efficacy was identified as the most important teacher characteristic contributing to student achievement (McLaughlin & Marsh, 1978). A significant relationship between teacher efficacy beliefs and the degree of innovation implementation has also been supported in the literature (Berman, McLaughlin, Bass, Pauly, & Zellman, 1977).

Curriculum decisions are another area that cannot be ignored in the implementation of science educational reform. The choice of instructional materials and methods for use in the classroom is a fundamental curriculum decision science teachers make every day. In making these decisions, teachers need tools to work with. Materials for classroom use abound in the United States. Hundreds of companies produce educational materials catalogs and most small cities have at least one teacher-supply store. Publishing companies produce beautiful textbook packages and actively compete for school orders. So teachers have a great number of potential choices. Unfortunately, recent studies critical of American instructional materials also abound. It seems that a plethora of materials does not necessarily ensure high quality materials (Pogrow, 1993).

The same is true for instructional techniques used in the classroom. There is no lack of instructional methodologies in education. Workshops and training sessions are offered for a myriad of methods. These strategies range from behavioristic models to humanistic approaches (Joyce, Weil, & Showers, 1992). As in the case of instructional materials, quantity does not guarantee quality. Not all methodological innovations have research-based support for their effectiveness.

In *A Study of Schooling*, a national study headed by Goodlad (1984; Klein, Tye, & Wright, 1979), teachers reported that textbooks had a low level of influence on their curricular decisions. Yet actual classroom observations revealed a heavy dependence on textbooks, lecture, and recitation. Since the pedagogy of lecture and recitation tends to ignore individual differences, textbooks seem predestined to meet the needs of only a limited number of learners, even though it is assumed they can meet the needs of all students (Komoski, 1985).

In too many instances, the curriculum has been controlled by the textbook rather than by local groups of parents, teachers, and administrators (Elliot, 1988; Komoski, 1985). Muther (1985) reports that research has found the following:

> 70 to 90 percent of classroom decisions are based on textbooks; . . . between 30 to 70 percent of time is spent by students working on dittos and workbooks; . . . and that the textbook may be, in some cases, the only book a student ever reads. (p. 5)

These facts concerning the textbook's domination of classroom instructional decisions raise specific concerns in the light of recent studies of the text.

Research has amassed much evidence concerning bias against women, African-Americans, and other minorities in textbooks (Elliot, Nagel, & Woodward, 1985; Westbury, 1992). Several studies have investigated the levels of thinking required by textbooks and related materials (Aman, 1988; Armbrulevich, 1986; Karns, Burton, & Martin, 1983; Logan, 1985; Nicely, 1985; Risner, 1987). Using the classification scheme of The Taxonomy of Educational Objectives (Bloom, 1956), researchers have found that textbooks concentrate up to 97% of their objectives and test questions at the two lowest levels of thinking: knowledge and comprehension.

P. Kenneth Komoski, head of the Educational Products Information Exchange (EPIE) Institute, describes the textbook as "a 19th century invention that has failed to evolve effectively during the 20th century" (Komoski, 1985, p. 34). He declares the computer to be the tool for the current era. Komoski also cites the shift in American business from standard products to the current existence of multiple product options. However, he contends, this has not occurred in education. Instead, the textbook remains the single most dominant force in education.

Because of these studies critical of the textbook and its domination of classroom practices, educators have become concerned with the current procedures for the development, evaluation, and selection of instructional materials for schools. Most reformers call for a major revision of the current procedures, or even a completely new process (Anderson, 1992; Apple, 1992;

Bailey, 1988; Brandt, 1985; Goodlad, 1984; Osborn, Jones, & Stein, 1985; Pogrow, 1993; Rothschadl, 1992; Scruggs, 1988; Tyson-Bernstein, 1988a, 1988b).

While calls for reform in instructional materials accompany the calls for reform in the field of science education (American Association for the Advancement of Science [AAAS], 1989, 1992; Kraus International Publications, 1992; McKinney, 1993), it is not clear if changes are actually occurring in the average classroom. For example, in two national studies of science education (Weiss, 1987), reported use of hands-on activities in the science lesson most recently taught actually decreased between 1977 and 1986. However, this trend was reversed in the 1993 National Survey (Weiss, 1994).

Statement of the Problem

As in previous decades, major reforms are being advocated in science education. A less-is-more attitude is in the ascendancy as is teaching for understanding. Since "familiar processes are likely to produce familiar results" (Brandt, 1993, p. 3), reform efforts place a major emphasis on use of innovative materials and methods.

While higher levels of teacher efficacy have been shown to be related to higher levels of implementation of exemplary educational innovations, such as cooperative learning (Wax & Dutton, 1991), the knowledge base on the relationship between science teaching and teacher efficacy is small. Teacher efficacy has been shown to be significantly related to the implementation of innovations after specific training programs (Berman et al., 1977; Wax & Dutton, 1991). However, it was not known if a relationship exists between teacher efficacy and the use of exemplary instructional practices by science teachers in the general population.

Exemplary practices in science education include the use of active, hands-on instructional techniques and materials. Science educators can classify these materials and methods which emphasize understanding, interaction with the concept, and active learning as "constructivist" (McCormack, 1992). Materials and methods that emphasize rote memorization, heavy use of textbooks, and covert academic learning can be labeled "absorption." Divisions between these two categories are not always clear, and this classification scheme is best conceptualized as a continuum (see Figure 1).

Exemplary science teachers tend to use materials and methods that are constructivist. Current reform efforts in science education call for all teachers to increase the use of constructivist techniques. These techniques are designed to increase student understanding and, thereby, student achievement. However, constructivist teaching requires materials and methods that are often quite different from traditional practices.

Prior to this study, a national, descriptive study of science education had not been released since 1986. However, after my data collection was completed, results of the 1993 National Survey of Science and Mathematics

Absorption education is typified by passive learning. Information is transferred from one source, such as a teacher or text, to the passive student. Methods are teacher centered, materials require little or no active participation of the student.

Constructivist education is a child-centered model of instruction that stresses building understanding on an individual basis. Constructivist methods are child-centered, active learning strategies. Materials require the active involvement of the learner.

Figure 1. The absorption-constructivism continuum.

Education were released. Data from my study and the 1993 National Survey provide an indication of instructional trends over that time period.

Purpose of the Study

The primary purpose of this study was to provide descriptive information about upper-elementary science education. These data serve as a comparison set to similar data from the three previous National Surveys of Science and Mathematics Education.

The second major purpose of this study was to explore possible relationships between teacher efficacy; the use of instructional practices, including instructional materials, instructional methodologies, and computer practices; and several context variables. The context variables included years of teaching experience, gender, preparation for science teaching, school organizational climate, and type of classroom.

Significance of the Study

Since self-efficacy expectations predict a person's willingness to initiate and persevere in stressful situations, Bandura's theory of self-efficacy (1977) can be used to explain a teacher's use or avoidance of certain instructional practices.

Many studies have supported the relationship between higher levels of teacher efficacy and greater use of effective teaching practices in math, reading, and English (Ashton, Webb, & Doda, 1983a; Gibson & Dembo, 1984;

Tracz & Gibson, 1986). The relationship between higher levels of teacher efficacy and greater use of effective teaching practices in science is probable as well, and was tentatively supported by Riggs and Enochs (1990). They reported a relationship between higher levels of teacher efficacy and greater use of hands-on activities in science education in grades 1 through 6.

My study added to the knowledge base on efficacy and science teaching practices, particularly at the middle school and junior high-school level. Results from this study provided detailed support for the relationship between higher levels of teacher efficacy and the use of effective, constructivist teaching practices.

This study was also significant in that it identified and obtained data from a sample of seventh- and eighth-grade science teachers from across the United States. This enabled the compilation of a fairly large sample of teachers with a wide range of teacher efficacy beliefs. Based on the theorized relationship between higher levels of teacher efficacy and greater use of effective, constructivist teaching practices, this sample was analyzed to determine which constructivist practices were significantly correlated with efficacy scores.

Because "familiar processes are likely to produce familiar results" (Brandt, 1993, p. 3), the findings of this study can be utilized in the redesign of pre-service and in-service teacher training programs in science education. This would include training in the use of constructivist practices identified in this study as significantly related to higher levels of teacher efficacy. It would also involve the use of reflective practices, such as networking and journal writing, which have been shown to increase pre-service teacher's levels of efficacy beliefs (Volkman, Scheffler, & Dana, 1992).

This study is significant, also, because it provides evidence concerning the strength of the relationship between teacher efficacy and the level of use of exemplary materials and methods in science education. Studies of teacher use of instructional materials in the educational literature tend to report findings in a very general way. For example, Levine and Lezotte (1990) in a meta-analysis of the effective schools literature used phrases such as "abundant, appropriate instructional materials, . . . alternative materials, . . . abundant teaching resources" (p. 32). While the 1977 National Survey (Weiss, 1978) did report specific details about use of specific materials and methods, these data were not correlated with the efficacy trait, student achievement, or effective schools.

McCormack (1992) describes four periods in the history of American science education. He contends that we currently are in the "second revolution" in science education that began in 1980. The current study collected data after 15 years of "revolution"; the 1977 national study collected data 3 years before the start of the current "revolution." The comparison of these data provided evidence of the impact of this "second revolution" on classroom practices at the seventh- and eighth-grade levels.

Findings of this study will also be useful to instructional materials developers and educational policy makers responsible for materials adoption at all levels. A knowledge of materials and methods preferred by high-efficacy teachers can provide the basis for a powerful process of instructional materials development and adoption.

Research Questions

The primary research questions of this study were descriptive in nature. They questioned the use of instructional practices in the general population of seventh- and eighth-grade science teachers.

1. What instructional practices are used by seventh- and eighth-grade science teachers?
2. To what extent are these practices used by teachers in seventh- and eighth-grade science?

These questions led to two additional questions that attempted to discover factors responsible for the use, or lack of use, of specific practices.

3. What is the relationship between teacher efficacy and the use of the specific practices enumerated on the Science Methods and Materials Scale?
4. Is there a relationship between the use of specific practices enumerated on the Science Methods and Materials Scale and a teacher's years of teaching experience, gender, and qualifications to teach science?

Research Hypotheses

These research questions led to the development of the following research, or working, hypotheses.

1. A relationship exists between the use of specific instructional practices and teacher efficacy.
2. A relationship exists between the use of specific instructional practices and a teacher's years of teaching experience, gender, and qualifications to teach science courses.

General Methodology

This study utilized standard survey research techniques for gathering data (Fowler, 1993; Rea & Parker, 1992). A sample of seventh- and eighth-grade science teachers was selected from the listings of the Official U.S. Registry of Teachers, maintained by the National Science Teachers Association. The survey instrument contained three sections: context variables (demographics); the Science Methods and Materials Scale; and the Science Teaching Efficacy Beliefs Instrument (STEBI) (Riggs & Enochs, 1990).

Instrumentation is discussed in detail in chapter 3. The STEBI consists of 25 Likert-response items designed to measure science teaching outcome expectancies and personal science teaching efficacy beliefs. The Science Materials and Methods Scale was derived by the researcher from the 1977 and 1985-1986 National Surveys of Science Education. The Science Methods and

Materials Scale consists of 5 items with 57 Likert-response sub-items using a self-reporting format. The instrument asked teachers to indicate their level of use for three different categories of instructional practices. (See Appendix C for the complete instrument.)

Descriptive statistics were used to present a profile of upper-elementary science teachers. Data analysis looked for relationships between variables included in the study. Hypothesis testing procedures were used to determine the significance of relationships between variables.

Theoretic Framework

This study is based on Albert Bandura's theory of self-efficacy (1977). Bandura's theory was developed through work in the treatment of dysfunctional inhibitions and defensive, avoidant behaviors. However, the theory is applicable to education as teachers sometimes react defensively to the implementation of educational innovations and school improvement initiatives.

Bandura's theory assumes that cognitive processes create and strengthen personal efficacy expectations. He differentiates between outcome expectancies and efficacy expectancies (see Figure 2). An outcome expectancy is defined as "a person's estimate that a given behavior will lead to certain outcomes," while efficacy expectations are defined as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193).

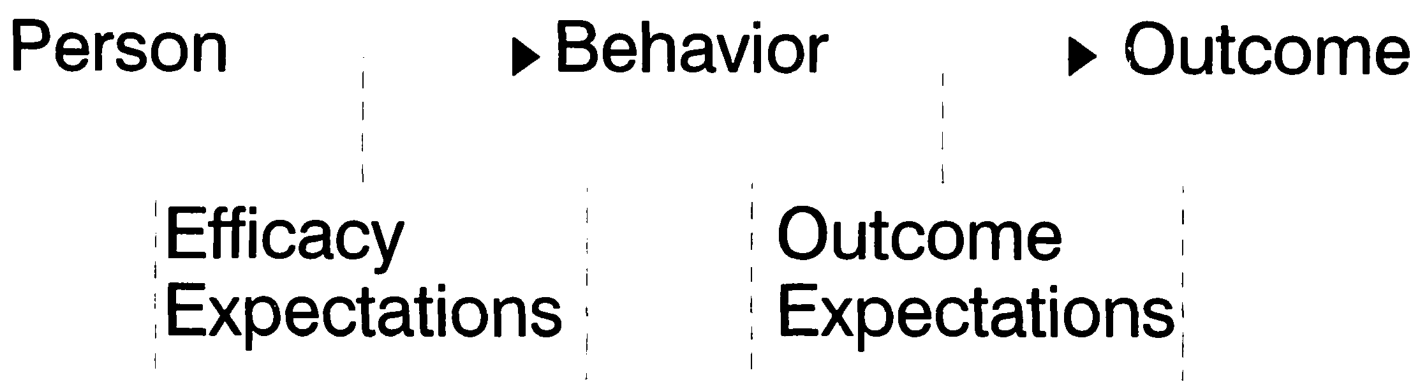


Figure 2. Diagrammatic representation of the difference between efficacy expectations and outcome expectations. Note. From "Self-efficacy: Toward a Unifying Theory of Behavioral Change," by A. Bandura, 1977, Psychological Review, 84, p. 193. Copyright 1977 by A. Bandura. Reprinted with permission.

Perceived self-efficacy expectations are a major influence on a person's "choice of activities and settings" (p. 194) if a person possesses adequate skills and if there are appropriate incentives. Self-efficacy expectations also predict a person's willingness to initiate and persevere in stressful situations. Applied to science education, Bandura's theory (see Figure 3) can be used to explain a teacher's use or avoidance of certain instructional practices.

The conceptual model of this study is illustrated in Figure 4. This is an open systems model that acknowledges influences other than those indicated in the figure. Teacher efficacy, instructional skills, incentives, and time demands are presented as the major determiners of instructional decisions. In turn, these instructional decisions determine which materials, methods, and management techniques will be used during instruction. Student achievement is affected as a result of the implementation of these instructional decisions. Finally, according to Bandura, successful teaching (as evidenced by student achievement) functions as a corrective experience that reinforces personal efficacy beliefs. Relationships investigated in this study are indicated in Figure 4 by shaded arrows.

Limitations and Delimitations of the Study

A limitation of this study was the use of a self-reporting instrument. In self-report studies, the validity of responses is always a limiting factor. However, steps can be taken to ensure the integrity of responses. The most

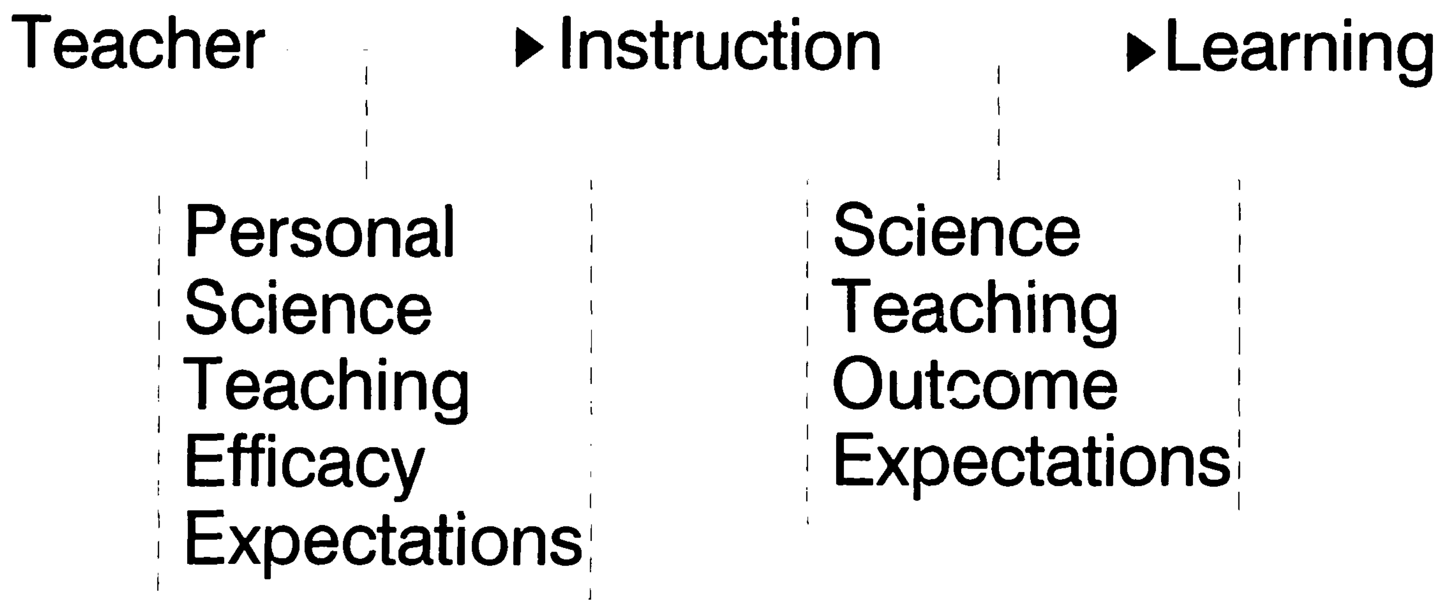


Figure 3. Bandura's graphic adapted to science education. From "Self-efficacy: Toward a Unifying Theory of Behavioral Change," by A. Bandura, 1977, *Psychological Review, 84*, p. 193. Copyright by A. Bandura. Adapted with permission.

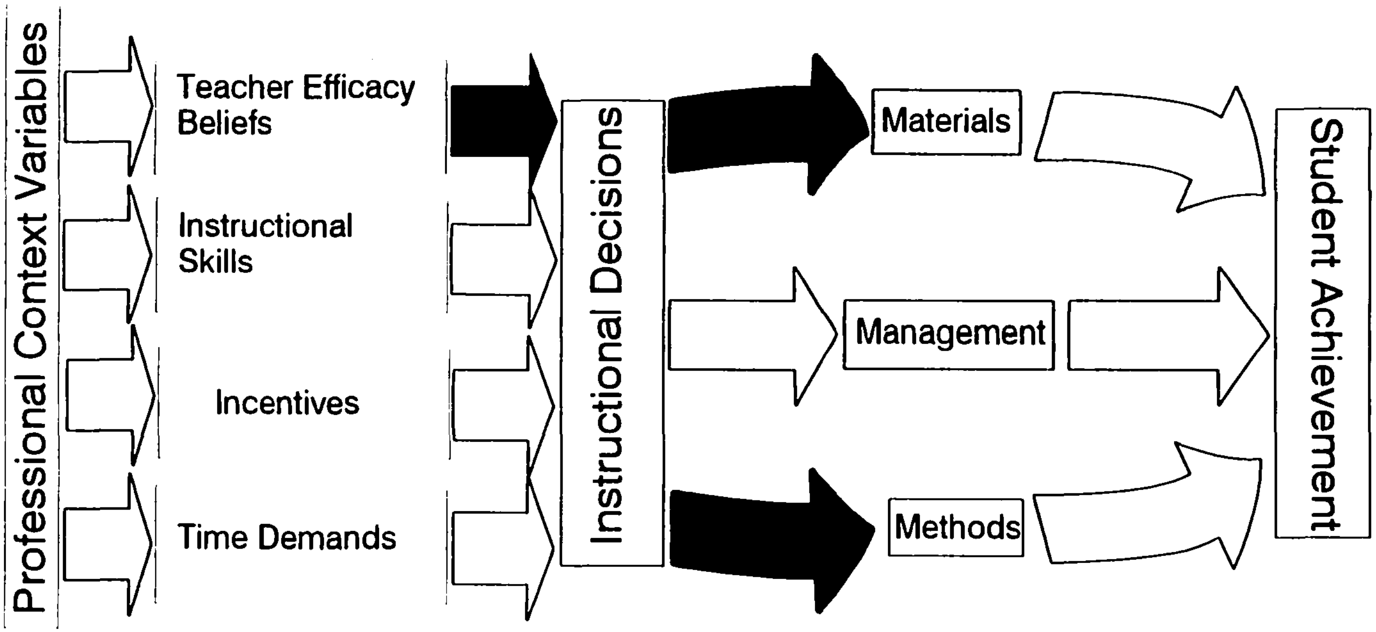


Figure 4. Conceptual model of the study.

important considerations are the validity and reliability of the survey instruments. The studies (Gibson & Dembo, 1984; Moore & Esselman 1992; Ross, 1992; Tracz & Gibson, 1986) that related scores on the Teacher Efficacy Scale to observed classroom behaviors support the validity and reliability of that instrument, and thus the STEBI, which was developed from the Teacher Efficacy Scale. The processes used by Weiss (1978) in the development of her instrument and during the follow-up procedures of the 1977 National Survey support the validity and reliability of the Science Methods and Materials Scale.

In interpreting the results of this study, it must be remembered that the instruments measured teachers' perceptions and beliefs, not unbiased observations of actual classroom behavior.

This study was delimited to science teachers who teach the seventh and eighth grade. I chose to limit my study to these grade levels for two primary reasons. First, because previous national surveys of science education used different instruments for elementary and secondary teachers, limiting my study to these two grade levels required the production of a single instrument. Second, when ordering the sample from the registry, I had three options: kindergarten through sixth grade science teachers, seventh- and eighth-grade science teachers, or high-school science teachers. By choosing seventh- and eighth-grade teachers, I attempted to limit any effects that might be introduced into the study by the inclusion of wide variations in teachers' instructional levels.

Definition of Terms

Absorption: Absorption education is typified by covert learning. Information is transferred from a teacher or textbook to the passive student (Tobin & Fraser, 1990).

Absorption materials: Absorption materials are instructional materials such as textbooks or videos that require no active participation by the student (Tobin & Fraser, 1990).

Absorption methods: Absorption methods are instructional methods such as lecture or assigned readings that require little active engagement of the student (Tobin & Fraser, 1990).

Constructivism: The constructivist view of learning sees the child as personally uncovering and constructing intelligence and understanding based on what is already known. This child-centered model of instruction makes large use of the scientific method and cooperative inquiry (McCormack, 1992).

Constructivist materials: Constructivist materials are instructional materials that require the active engagement of the learner. Usually these materials depend on a complex interaction of peer involvement, cooperative work, independent work, interactions with the teacher, and manipulation of data or objects (McCormack, 1992; Tobin & Fraser, 1990).

Constructivist methods: Constructivist methods are instructional methods that facilitate student construction of meaning. These include open-ended inquiry, cooperative learning, use of manipulatives, and interaction between students and teacher (McCormack, 1992; Tobin & Fraser, 1990).

Efficacy expectations: An efficacy expectation, as defined by Bandura (1977), is "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193).

Instructional materials: Instructional materials include a wide range of products used by teachers during instruction. This study is limited to the consideration of two broad categories of instructional materials: absorption and constructivist. See also **Absorption materials** and **Constructivist materials.**

Outcome expectancies: An outcome expectancy, as conceived by Bandura (1977), is "a person's estimate that a given behavior will lead to certain outcomes" (p. 193).

Personal science teaching efficacy beliefs (PSTEB): This term refers to teachers' specific beliefs in their own perceived competencies in increasing student science achievement through instruction (Ashton, Webb, & Doda, 1983a, 1983b; Gibson & Dembo, 1984; Guyton, Fox, & Sisk, 1991; Riggs & Enochs, 1990; Woolfolk & Hoy, 1990). Personal science teaching efficacy belief is operationally defined as a teacher's score on the PSTEB subscale on the STEBI. In this study, PSTEB is referred to as "efficacy beliefs." See **Efficacy expectations.**

Teacher efficacy: Teacher efficacy refers to a teacher's beliefs concerning the effectiveness of teaching in general and their personal abilities in teaching specifically. For this study, these two distinct factors of teacher efficacy are labeled science teaching outcome expectancies and personal science teaching efficacy beliefs. Teacher efficacy is operationally defined as the score received from the STEBI.

Science teaching outcome expectancies (STOE): This refers to a general belief in the ability of science teachers to affect students' achievement through instruction (Ashton et al., 19831, 1983b; Gibson & Dembo, 1984; Guyton et al., 1991; Riggs & Enochs, 1990; Woolfolk & Hoy, 1990). Science teaching outcome expectancy is operationally defined as a teacher's score on the STOE subscale of the STEBI. In this study, STOE will be referred to as "outcome expectancies". See **Outcome expectancies**.

Outline of the Study

The study begins with an introduction to the problem in chapter 1. The first chapter also includes a statement of the problem, the purpose of the study and its significance. Research questions and hypotheses are presented. These are followed by a discussion of research methodology and the study's theoretic framework. Chapter 1 closes with a glossary of terms used in the study.

Chapter 2 contains a review of relevant educational literature. Areas of the literature searched include effective teachers, methods, instructional materials, science materials, preferred instructional materials, innovation, educational innovation, demonstration programs, science, science education, and science curriculum. These searches were combined, for presentation purposes, into four groupings: teacher efficacy, exemplary science teaching, reforms in science education, and national studies of science education.

Chapter 3 is devoted to a discussion of the survey research methodology used in this study. This chapter includes a description of the population, sampling procedures, identification of variables, and instrumentation, including a description of the process used to derive the Science Methods and Materials section of the survey instrument from the 1977 and 1985-86 National Survey instruments. Procedures are presented for data collection and analysis.

Chapter 4 begins by providing details about the study's response rate. The second section gives a demographic description of the sample. This is followed by a discussion of responses to the STEBI. Data related to teachers' use of instructional practices are presented next. The chapter continues with a presentation of the results of hypotheses testing. A discussion of the study results follows immediately after the presentation of the results. The chapter closes with a summary.

Chapter 5 begins with a summary of the study including the purpose of the study, relevant literature, and research design. Conclusions drawn as a result of this study are then presented in a concise form. The study closes with a series of recommendations based upon descriptive statistics and hypotheses tests.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

In developing this review of literature, I accessed computerized card catalogs; computerized databases produced by Educational Resources Information Center (ERIC) and Dissertation Abstracts International; and bound indices including the Education Index, Current Index to Journals in Education, and Resources in Education. These literature searches were conducted at James White Library on the campus of Andrews University and at Linus A. Sims Memorial Library on the campus of Southeastern Louisiana University.

Descriptors used as key words for the computerized literature searches included effective teachers, methods, instructional materials, science materials, preferred instructional materials, innovation, educational innovation, demonstration programs, science, science education, and science curriculum. These key words were combined in a variety of permutations to create more specific limits for each search. This process reduced the list of citations retrieved to a reasonable number. For example, instead of having to peruse 16,454 citations for science education, I combined science education, instructional materials, instruction, and innovation into one search. This delimited search resulted in nine citations, which were then viewed.

After significant sources were located through library searches, I obtained these documents and began reading. If an article was particularly relevant, I checked its bibliography. Through this process, I obtained additional studies pertaining to my research that were not located during the initial library searches.

This literature review is divided into four major sections. The first division deals with the concept of efficacy and its interpretation in an educational context. This is followed by a discussion of studies of exemplary science teachers, particularly the instructional characteristics of these teachers. The third section of this review presents current reform efforts in American science education. The final section gives an overview of national surveys of science education in the United States. The chapter concludes with a summary of the literature.

Efficacy

Defining the Construct

Efficacy is an illusive term. Many assume the term is synonymous with efficiency or effectiveness. While relationships between these three terms can be supported, efficacy is a unique concept. However, there are different approaches to defining efficacy. For some, efficacy would be described simply as the belief that you "get what you work for", while for others it means having influence in making decisions that affect your work environment.

In one of the earliest studies investigating teacher efficacy, Brogdon (1973) used the Political Efficacy Scale (Campbell, Gurin, & Miller, 1954) as the basis for developing a revised scale specifically related to teaching. Thus defining teaching efficacy in terms of personal power. He constructed three items for each of the 5 original items in the Campbell Political Efficacy Scale. These items were submitted to a panel of judges, and 10 were retained as valid.

Barfield and Burlingame (cited in Woolfolk & Hoy, 1990) defined efficacy as "a personality trait that enables one to deal effectively with the world" (p. 82). For measurement of the efficacy trait, the researchers used the original Political Efficacy Scale, which they retitled Teacher Efficacy Scale without making any changes.

Moving away from the arena of political science, other efficacy studies have used psychology as a basis for their conceptualization. Based on Rotter's locus-of-control construct, two items were developed to measure efficacy for a Rand Corporation study of federally funded projects (Armor et al., 1976; Berman et al., 1977). Efficacy levels were assessed by scores on two 5-point Likert items: "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 or her home environment" and "If I try really hard, I can get through to even the most difficult or unmotivated students" (Armor et al , 1976, p. 23).

Bandura's (1977) cognitive social learning theory has been used to adapt the Rand items and expand methods of efficacy assessment. Bandura's theory assumes that cognitive processes create and strengthen personal efficacy expectations. He bases his theory on the interaction of outcome expectancies and efficacy expectancies. An outcome expectancy is defined as "a person's estimate that a given behavior will lead to certain outcomes," while efficacy expectations are defined as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193).

In Bandura's conceptualization, perceived self-efficacy expectations are a major influence on a person's "choice of activities and settings" (p. 194) if that person possesses adequate skills and if there are appropriate incentives. Self-efficacy expectations are said to predict a person's willingness to initiate and persevere in stressful situations.

Applied to education, Bandura's theory can be used to explain a teacher's use or avoidance of certain instructional practices. According to Bandura, successful classroom experiences function as corrective experiences that reinforce personal efficacy beliefs. Since the implementation of innovation creates job-related stress, self-efficacy expectations would predict both a teacher's willingness to attempt an innovation, and the teacher's perseverance in the innovation's implementation.

The Teacher Efficacy Study (Ashton et al., 1983a) was based on a multi-dimensional model of teacher efficacy, heavily influenced by Bandura's mechanism of self-efficacy. These researchers hypothesized a complex interrelationship of action-outcome contingencies, teaching efficacy, personal efficacy, and personal teaching efficacy (Ashton et al., 1983b). As conceived in this exploratory study, teaching efficacy is an expression of "beliefs about the general relationship between teaching and learning"; personal efficacy is defined as "a teacher's general sense of effectiveness as a teacher"; and personal teaching efficacy is viewed as the interaction of these two dimensions (Ashton et al., 1983a, p. 2).

However, efficacy was not considered a constant, stable trait. It was considered to be personally renegotiated each day. Following up on this idea, Ashton, Buhr, and Crocker (1984) found that teacher efficacy is a norm-referenced rather than a self-referenced trait. This means that efficacy level is determined by teachers comparing personal performance with performance of colleagues. Since teachers have typically been isolated from significant professional interaction with colleagues, this may explain why efficacy has not been shown to be a stable trait.

The trait of teacher efficacy has also been viewed as a bidimensional construct consisting of teaching efficacy and personal teaching efficacy

(Gibson & Dembo, 1984; Guyton et al., 1991; Riggs & Enochs, 1990; Woolfolk & Hoy, 1990). In these studies, teaching efficacy is described as the generalized belief that students can be taught. Personal teaching efficacy is the degree to which an individual feels personal competence in the teaching act.

Some researchers have expanded the bidimensional conception of teacher efficacy to include three or more components (Hoover-Dempsey, Bassler, & Brissie, 1987; Wax & Dutton, 1991; Woolfolk & Hoy, 1990). Hoover-Dempsey et al. (1987) define teacher efficacy as "teachers' beliefs that they are effective in teaching, that the children can learn, and that there is a body of professional knowledge available to them when they need assistance" (p. 421).

A typical definition of teacher efficacy is expressed by Wax and Dutton: "the teacher's expectation that he or she can help students learn" (1991, p. 2). Woolfolk and Hoy (1990) stress the importance of a researcher explicitly defining the construct of teacher efficacy to guide a proposed study.

Walker (1992) assessed efficacy of student teachers through self-ratings on a checklist derived from a list of teacher competencies and indicators of effectiveness. The rating scale asked for ratings varying from "very effective" to "very ineffective." It would appear that only self-efficacy was being measured, not both dimensions of the teacher efficacy construct. While Walker reported content validity for her instrument, as supported by a team of university supervisors, the measures collected do not appear to agree with the two-dimensional definition of teacher efficacy given in her review of literature.

Efficacy and Student Achievement

The impetus to study teacher efficacy came from early studies of the construct that linked higher levels of efficacy to higher levels of student achievement. Several studies have shown higher levels of student achievement in classrooms of teachers with higher levels of efficacy (Armor et al., 1976; Ashton et al., 1983a, 1983b; Berman et al., 1977; Brookover, Beady, Flood, Schweitzer, & Wisenbaker, 1977; Tracz & Gibson, 1986). Armor et al. (1976) were among the first to report the link between efficacy and achievement. In a study of federally funded reading programs, these researchers found a strong relationship between efficacy and reading achievement.

Brookover et al. (1977) labeled the efficacy construct "teacher climate" and found a significant relationship between teacher climate and school achievement. Berman et al (1977) identified a teacher's sense of efficacy as the most important factor related to student achievement and teacher innovation. Ashton et al. (1983a, 1983b) have shown a significant relationship between teacher efficacy and student achievement in high-school basic skills classes.

Tracz and Gibson (1986) investigated the relationship between teacher efficacy and teacher use of time, student time on task, and student achievement. A relationship was indicated between levels of personal teaching efficacy and reading achievement, while teaching efficacy was positively correlated with language and math achievement. These results highlight the complex interactions and sometimes unexpected results in efficacy research. This study supports the bidimensional construct of teacher efficacy, as teaching efficacy was not found to be significantly correlated with personal teaching efficacy. For example, reading achievement was positively correlated with personal teaching efficacy beliefs, while math and language achievement were positively correlated with general teaching efficacy beliefs.

Measuring Teacher Efficacy

The earliest research on teacher efficacy borrowed heavily from the construct of political efficacy in measurement techniques. These studies used 5 (Barfield & Burlingame, 1974) and 10 items (Brogdon, 1973) to assess teacher efficacy.

The approach used for assessing teacher efficacy in studies based on Rotter's locus-of-control construct utilized two Likert-format items: one to measure teaching efficacy and a second to measure personal teaching efficacy (Armor et al., 1976; Ashton et al., 1983a; Berman et al., 1977).

However, the use of only two items to assess the efficacy construct made it difficult for researchers to collect reliable data.

Ashton et al. (1984) expanded assessment of teacher efficacy through the development of a set of 25 teaching situations. Teachers were asked to rate their ability for success in each situation. This score was combined with scores from the two Rand items to report level of teacher efficacy.

In a study that utilized secondary analysis of data, Fletcher (1990) used two existing items from the Administrator-Teacher Survey to measure teacher efficacy. These two items were judged to have face validity with the efficacy construct as defined by Bandura. Only the self-efficacy trait was addressed in this study, no measure was defined for the outcome expectancy trait.

In an effort to develop a more reliable and practical measure of teaching efficacy, Gibson and Dembo (1984) developed and tested the Teacher Efficacy Scale. The Teacher Efficacy Scale consists of 30 Likert-format items. In the original study, factor analysis of the Teacher Efficacy Scale yielded two substantial factors. Factor 1 was labeled Personal Teaching Efficacy, while Factor 2 was labeled Teaching Efficacy. Sixteen of the 30 original scale items yielded significant loadings on one of these two factors. Factor 1 was interpreted to represent Bandura's concept of self-efficacy beliefs, while Factor 2 was equated with outcome expectancies.

Validity of the Teacher Efficacy Scale

A multitrait-multimethod analysis assessed convergent and discriminant validity of the efficacy trait. Gibson and Dembo (1984) analyzed efficacy along with two other traits identified in effective teachers: verbal ability and flexibility. Using both open-ended and closed-ended methods, validity diagonal values for all three traits passed the criterion for convergent validity and were found to be significant beyond the .05 level. That is, evidences of teacher efficacy gathered from a closed-ended additive scale and from a more open-ended format converged. This was supported by a positive correlation of .42 ($p > .001$).

Discriminant validity was supported by a two-step process. This process indicated teacher efficacy measures could be differentiated from measures of verbal ability and flexibility. This provides support for the existence of teacher efficacy, as measured by this instrument, as a specific, separate construct.

Reliability of the Teacher Efficacy Scale

Internal consistency reliability was computed for the Teacher Efficacy Scale, which resulted in Cronbach's alpha coefficients of .78 for the Personal Teaching Efficacy factor, .75 for the Teaching Efficacy Factor, and .79 for the total 16 items (Gibson & Dembo, 1984). Woolfolk and Hoy (1990), in a replication of Gibson and Dembo's procedures found a Cronbach's alpha of .82 for the Personal Teaching Efficacy factor and .74 for the Teaching Efficacy factor. These researchers also presented a three-factor solution for the Teacher Efficacy Scale. The three-factor solution subdivided the personal teaching efficacy trait into feelings of responsibility for student successes and feelings of responsibility for student failures. Although the three-factor solution was valid, it added nothing to the simpler two-factor solution and was not used in data analysis.

Because of the multidimensional nature of the efficacy construct, combining measures of the different dimensions into one scale may cause researchers to miss vital relationships (S. Gibson, personal communication, July 13, 1994; Woolfolk & Hoy, 1990). Additionally, it is not always a simple matter to designate high-efficacy, average-efficacy, and low-efficacy groups. Trentham, Silvern, and Brogdon (1985) were unable to differentiate between high-, average-, and low-competency groupings of teachers based on superintendent ratings. However, low-competency groups could be differentiated from the combined high- and average-competency groups.

Woolfolk and Hoy (1990) suggest four methods of establishing high- and low-efficacy categories:

1. Use a composite score and determine cutoff points.
2. Use teachers who score high on both teaching efficacy and personal teaching efficacy for the high-efficacy category. Use teachers who

score low on both teaching and personal teaching efficacy for the low-efficacy category.

3. Use only one scale. Disregard either the personal teaching efficacy scale or the teaching efficacy scale.

4. Make categories based on personal teaching efficacy scores, but ignore those cases with widely different scores on the two scales.

Characteristics of Efficacious Teachers

General characteristics common to teachers with high or low senses of efficacy have been reported by several studies. Results are sometimes contradictory to other studies, but this possibly could be explained by poor conceptualization of the study and/or imprecise definition of the efficacy trait or other specific variables assessed in the study.

Teachers with high senses of efficacy have been shown to "maintain high academic standards, concentrate on academic instruction, monitor students' on-task behavior, and work to build friendly, non-threatening relationships with their low-achieving students" (Ashton et al., 1983a, p. v). Gibson and Dembo (1984) found that high-efficacy teachers devoted more classroom time to whole group instruction, checking seat work, and non-academic activities. Low-efficacy teachers spent more time on academic activities, but most of this was spent in small group instruction. These teachers used more intellectual games and more time to make transitions when compared to high-efficacy teachers. Similar results were reported by Tracz and Gibson (1986). Personal teaching efficacy was positively correlated with use of whole group instruction and negatively correlated with small group instruction.

In a study investigating pre-service teachers and feelings of efficacy and student control (Woolfolk & Hoy, 1990), higher levels of teaching efficacy were related to a less custodial and less bureaucratic pupil control orientation. Higher levels of personal teaching efficacy were related to a less custodial but more bureaucratic pupil control orientation.

Efficacy and Teachers' Professional Context

Many studies have addressed issues related to teacher efficacy and a teacher's professional context. These include investigations of relationships between efficacy levels and school organizational factors, years of teaching experience, type of teacher certification program, and components of student teaching programs.

Efficacy and Organizational Factors

Efficacy factors differ significantly across schools, levels, and grades (Moore & Esselman, 1992). In fact, the organizational form of the school may contribute to the denial of a teacher's sense of efficacy (McLaughlin, Pfeifer, Swanson-Owens, & Yee, 1986). Conditions of isolation, uncertainty, powerlessness, and lack of economic rewards or social recognition can threaten perceptions of teacher efficacy (Ashton et al., 1983a).

Some school organizational structures have also been shown to be related to feelings of high efficacy. In an ethnographic study, Ashton et al. (1983a) studied two organizationally different schools. The middle school was organized around collaborative, cooperative groups of faculty members. Each year these groups were assigned one third of the incoming students. Each class consisted of 24 students. Eight students were in their first year of middle school, 8 were in their second year, and 8 were in their final year. The second school was organized around a traditional departmental framework. The study data supported a relationship between higher levels of teacher efficacy and the cooperative, innovative middle school organizational pattern.

A relationship between teacher efficacy and parent-teacher interaction has been supported by research. While the relationship has been supported by two different studies (Ashton et al., 1983a; Hoover-Dempsey et al., 1987), no causative effect has been shown. It is probable that parent-teacher interactions influence a teacher's efficacy attitudes, but it is just as probable that a teacher's feelings of efficacy affect the extent and quality of parent-teacher interactions. It also appears that there is a significant relationship between high teacher efficacy levels and higher levels of parental participation in the local school program (Hoover-Dempsey et al., 1987).

Efficacy and Teaching Experience

Several studies have been conducted seeking information about the stability of the teacher efficacy trait, its development across time, and teacher efficacy beliefs in pre-service teachers.

In an effort to identify characteristics that teachers believe to account for student successes and failures, Hall, Hines, Bacon, and Koulianos (1992) sampled teachers in elementary, middle, and secondary schools. Elementary teachers differ from both middle and secondary teachers on characteristics that account for student failure, but not student success. This study also looked at differences based on efficacy levels. Using an adapted form of the Rand items, efficacy scores were divided at the median to provide groupings of high and low efficacy.

Using a multivariate analysis of variance (MANOVA), Hall et al. found that teachers high in personal teaching efficacy rated the role of teacher and the instructional program as more important attributes of student success than factors external to the school. Teachers high in personal teaching efficacy were more likely to see themselves as responsible for student failure. Teachers high in teaching efficacy showed no significant differences in beliefs about attributions for student failure. This group did emphasize the role of the teacher and instructional program to explain student success.

A developmental study of the teacher efficacy trait (Pigge & Marso, 1993) hypothesized an increase in efficacy across time. Success in past teaching situations was expected to increase feelings of efficacy. High-potential teacher candidates and highly successful teachers at three different stages of career development were sampled for this study. The four groups represented prospective teachers at the beginning of teacher training and teachers at early-, mid-, and late-career development stages. Results, however, did not support the developmental efficacy model. No significant differences in perceptions of efficacy were found between the four groups.

Another approach to studying efficacy levels at different stages of career development involved the study of current and former teachers (Glickman & Tamashiro, 1982). Former teachers' perceptions of efficacy were compared to those of first-year and fifth-year teachers. Both groups of practicing teachers had significantly stronger senses of efficacy than the former teachers.

Teacher competence ratings have been positively correlated with birth order, race, and efficacy beliefs (Trentham et al., 1985). Therefore, some research has focused on techniques to increase efficacy beliefs, the only one of these variables that has been shown to change. In an attempt to increase teacher efficacy and thus change teacher behavior, Ashton et al. (1983a, 1983b) presented three different 2-hour workshop training sessions. A different approach was used for each of three schools, while a fourth school, serving as the control group, received no training. No significant difference was observed for any of the four groups. But in light of research in transfer of training and the ineffectiveness of typical in-service sessions, this is not surprising.

Efficacy, Pre-service Teachers, and Certification Programs

In studies of pre-service teachers, high efficacy can be considered to indicate a personal expectation of success as a teacher (Woolfolk & Hoy, 1990). The use of reflective practices such as journals, coaching, and networking has been shown to have a significant positive impact on levels of self-efficacy in pre-service teachers (Volkman et al., 1992).

A comparative study of beginning teachers (Guyton et al., 1991) measured the efficacy levels of those who had been prepared through traditional teacher education programs and those who had entered teaching through Georgia's alternative certification program. Efficacy levels were assessed at the middle of the year and at the end of the year. No significant differences were found between the two groups of teachers at either assessment. No significant differences were found for the change in efficacy level between mid-year and year-end.

Efficacy and Implementation of Innovations

Links between efficacy and implementation of educational innovations have been supported by several studies. Berman et al. (1977) found a significant relationship between efficacy and degree of innovation implementation. Teacher efficacy has been identified as the most important teacher characteristic contributing to student achievement in an analysis of over 400 federally funded innovative school programs (McLaughlin & Marsh, 1978).

In a study investigating the degree of implementation of cooperative learning as the result of a large staff development project, a relationship was found between high levels of efficacy and high cooperative learning use. This group of high-use teachers reported a significantly stronger sense of power in their teaching role, confidence in working with students, and willingness to innovate (Wax & Dutton, 1991).

Poole and Okeafor (1989), in a study of curriculum implementation, obtained unexpected results. Their findings showed no relationship between efficacy and curricular implementation. Perhaps this could be explained by the fact that the change was implementation of a new curriculum guide, not a program of research-based innovative practices. The results did indicate that coupling high efficacy with collaboration may result in higher implementation of traditional curriculum guides.

Efficacy and Decision Making

In a list of suggestions for further research, Gibson and Dembo (1984) express the need to investigate the relationship between efficacy and teacher decision making. Fletcher (1990) found support for a relationship between efficacy and the degree to which teachers are involved in school-level curriculum decisions. Moore and Esselman (1992) also found support for a relationship between teacher efficacy and perceived involvement in school-level decision making. However, no support was found for a link between teacher efficacy and decision making at the classroom-level.

Exemplary Science Teachers

Partly as a reaction to the many reports issued during the 1980s revealing negative aspects of American education, researchers began looking for the best American science programs and educators. The Search for Excellence was one effort, begun in 1982, to identify exemplary science education programs (Penick & Yager, 1983). The identification of exemplary teachers has also been the focus of several studies. It was postulated that an accurate description of exemplary science programs and teachers could be used to initiate improved science education across the nation.

The Search for Excellence, which focused on exemplary science education programs, found six common characteristics of these programs:

1. administrative support
2. a single leader for the program
3. community and parent involvement and support
4. connections with universities and colleges

5. teachers actively involved in professional organizations
6. little dependence on textbooks (Tobin & Fraser, 1990).

Characteristics of Exemplary Science Teachers

Management, teaching, and learning are all vitally linked in an exemplary science teacher's classroom (Tobin & Fraser, 1990). While management style may not be important, exemplary teachers tend to exhibit a high level of managerial efficiency (Treagust, 1991). Exemplary science teachers also create a favorable classroom climate to enhance learning and support weaker students (Tobin & Fraser, 1990; Treagust, 1991). This includes the use of "safety nets" to decrease student apprehension about failure. Effective teachers make it "safe" for students to fail and then learn from the experience. Since my study was limited to a teacher's decisions related to instructional materials and methods, this review did not include specific sections on literature related to management and learning.

Exemplary Science Teachers and Instructional Materials

The separation of instructional materials and instructional methodologies used by exemplary science teachers in this review is artificially imposed. The literature indicates an extremely close relationship between decisions about materials and methods. However, because the survey instrument used in this study differentiated between materials and methodologies, the review of the literature followed the same format.

In a study to assess teacher and principal perceptions of outstanding science teachers, Searles and Kudeki (1987) found both groups rated highly the ability to organize and present effective teaching materials. This was the highest-rated item in the area of lesson planning and presentation. Principals and teachers also rated "creativity in teaching" and "able to use a variety of materials and methods of teaching" as important characteristics of an outstanding science teacher.

Searles and Kudeki (1987) give a profile of an outstanding science teacher based on the feedback from their study. According to their findings, an exemplary science teacher uses a variety of methods and materials, hands-on activities, student-centered approaches, and up-to-date methods. They contend that a "variety of materials and methods in teaching tend to induce interest and foster greater effort as well as clarify important concepts" (p. 6).

This theme of variety runs through all studies of exemplary science teaching. It is sometimes included as a portion of the definition of an effective science teacher. By contrast, an ineffective teacher is described as being textbook dependent (Yager, Hidayat, & Penick, 1988). Unfortunately, some writers do not operationalize the meaning of "a variety of materials." Tobin and Fraser (1990) were more specific when they reported that exemplary science teachers used a materials-centered approach to encourage hands-on activities and skills development.

Exemplary Science Teachers and Instructional Methodologies

Constructivism and absorption are two methodological approaches that can be considered as opposite ends of the instructional continuum in science education (Tobin & Fraser, 1990) (see Figure 1). Absorption involves information transfer from the teacher or textbook to the student. As reported in *A Place Called School* (Goodlad, 1984), absorption was the dominant approach in American classrooms in the late 1970s. Methodologies typically used for absorption are lecture and recitation, and the academic emphasis is on recall of facts.

Constructivism requires overt, active learning. Students must be actively engaged, both individually and with peers. Manipulation of real objects, data, and variables is a vital component of instruction. While students do spend time listening to the teacher, they also respond and express their understandings.

Exemplary science teachers tend to use a wide variety of instructional methods. Most of these methodologies could be classified toward the constructivist end of the instructional continuum. These teachers keep students busy and actively engaged in learning (Tobin & Fraser, 1990; Treagust, 1991). Strategies and activities used by outstanding science teachers required active, overt academic involvement with the materials (Tobin & Fraser, 1990). Treagust (1991) found that two exemplary teachers in Australia made inquiry-based lab sessions an integral part of the biology course. One teacher utilized the laboratory 20% of the time, while the second teacher used laboratory activities during 35% of the instructional time.

A constant effort to remain current in instructional methods is another characteristic of exemplary science teachers. Teachers and principals both considered "changes teaching methods to keep up-to-date" as very important (Searles & Kudeki, 1987). Yager et al. (1988) found that more science teachers rated as highly effective by science supervisors chose to attend elective in-service programs than did those rated as least effective.

Because of limited available funding and America's past experiences with educational fads, the search for up-to-date teaching strategies should focus on those techniques that have shown their validity, that is, their ability to increase student understanding and achievement. An extensive research base exists for a variety of effective strategies that are applicable to science education (Joyce et al., 1992). Exemplary science teachers can make use of this knowledge base.

Variables Unrelated to Exemplary Science Teaching

In studies focusing on individual teachers, a wide range of characteristics of exemplary science teachers have been identified. In some cases, the discovery of variables that are *not* related to science teaching effectiveness are as valuable as the discovery of variables that *are* related to teacher effectiveness. These studies help to overcome many common misconceptions about what makes a good science teacher.

Yager et al. (1988), in a study comparing least-effective and most-effective teachers, found no relationship between teacher effectiveness and age, years of teaching experience, number of preparation periods, or number of content courses taken at the undergraduate or graduate level. Thus it appears that strong content preparation by itself is not enough for effective teaching.

In fact, the 1977 and 1982 National Assessments of Educational Progress indicated that teachers who are the most knowledgeable in science tend to have students who are less likely to consider science interesting, useful, or fun (cited in Yager et al., 1988). Findings such as these have helped to fuel current drives for systemic reform in science education.

Reform in American Science Education

Background

Alan McCormack (1992) presents an excellent overview of the historical development of science education in the United States. He describes the years from 1860 to 1920 as the infancy period of American Science education. This era was followed by the textbook period. The third period of American science education began with the launching of Sputnik in 1957, which McCormack labels the first revolution in science education. A second revolution began in 1980 and continues to the present day.

At the Secretary of Education's Second Conference on Mathematics and Science (McKinney, 1993), four themes emerged for educational reform. These were the need for national standards, the improvement of mathematics and science teaching, the improvement of instructional materials, and the need for systemic change.

Systemic change or reform is defined as "transforming all parts of the education system at the same time to achieve high standards of student performance" (McKinney, 1993, p. 1). The conference presenters stressed the need for national standards in science education to guide reformation efforts at all levels: local, state, and national. Lifelong professional development plans for teachers were cited as a vital need if systemic reform is to occur.

Current Initiatives

There are four current initiatives promoting educational reform in science. None of these projects is exclusive of the others, rather, each is complementary. These four initiatives are the Science, Technology, and Society (STS) movement; the National Science Teachers Association (NSTA) *Project on Scope, Sequence, and Coordination* (SS&C); development of national standards by the National Committee on Science Education Standards and Assessment; and *Project 2061* (McCormack, 1992).

STS, SS&C, and National Standards

Science, Technology, and Society represents a turning from the teaching of "pure" science. Instead, science instruction is to be related to societal issues and technological implications. This approach was suggested by the findings of *Project Synthesis* (Harms & Yager, 1982), essentially a meta-analysis of the science education literature, sponsored by the National Science Foundation.

The NSTA's *Project on Scope, Sequence, and Coordination* (SS&C) also grew from a synthesis of science education literature in the late 1980s. The SS&C rejects the layer-cake science curriculum approach typically used in secondary schools, where students study one year of earth/space science, one year of biology, one year of chemistry, and one year of physics. This project calls for teaching a content core each year from grade 6 through grade 12. Thus, each year students will study biology, physics, chemistry, and earth/space science. This approach stresses the interconnectedness of science, so it is likely that students may study content from each of these science strands weekly ("SS&C's Basic," 1995).

The project also espouses a less-is-more philosophy. Therefore the number of science concepts taught and the quantity of science terminology presented are greatly reduced. Instead of surveying a large number of topics, the goal is for in-depth understanding of fewer concepts. Specific details for implementation of the SS&C can be found in *The Content Core: A Guide for Curriculum Designers* (National Science Teachers Association, 1992).

The National Committee on Science Education Standards and Assessment was established by the National Research Council in 1991. Its commission was to develop six sets of standards. Draft versions of science teaching standards, professional development standards, assessment standards, content standards, program standards, and system standards were released in December 1994 ("Draft National," 1995; "Highlights From," 1995). The purpose of the standards is not prescriptive, but procedural. The committee attempted to produce standards that can be used to judge a wide range of practices in these six basic areas of science education. The final version of the standards was scheduled for release in late 1995. Almost immediately upon the release of the draft version of the standards, plans were announced by NSTA's SS&C project to launch a field test of standards-based materials developed from the pre-draft standard issued in May of 1994 (Aldridge, 1995).

Project 2061

Project 2061, as the name suggests, is a long-term approach to science education reform. Sponsored by the American Association for the

Advancement of Science (AAAS), the project has four goals: (1) develop new curriculum models, (2) improve instruction in science, mathematics, and technology, (3) understand what is needed for sustained reform, and (4) initiate collaborative action. To achieve these goals, *Project 2061* is openly seeking change throughout the entire educational system. Its curriculum development efforts make no attempt to revise current curricula, but attempt to develop a science curriculum from theory and research (Ahlgren & Rutherford, 1993).

Project 2061 plans to issue four reports: (1) *Science for All Americans* (AAAS, 1989), (2) science education benchmarks for specific grade levels, (3) curriculum models, and (4) a resource database.

Science for All Americans gives recommended knowledge and skills in science, mathematics, and technology that should be retained by students after graduation from high school. These recommendations fall into four categories: "(1) Scientific Endeavor, (2) Scientific Views of the World, (3) Perspectives on Science, and (4) Scientific Habits of Mind" (AAAS, 1989, p. 5).

Science for All Americans is already having an effect on education in the United States. On a local scale, the project asks individual teachers to begin implementing the called-for changes and to reduce the number of concepts taught in their classrooms (Ahlgren & Rutherford, 1993). On a much larger scale, California developed a new framework for science education based on the work done in *Project 2061* (Reed & Calhoon, 1992). The primary audience of this State framework is the publishers and producers of school science materials. Because of the lucrative educational-materials market in California, immediate changes in materials can be expected. The California Department of Education has developed a database of more than 150 activity-based, interactive lessons to support its science framework (McKinney, 1993).

The benchmarks developed by *Project 2061* will be designed for grades 2, 5, 8, and 12. The benchmarks are descriptions of pupil outcomes that will serve as guides for developing curriculum. According to Heller, the committee tries to "make benchmarks not so specific as to be limiting and not so general that no one is quite sure what you're talking about" (cited in Ahlgren, 1993, p. 49).

To create the benchmarks, developers used a process called "progression-of-understanding" mapping. This required working backward from the 12th-grade understandings listed in *Science for All Americans*. When released, the benchmarks will be accompanied by essays indicating potential problem areas and instructional suggestions for overcoming these difficulties.

The final two phases of *Project 2061* include development of curriculum models and an instructional database. Curriculum models are under development at six school-based sites throughout the nation. Each team of curriculum developers is taking a different approach. As these curriculum models develop, curriculum blocks, including instructional details, will be released (Ahlgren & Rutherford, 1993). Software development is already underway to support the progression-of-understanding maps included in the benchmarks. Eventually, it will be possible to link sections of the maps with appropriate activities, materials, and assessment strategies (Ahlgren, 1993).

Common Reform Goals

While each of these reform movements has its own unique characteristics, it is possible to identify several common attributes. With few exceptions, these goals are held in common:

1. an integrated, thematic approach that emphasizes connections within science and with "other" subject areas
2. relevance of science education to daily life
3. teaching for understanding, which includes in-depth treatment of core concepts rather than superficial treatment of many topics
4. use of hands-on, constructivist learning activities
5. inclusion of important societal topics
6. integration of technology, and
7. inclusion of higher-order thinking and decision-making skills (AAAS, 1989, 1992; Ahlgren, 1993; Ahlgren & Rutherford, 1993; McCormack, 1992; McKinney, 1993).

Implications for Instructional Materials and Methods

While the National Diffusion Network (Sivertsen, 1990) regularly identifies and disseminates exemplary programs in science education, there is some evidence that quality, commercially developed science materials for the general school population are almost nonexistent. In a review of materials nominated by teachers, Pogrow (1993) and his evaluation team identified only one commercially developed, comprehensive science program as exemplary. Perhaps this is because of his insistence that the materials require use of the Socratic method, but the results are still shocking.

Typical teaching of science has stressed print, paper, pencil, and textbooks that teach little more than vocabulary. Some science educators have suggested the development of new instructional materials that address three phases of a teacher's professional development:

1. teacher as learner
2. teacher as teacher, and
3. teacher as leader (McKinney, 1993).

These instructional materials are not limited to textbooks and other traditional categories, but include anything a teacher uses to teach a lesson.

Due to the entrenched position of the textbook in American science education, it may take policy changes, significant incentives, or other action to encourage teachers to move from textbook dependence to more use of hands-on materials. Examples of materials mentioned by educators as needed or exemplary include videos, overhead transparencies, films, quality science books, computer simulations, multimedia packages, and interactive computer simulations (Barrow & Germann, 1987; Imhof, 1991). Of course, it cannot be assumed that all films or all computer simulations are exemplary. Some educators suggest that teachers take the lead in certifying instructional materials. For example, exemplary science materials could receive and be labeled with a seal of approval from the NSTA (McKinney, 1993).

Science education reform movements emphasize teaching for understanding. Teaching for understanding requires several changes in classroom practice. Teachers must first understand science themselves if they are to teach for understanding. It requires a shift from dependence on textbooks, worksheets, and lectures to a more student-centered approach. And since teaching for understanding requires different teacher skills and instructional strategies, extensive revisions of both pre-service and in-service teacher education will be required (McKinney, 1993).

Methods best suited to teaching for understanding require any combination of the following: active involvement of the learner, interaction with student peers, interaction with the teacher, interaction with the concept, higher-level thinking, decision making, and open-ended inquiry (AAAS, 1992; McCormack, 1992; McKinney, 1993).

National Studies of Science Education

The National Science Foundation has funded three national surveys of science and mathematics education in the United States, the first in 1977, the second in 1985-1986, and the most recent in 1993 (Weiss 1978, 1987, 1994). In the first national survey, 10,000 teachers, principals, superintendents, local district supervisors, and state supervisors were sampled (Weiss, 1978). This descriptive study collected data on science, mathematics, and social studies education. Information was gathered on a wide variety of topics including instructional time, required classes, course offerings, and federally funded programs. The survey also collected specific information from teachers on use of textbooks, instructional materials, and instructional strategies.

The 1985-1986 national survey followed similar procedures to the first national survey, but the sample size was reduced to approximately 4000. Sampling was limited to teachers and principals, K-12, since these two groups returned the information that had proven to be of most use (Weiss, 1986). The 1977 survey instrument was used as a basis to develop an up-dated instrument for data collection (Weiss, 1987).

In comparing the first two national surveys, one of the most striking findings is that when reporting on their most recently taught science class, fewer teachers were using hands-on activities in 1985 than in 1977. This reduction in student-centered instruction occurred while calls for increased use chapter (Weiss, 1978, 1986, 1987).

The third National Survey of Science and Mathematics Education was designed to answer four basic questions. These concerned teacher preparation, teacher support of reform efforts, classroom practices, and barriers to effective and equitable instruction. This survey sampled 6,000 teachers from 1,250 schools across the United States ("Standards Found," 1995).

Data from the 1993 study indicate high school teachers feel better prepared to teach science than do their elementary colleagues, yet are less willing to consider new teaching techniques, such as cooperative learning and multi-disciplinary teaching ("Science and," 1995). Elementary teachers tend to feel more confident in teaching math than in teaching science. This confidence translates into action, as elementary teachers spend at least one hour per day teaching math and less than 30 minutes per day for science.

Summary

This chapter contained a summary of the educational literature relevant to this study. The review began with an in-depth discussion of the teacher efficacy construct. This included a description of behaviors and characteristics that have been shown to have a relationship with the efficacy construct. Techniques for measuring teacher efficacy were discussed. The need for further research on the relationship of teacher efficacy and classroom instructional decisions was established. The most common decisions made by teachers involve instructional materials, instructional strategies, and classroom management; and these decisions directly affect student learning.

The second section of the review presented research findings about exemplary science teachers. These teachers' use of instructional materials and methods was the primary focus of the discussion presented. Exemplary teachers tended to use constructivist practices in their classroom. As a result, current science education reform efforts focus much attention on constructivism and teaching for understanding.

The review concluded with a short discussion of two national surveys of science education in the United States. From this synthesis of the literature, the following statements are supported:

1. Teacher efficacy is positively correlated with student achievement and implementation of educational innovations.
2. Leading educators are pressing for innovation and reform in science education.
3. In 1993 instructional practices in American classrooms did not reflect constructivist practices.

The purpose of this study was to integrate these facts and discover if science educators with higher levels of teacher efficacy utilize constructivist practices to a higher degree.

CHAPTER 3

METHODOLOGY

Introduction

This descriptive study employed a correlational design utilizing cross-sectional survey methodology. Data were collected via one survey instrument with three subdivisions. The purpose of this design was twofold: to gather descriptive data on science education in seventh- and eighth-grade classrooms in the United States and to correlate reported use of instructional practices with teacher efficacy and selected context variables. This chapter describes the study participants, variables, instrumentation, survey procedures, null hypotheses, and data analysis procedures.

Participants

Population

This study selected as its population the seventh- and eighth-grade science teachers in the United States of America. To attempt a national probability sample of the entire population of science teachers, such as was done in the three previous national surveys of science education (Weiss, 1978, 1987, 1994), was beyond the scope of a single researcher. However, I drew the study sample from a subset of this national population. The National Science Teachers Association (NSTA) maintains the largest listing of K-12 teachers by name in the United States. This Official U.S. Registry of Teachers lists 664,412 K-12 science, math, English, and social science teachers by name and mailing address. Of this K-12 total, 281,465 are science teachers, and 77,926 of the science teachers teach at the seventh- and eighth-grade levels. Use of this registry allowed the selection of a random sample from a significant subset of the entire national population of seventh- and eighth-grade science teachers.

Sample

The sampling procedure was a limiting factor for this study. If funds had permitted, a national probability sample could have been implemented as in the three previous national surveys of K-12 science education. A national probability sample ensures that every member of the population has an equal chance of being selected. However, since this was not possible, a subset of the national population, the Official U.S. Registry of Teachers, consisting of 77,926 seventh- and eighth-grade science teachers was selected as the study population.

Inclusion in the registry was not dependent on individual characteristics of the science teacher, but response to the registry survey by the school principal. Therefore, use of teachers listed with the registry was predicted to result in a truly random sample of seventh- and eighth-grade science teachers. This sample was assumed to be typical of the broader U.S. population of junior-high science teachers.

The success of this study depended on a sample of teachers that exhibited variation in efficacy levels. Since I assumed a normal distribution of the efficacy trait in the teacher population, a random sample from within the registry population was predicted to provide sufficient variance in efficacy. Fowler (1993) presents guidelines for selecting sample size based on the error range determined acceptable by the researcher. Fowler indicates researchers can be 95% confident that a sample of 300 would supply results within 6% of population values. Based on this information, the initial sample size was set at 300.

However, since return rates for mail surveys are often 50% or less, Rea and Parker (1992) suggest oversampling to achieve the minimum number of desired responses. Therefore, I decided to sample 500 seventh- and eighth-grade teachers in an attempt to ensure a minimum of 300 responses. A systematic sample (every Nth name) was ordered from the Official U.S. Registry of Teachers' listing of more than 75,000 seventh- and eighth-grade science teachers. When I received the order, it contained exactly 543 names and addresses. These teachers were then used as the sample for this study.

Identification of Variables

This study investigated three variables: teacher efficacy, instructional decisions, and context of teaching. Teacher efficacy in this study was defined as consisting of two sub-variables: science teaching outcome expectancy and personal science teaching efficacy belief. Science teaching outcome expectancy was defined as a general belief in the ability of science teachers to affect students' achievement through instruction. Personal science teaching efficacy beliefs were defined as teachers' specific beliefs in their own perceived competencies in increasing student science achievement through instruction (Ashton et al., 1983a, 1983b; Gibson & Dembo, 1984; Guyton et al., 1991; Riggs & Enochs, 1990; Woolfolk & Hoy, 1990).

In this study, the variables related to instructional decisions were teacher use of instructional methods, use of computer practices, and use of instructional materials. Based on the review of the literature and feedback from science education professionals, instructional methods and materials listed on the Science Methods and Materials Scale were placed in two categories: absorption and constructivist.

Absorption materials were defined to include instructional materials such as textbooks or videos that require no active participation by the student. Absorption methods included instructional methods such as lecture or assigned readings that require little active engagement of the student.

Instructional materials that require the active engagement of the learner were designated as constructivist materials. Usually these materials depend on a complex interaction of peer involvement, cooperative work, independent work, interactions with the teacher, and manipulation of data or objects. Constructivist methods were defined as those methods that facilitate student construction of meaning. These included open-ended inquiry, cooperative learning, use of manipulatives, and interaction between students and teacher (McCormack, 1992; Tobin & Fraser, 1990).

Based on the literature review, variables were also selected for inclusion in this study that relate to the context of a teacher's career. They included the following:

1. years of teaching experience (Pigge & Marso, 1993; Riggs & Enochs, 1990)
2. classroom type (self-contained, single subject, multi-age, other)
3. gender (Riggs & Enochs, 1990; Weiss, 1978, 1987)
4. preparation for science teaching (Riggs & Enochs, 1990; Weiss, 1978, 1987), and
5. organizational climate (Ashton et al., 1983; Poole & Okeafor, 1989).

Instrumentation

The survey instrument for this study consisted of three sections: context variables (demographics), the Science Methods and Materials Scale, and the

Science Teaching Efficacy Beliefs Instrument (STEBI) (Riggs & Enochs, 1990). The Science Methods and Materials Scale was adapted for this study from instruments used in two previous national studies (Weiss, 1978, 1987).

Science Teaching Efficacy Beliefs Instrument

Because Bandura indicates self-efficacy is a situation-specific construct, Iris Riggs revised the Teacher Efficacy Scale (Riggs & Enochs, 1990). One of her goals was to develop an instrument specific to the teaching of elementary science. Another goal was to produce items that discriminated more clearly between outcome expectancies and self-efficacy.

Riggs began development of her scale, the Science Teaching Efficacy Beliefs Instrument (STEBI), by modifying the items in Gibson's scale. The items were revised to measure only self-efficacy or outcome expectancy, and an elementary classroom setting was added to each item. Next, additional items were created. This enlarged item pool was edited, evaluated, and categorized by several experts to ensure content validity of the instrument.

The preliminary version of the STEBI consisted of 50 Likert-format items. After a field test involving 71 teachers, items with poor variability were eliminated and only the items that loaded clearly on one of the substantial factors were maintained (Riggs & Enochs, 1990). Twenty-nine items were retained for the revised version of the STEBI. This revised scale was then used in a construct validation study using a correlational design.

Riggs and Enochs (1990) reported that factor analysis of the STEBI yielded two substantial factors. Factor 1 was labeled the Personal Science Teaching Efficacy Belief Scale, while Factor 2 was labeled the Science Teaching Outcome Expectancy Scale. Twenty-five of the 29 original scale items yielded significant loadings on one of these two factors. Analysis of internal consistency reliability yielded an alpha of .92 for the Personal Science Teaching Efficacy Belief Scale and .77 for the Science Teaching Outcome Expectancy Scale.

The final version of the Personal Science Teaching Efficacy Belief Scale contained 13 items, while the Science Teaching Outcome Expectancy Scale had 12 items. All items were in Likert format, with the following possible responses: strongly agree, agree, uncertain, disagree, and strongly disagree. The 13 positively phrased items on the STEBI were scored by assigning a value of 5 to a "strongly agree" response, 4 to an "agree" response, and so on. Negatively phrased items were reverse-scored, that is "strongly disagree" responses received a score of 5, "disagree" responses received a score of 4, and so on.

Construct validity of the instrument was supported by the collection of data shown to be related to teaching efficacy. These validity variables included years of teaching experience, choice of teaching science, time teaching science, use of activity-based science instruction, science teaching self-rating, subject preference, and principal ratings. All of these variables were positively correlated with science teaching efficacy beliefs except for years of teaching experience. Enochs and Riggs have also developed STEBI (Form B), which assesses the efficacy beliefs of pre-service science teachers (Enochs & Riggs, 1990).

The Science Methods and Materials Scale

Original Development

The Science Methods and Materials Scale was adapted from instruments developed by the Research Triangle Institute (RTI) for the 1977 National Study of Mathematics, Science, and Social Studies Education (Weiss, 1978) and the 1985-86 National Study of Science and Mathematics Education. In the original development of the 1977 instrument, a review of the research literature identified important variables. A preliminary set of research questions was then submitted to the National Science Foundation (NSF), the underwriter of the study. Based on NSF feedback, the research questions were revised, and an item pool was developed to address this revised set of research questions. These items were then used to create preliminary drafts of the survey instrument.

The preliminary drafts of the instrument were reviewed by science, mathematics, and social studies consultants representing all levels of the public education system. These persons were asked to rate each item as to the importance of the information being collected, the adequacy of item format, and clarity of the structure. Representatives of the Educational Products Information Exchange Institute (EPIE), the American Association for the Advancement of Science (AAAS), the American Psychological Association (APA), and other professional organizations also reviewed the preliminary instruments.

These reviews, together with committee discussions and small pretests (N = 200), served as the basis for further revision of the instrument. After obtaining approval from the Committee on Evaluation and Information Systems of the Council of Chief State School Officers and the Office of Management and Budget, a field test was conducted using a small number of administrators and 200 teachers. This field test yielded important information needed for the final revision of the questionnaires.

An identical process was used in the development of the survey instrument used for the 1985-1986 National Survey of Science and Mathematics Education (Weiss, 1987).

Reliability

Reliability data for the 1977 National Survey instruments was collected through the use of a follow-up instrument to test stability of responses over time. Ten percent of the original sample was preselected for inclusion in the reliability study. Approximately 2 weeks after the original questionnaire was returned to Research Triangle Institute the reliability instrument was sent out. The response rate for the reliability instrument was 65%.

Reliability for some categorical data was expressed in terms of the percentage who responded exactly the same on both instruments. These rates varied from 56 to 70% on the items that assessed utility of sources of information. In responding to frequency of use of instructional techniques, four degrees of responses were possible. To calculate reliability for these items, the percentage of exact match was summed with the percentage of answers that were off by one category. These reliability rates ranged from 78 to 92%. Weiss (1978) reported that these reliability rates were "quite reasonable for categorical data" (p. 163).

Revision

My revision of the questionnaire followed the process outlined in Heller's (1984) Minnesota study which used a revised form of the 1977 instrument. This involved elimination of items requesting information irrelevant to the current study and the addition of items to aggregate needed information not collected by the original instrument. In order to maintain the validity of the instrument, additions to the instrument were approved by a panel of science educators and university professors.

The items used on my revised form of the instrument which gathered data related to use of textbooks and computers were adapted from the instrument used in the 1985-86 national study. The items concerned with use of specific teaching methods and specific teaching materials were adapted from the 1977 national study instrument.

Classification of Constructivist Practices

The preliminary draft of the survey instrument for this study was examined by three science educators, including the researcher. These educators were asked to classify each of the methods and materials listed in Part 2 of the survey instrument as either absorption or constructivist. Results were tabulated for each method or material (see Table 1).

These science educators agreed on all methods classifications. In the area of computer practices, the classifiers did not agree on 3 items. For those three, one educator said the items could be constructivist or absorption depending on how they were used. Only one educator, the researcher, classified materials as constructivist or absorption. However, given the high level of agreement in classification of methods and computer practices, this classification of materials was assumed to be satisfactory for data analysis. These science educators also provided feedback on the content of the instrument and suggestions for additions or deletions.

TABLE 1

CLASSIFICATION OF INSTRUCTIONAL PRACTICES

	Constructivist practices	
Methodologies	*Computer practices*	*Materials*
Discussion	Students writing programs	Camcorder
Student projects	As a lab tool	Living plants or animals
Hands-on or lab work	Simulations	Collections
Cooperative learning	Problem solving	Lab supplies
Inductive thinking	Interactive software	Telescopes, microscopes
Simulations	Databases	Models
Role play	Robotics	Cameras
Field trips	Networks	
Inquiry		
Discovery		
Problem solving		
Learning cycle		
Application to real life		
	Absorption practices	
Lecture	Demonstration	Videos, filmstrips, etc.
Student reports	Learning content	Records, compact discs
Textbook seat work	Drill and practice	Slides
Worksheets	Games	Overhead projectors
Tests/quizzes	Testing/Evaluation	Television or ITV
Demonstrations	Multi-media, CD-ROM	Games and puzzles
Programmed instruction		Guest speakers
		Student workbooks
		Activity cards
		Laser discs

Procedures

This study utilized standard mail survey techniques for data collection. The initial mailing included a cover letter, the survey instrument, and a postage-paid return envelope. Gay (1987, p. 201) suggests the use of creative follow-up ideas to build an acceptable percentage of returns. Instead of waiting for follow-up activities to use creative ideas, I included a gift in the initial mailing. This gift, an inductive science lesson taken from *Models of Teaching - Science* (Burton, 1994), was included in the initial mailing to express appreciation in advance for subject participation. Inclusion of this inductive lesson was meant to serve as an incentive for participant response, thus building the response rate.

The second mailing consisted of postcard reminders, which were mailed to nonrespondents 17 days after the initial instrument distribution. Participants who had not returned a completed instrument after 26 days received a second instrument accompanied by a new cover letter. A second mailing of postcard reminders completed the survey follow-up activities.

Rea and Parker (1992) indicate that the above procedure should result in a response rate of 50 to 60%. For specialized populations, the response rate is sometimes somewhat higher. The net response rate for this study was 52.5%. According to Rea and Parker, this response rate "can be considered satisfactory for purposes of analysis and reporting findings" (p. 85).

Null Hypotheses

The research questions guiding this study led to the following null hypotheses.

1. There is no relationship between the use of specific instructional practices and teacher efficacy.
2. There is no relationship between the use of specific instructional practices and the following context variables: years of teaching experience, qualification to teach specific science classes, and gender.

Data Analysis

Data entry and statistical analyses were completed using WordPerfect™ word-processing software and the Statistical Package for the Social Sciences (SPSS™) software package. Data entry began with the first returned questionnaire and continued throughout the data-collection process. (See Appendix F for the complete database, Appendix E for the respondent commentary, and Appendix D for nonparticipant comments.)

Descriptive statistics and diagrams were used in this report to present an overview of responses related to use of instructional materials and instructional methodologies. Data were reported as percentage of respondents choosing each alternative for each item. Statistical testing of the hypotheses involved the use of the Spearman rho correlation and chi-square. The alpha for testing the hypotheses was set at .05.

Treatment of the Data

In any statistical research study a process must be used to transform each subject's responses on the survey instrument to integers for computerized statistical analysis. Approximately one-third of these respondents included written comments of some type on the completed instrument or on an accompanying note. Three expressed appreciation for the free lesson included in the initial mailing. One teacher asked to receive a copy of the study results. Most comments were made in an attempt to clarify answers selected on the survey instrument.

Survey respondents were positive in tone. Many, at least 10%, included return addresses on the envelope or on the survey instrument itself. Two instruments were returned in official school letterhead envelopes.

Context Variables

The first section of the Science Methods and Materials Survey instrument collected data concerning the professional context of each subject's current teaching position. To prepare for statistical analysis, these data were entered into a numeric database. Some items, such as gender and classroom type, had to be converted from alphabetic characters to integers. (See Appendix F for the complete numeric database.)

During the data entry process, consistent procedures were followed in the interpretation of respondent information. Any written comments were noted and recorded. (See Appendix C for a complete copy of the instrument. See Appendices D and E for comments.)

The coding of years of teaching experience required no conversion. One respondent noted that she had a total of 25 years experience in education, 13 years as a classroom teacher and 12 years as an administrator. Since this study was concerned with teaching decisions, not administrative decisions, only the 13 years of teaching experience were entered into the database. Two participants responded to this item with mixed numbers. These were rounded to the nearest integer before coding.

For gender classification, responses were converted to a numeric representation. One respondent chose not to indicate gender. No written comments were noted for the gender item.

Teachers indicated the type of classroom in which they taught on item 3. These responses required numeric conversion and generated 13 comments. The majority of the comments explained the teacher's choice of response "a" or "b," often indicating which subjects or grades were taught. Teachers indicating response "c" included a teacher at a planetarium, a member of a teaching team, and one teacher in a classroom where students worked independently and received instruction only if they asked for help.

The fourth item on Part 1 of the survey instrument asked teachers to assess their personal qualifications for teaching specific curricular areas.

Responses for this item required no conversion. No comments were noted for this item.

Teachers also provided information about the organizational climate of their school. These responses required numeric conversion. This item also generated written comments. Most of the comments provided justification for a combination of the possible responses. One teacher selected "d" (other) and commented, "We are losing discipline."

Part 1 of the survey instrument appeared to be clearly understood by the study participants. Most responses were entered into the numeric database directly from the instrument. This section of the instrument required a minimal amount of interpretation.

Science Methods and Materials

The second part of the survey instrument contained five items. The first two of these items asked teachers to supply information on textbook usage. These items generated very few comments. These comments were explanatory in nature. For example, "They are issued but I seldom use the text." Another teacher indicated the use of 25-50% of the text in a "one semester course."

One respondent described the dilemma some teachers face: "There is so much information, if you want to do any activities at all you will run out of time for the whole book." Only one respondent indicated use of a textbook but not the percentage of textbook coverage.

Two respondents indicated that certain portions of specific textbooks were assigned to specific grade levels. For example, in one school, students study one semester of earth science and one semester of physical science in both eighth and ninth grades.

Items 3, 4, and 5 on the Science Methods and Materials section of the instrument were similar in structure, and therefore were similar in coding. The third item asked teachers to indicate how often they used 20 specific teaching methods. This section generated comments from nine respondents. One respondent indicated use of lecture "just about daily," but only for "very short periods of time." Another teacher said that the use of teacher demonstrations depended on the topic being studied. Two teachers commented on field trips. One teacher was allowed one trip per year. The other teacher was allowed no field trips or excursions.

Many respondents put question marks next to methodologies with which they were not familiar. These question marks were not coded as respondent comments. Methods that had question marks placed beside them included the learning cycle, programmed instruction, discovery, inductive thinking, and inquiry. One teacher commented that without knowing my definition of these methodology terms, she was unsure of how to respond. To her, inquiry and discovery were the same, as were inductive thinking, problem solving, and application to real-life situations.

Item 4, the subsection asking for information on classroom computer practices, generated comments from more participants than any other item on the instrument. Of teachers commenting on this item, 74% indicated they had no computer access or very limited computer access. Other comments indicated specific uses of computers or provided explanations about computer practices in the classroom.

One respondent, after circling "Never" for all categories of computer practices, wrote "You should ask why--I don't use computers because we have one lab which has classes scheduled in it all day. I'm well-trained in using technology in the classroom however and would if I had the equipment available."

Item 5 appeared to be clearly understood by all respondents. Only two comments were noted for this item. One teacher indicated that plants and animals were used every day when studying those units. The other teacher commented that the school was unable to afford some equipment and that was the reason it was never used.

Teachers responded to items 3, 4, and 5 by circling a number for each subitem. Therefore, no transformation of data was required. Non-responses were coded as "0." If a teacher marked two numbers on the same line, only the lower number was coded.

Science Teaching Efficacy Beliefs Instrument (STEBI)

The STEBI was the third section of the instrument used in this study. The STEBI consisted of 25 items that respondents answered by indicating their agreement or disagreement with each item. These items were in Likert format with five possible responses: strongly agree, agree, undecided, disagree, and strongly disagree.

Thirteen of the items were phrased in a positive manner and 12 were phrased negatively. Positively phrased items were coded as SA = 5, A = 4, UN = 3, D = 2, and SD = 1. Negatively phrased items were reverse scored. The STEBI yields two subscales: the Science Teacher Outcome Expectancy Scale (STOE) and the Personal Science Teaching Efficacy Beliefs Scale (PSTEB). The score for the STOE was calculated by summing responses to the 12 items on the STOE subscale. Similarly, the PSTEB score was computed by summing responses to the 13 PSTEB subscale items.

The STEBI generated comments from 22 respondents. These comments tended to be qualifying statements or statements explaining a teacher's response. One respondent expressed doubts about the validity of the STEBI due to the inclusion of the word "some" in so many items.

Human Subjects Review Board

All research projects involving human subjects conducted by students at Andrews University must be approved by the university-appointed Human

Subjects Review Board (HSRB). This board is commissioned to protect the rights and safety of all subjects involved in a study and to ensure that the confidentiality of data is maintained. For studies involving survey methodology, a copy of the survey instrument must be submitted to the board but a full proposal review is not required.

The survey instrument for this study was submitted to the HSRB. The HSRB approved this project as exempt from review, which indicated the study posed no threat to the physical or psychological safety of an individual, or to individual privacy rights. (See Appendix A.)

Summary

This descriptive study was based on a correlational design. Data was collected using standard, cross-sectional survey methods. The study correlated scores of teacher efficacy with self-reported use of instructional materials and methods. Participants consisted of a systematic, national sample of 543 seventh- and eighth-grade science teachers obtained from the Official U.S. Registry of Teachers maintained by the National Science Teachers Association.

The sample received the survey instrument compiled for this study. The instrument provided information in three areas: teaching context (demographics), teacher efficacy, and use of instructional practices. WordPerfect™ software was used for data entry. Descriptive statistics and tests of hypotheses were computed with the SPSS™ software package. The complete data base, respondent comments, and nonparticipant comments are included in Appendices D, E, and F.

CHAPTER 4

PRESENTATION OF FINDINGS

Introduction

This study investigated relationships between teachers' use of instructional practices, teacher efficacy, and selected context variables. Data for this study were collected via a mail-out survey instrument. This chapter presents the study response rate, a demographic description of the sample, teacher efficacy data, instructional practices in seventh- and eighth-grade science education, tests of the hypotheses, discussion of the findings, and a summary.

Response Rate

The prestudy goal of 300 returns was reached, as a total of 303 returns were received. This resulted in a gross return rate of 55.8% of the 543 teachers sampled. These returns were divided into two subgroups: those who did not qualify for inclusion in the study, and those who were included in the data analysis procedures.

Eighteen individuals responded to the survey but did not qualify for inclusion in the study. Fourteen of these individuals did not complete the instrument, but responded to explain why they were not participating. One teacher had retired. Four teachers did not teach science. One teacher responded to say he was not interested in the study and wanted to be removed from my mailing list. Another teacher's follow-up postcard was returned by the postal service as undeliverable. Others were high-school science teachers, so did not qualify as part of the study population.

Four teachers returned completed survey instruments, but were excluded from data analysis procedures. Three of these teachers were excluded because they indicated they taught high-school classes. One respondent was not included in data analysis procedures because Part 2 of the survey instrument was left blank.

Two hundred eighty-five teachers returned survey instruments which were included in data analysis. Two of these teachers indicated they taught ninth grade classes. These were included in data analysis since many junior high schools in the United States educate seventh-, eighth-, and ninth-grade students. I assumed that teaching practices for these three grades would not be significantly different from one another. Similarly, one instrument from a fifth-grade middle-school teacher was included in the analysis since many middle schools serve students from grades 5 through 8.

The net return rate, based on the 285 individuals used in the data analysis procedures, was 52.5%. Rea and Parker (1992) indicate that return rates between 50% and 60% can be considered adequate for data analysis and the reporting of results. Return rate was not the only factor to consider in judging the success of the sampling procedure. This sampling procedure achieved its goal of 300 returns.

The 285 returns used for data analysis represented 95.0% of the prestudy goal of 300 returns. Therefore the sampling procedure used in this study resulted in a much larger pool of respondents than could have been expected from a sample of 300 teachers and an 80% return rate. Table 2 shows the return rate for each of the 10 U.S. postal zip code areas. Figure 5 illustrates the location of each of the U.S. postal zip code areas.

Description of the Sample

Simple descriptive analyses of the data provided an overview of the sample. By looking at these results, it is possible to compare this sample with samples from previous national surveys of science education in the United States (Weiss, 1978, 1987; Matti, Soar, Hudson, Weiss, 1995).

Years of Teaching

Responses for years of teaching experience ranged from 1 year of experience to 40 years of experience. The mean length of teaching experience for this sample was 15.95 years, with a standard deviation of 9.0. The mode was 18 years of teaching experience, and the median was 15 years. As shown in Table 3, approximately one third of the sample had from

TABLE 2

RETURNS BY U.S. ZIP CODE REGIONS

US Zip Code Region	n sampled	% of total sample[a]	n returned	Regional return rate	% of total return[a]
0	55	10.1	25	45.5	8.8
1	74	13.6	39	52.7	13.7
2	41	7.6	21	51.2	7.4
3	49	9.0	22	44.9	7.7
4	73	13.4	37	50.2	13.0
5	55	10.1	38	69.1	13.3
6	58	10.7	37	63.8	13.0
7	50	9.2	22	44.0	7.7
8	28	5.2	17	60.1	6.0
9	60	11.0	27	45.0	9.5
Total	543	100.0	285		100.0

[a]Due to rounding, column may not total 100%.

TABLE 3

YEARS OF TEACHING EXPERIENCE IN TWO RECENT STUDIES OF SCIENCE EDUCATION

Years[a]	1993[b]	Years[a]	1995[b]
0-5	32	1-10	33.7
6-10	25	11-20	33.7
11-20	25	21-30	28.8
21+	19	31-40	3.9

[a]Previous years of experience was reported in 1993, while years of experience including current year reported in 1995.
[b]Due to rounding column may not total 100.

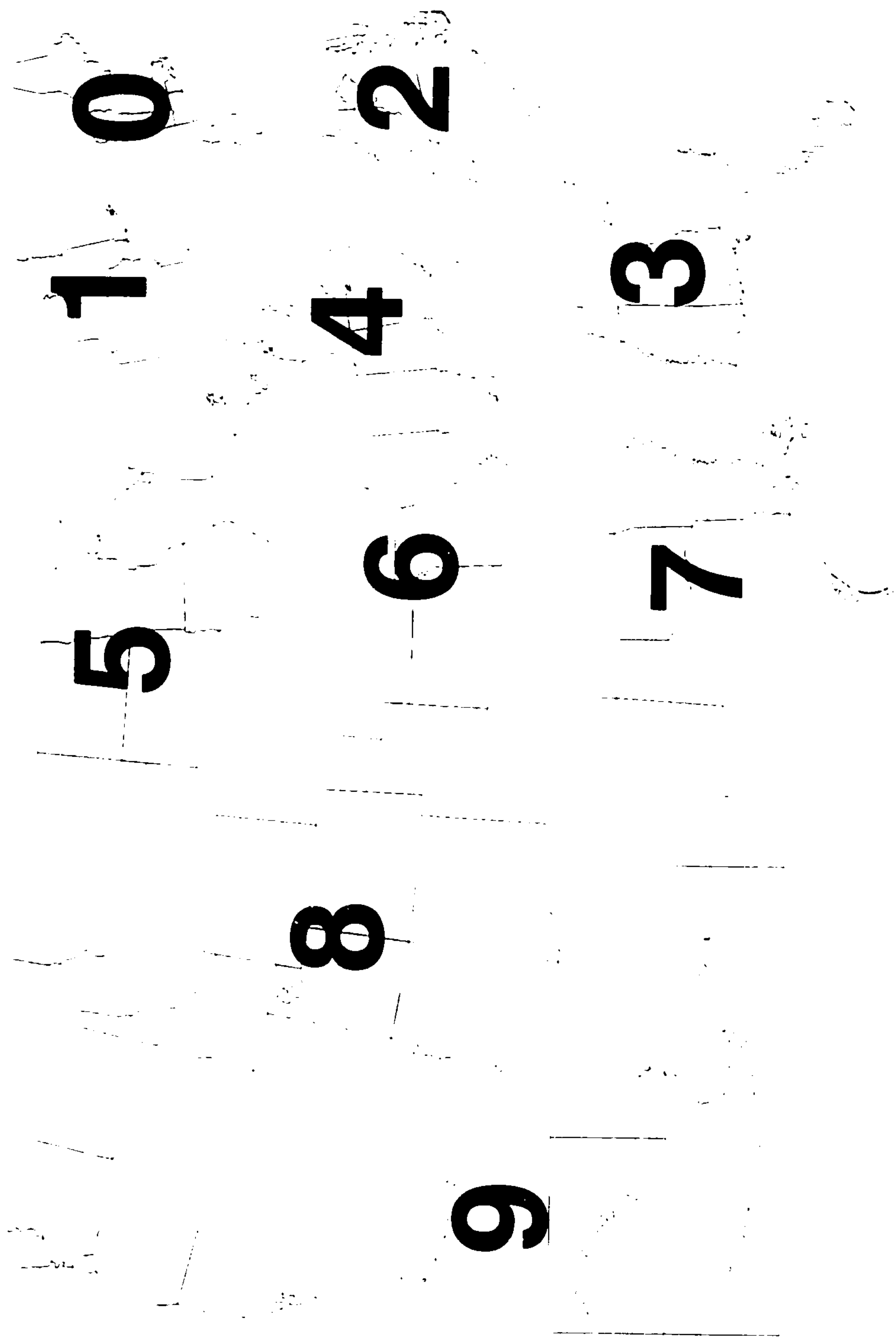


Figure 5. US zip code regions.

1 to 10 years of experience, and another third had from 11 to 20 years of teaching experience. The final third had from 21 to 40 years of experience. This sample represents a more experienced group of teachers than the 1993 National Survey. Table 4 shows the years of experience data comparison between this study and the first two national surveys of science education.

Gender

Response to the gender item was divided almost evenly among respondents. Only one respondent (0.4%) refused to indicate gender. Of respondents, 137 (48.1%) were female and 147 (51.6%) were male. The data from this study appears to continue the trend of increasing gender equalization in junior-high science education shown in the 1977 and the 1985-86 national surveys of science education. The male share of junior-high science teaching positions has decreased by 10% during the last 18 years, bringing the ratio of male to female science teachers in the current study to 24:26, which approximates a 1:1 ratio (see Table 5).

Classroom Type

Of the 283 respondents indicating the type of classroom in which they taught, 234 or 82.1% described themselves as subject-area specialists. Twenty-seven (9.5%) teachers served in self-contained classrooms. Twenty-two (7.7%) teachers selected "other" as their response to this item (see Table 6). These teachers wrote in a description of their teaching assignment.

TABLE 4

YEARS OF TEACHING EXPERIENCE IN THREE NATIONAL STUDIES OF SCIENCE EDUCATION

Study	Average number of years of teaching
1977	11.50
1985-86	13.10
1995	15.95

TABLE 5

TEACHER GENDER IN FOUR NATIONAL STUDIES OF SCIENCE EDUCATION

Study	Percentage of teachers			
	Female	Male	Missing	Sample _N_
1977	38	62	0	535
1985-86	41	56	3	658
1993[a]	69	31	0	na
1995	48	52	0	285

[a]Data from the 1993 study include data from teachers of grades 5 and 6.

TABLE 6

TYPE OF CLASSROOM IN WHICH THE TEACHER WORKS

Type of classroom	Frequency	%	Cumulative %[a]
No response	2	0.7	0.7
Self-contained	27	9.5	10.2
Subject-area specialist	234	82.1	92.3
Other	22	7.7	100.0

[a]Due to rounding column may not total 100%.

Preparation for Teaching

Teachers provided a self-evaluation of their qualifications to teach six specific subject areas. Table 7 provides a synopsis of the responses to these items. The largest group of teachers (94%) felt at least adequately prepared to teach life sciences. Ninety-three percent felt at least adequately prepared to teach earth or space sciences. In considering physical sciences, 90.2% felt at least adequately prepared for their teaching assignment.

When looking at the academic subjects teachers felt very well qualified to teach, 70.2% of all teachers included in this study indicated they felt very well qualified to teach life science. Over 50% of the sample indicated they felt very well prepared to teach physical sciences and earth/space sciences.

Over 75% of the sample felt adequately prepared to teach mathematics, while only half of the sample felt adequately qualified to teach

TABLE 7

TEACHERS' PERCEPTIONS OF THEIR QUALIFICATIONS TO TEACH SPECIFIC SUBJECTS

Subject	No response	Not well qualified	Adequately qualified	Very well qualified
Mathematics	1.8	22.5	55.4	20.4
Life sciences	0.0	6.0	23.9	70.2
Physical sciences	1.4	9.8	37.2	51.6
Earth/space sciences	2.8	7.0	39.3	50.9
Social studies, history	2.1	47.7	33.3	16.8
Reading, language arts, English	2.5	49.5	34.7	13.3

Note. All values are percentages. Due to rounding, rows may not total 100%.

social studies or language arts classes. In general, these teachers felt adequately qualified to teach science content and mathematics courses, but not well qualified to teach social studies or language arts classes.

Given the large number of subject-area specialists included in the sample, it would be expected that a majority of respondents would feel "adequately qualified" or "very well qualified" to teach science.

Identical data was not available for this study and the two previous national studies of science education. However, a limited comparison can be made. As shown in Table 8, in 1977 13% of teachers reported that they felt inadequately prepared to teach at least one subject. In the 1985-86 study,

TABLE 8

PERCENTAGE OF TEACHERS WHO FELT INADEQUATELY PREPARED TO TEACH IN FOUR NATIONAL SURVEYS OF SCIENCE EDUCATION

Subject Area	1977	1985-86	1993	1995
Not specified	13.0	11.0		
Life science			7.0	6.0
Physical science			47-52[a]	9.8
Earth/space science			9.0	7.0
Sample N	535	658	na	285

[a]Chemistry 47%, physics 52%.

this had dropped to 11%. In this study, 50 (17.5%) teachers indicated they were inadequately prepared to teach one of the sciences. However, it is not known if these teachers actually teach one of these areas. Of the three science subject areas investigated in this study, 9.8% of the teachers sampled indicated they felt inadequately prepared to teach physical science. Life science was indicated as a weak instructional area by 6% of teachers, and earth/space science by 7% of teachers. The data for life science and earth/space science are almost identical for the 1993 and 1995 studies.

School Climate

In responding to the item asking for an appraisal of the overall organizational climate of the school in which the respondent taught, teachers were given four options. Table 9 presents responses to this item. An

TABLE 9

TEACHERS' PERCEPTIONS OF SCHOOL CLIMATE

School climate	Frequency	%	Cumulative %[a]
No response	5	1.8	1.8
Cooperative	219	76.8	78.6
Competitive	8	2.8	81.4
Isolated	40	14.0	95.4
Other	13	4.6	100.0

[a]Due to rounding, column may not total 100%.

overwhelming majority, 76.8%, indicated that the teachers in their school were cooperative. Only 3% described the climate in their school as competitive. Forty teachers, or 14.0%, said that teachers in their school were isolated from one another. Write-in comments were noted by 4.6% of the respondents who indicated a combination of the other three choices. Five teachers failed to respond to this item. Similar data were not available from the previous national surveys of science education.

Teacher Efficacy Data

The third section of the survey instrument contained the Science Teaching Efficacy Beliefs Instrument (STEBI) and was completed by the seventh- and eighth-grade science teachers who participated in the study.

The two subscales on the STEBI are named Science Teaching Outcome Expectancy and Personal Science Teaching Efficacy Beliefs.

In this discussion, the Science Teaching Outcome Expectancy subscale is referred to as "outcome expectancies" and the Personal Science Teaching Efficacy Beliefs subscale is referred to as "efficacy beliefs." Subscale scores for outcome expectancies and efficacy beliefs were computed by summing the responses to the items included on each subscale. Descriptive statistics were calculated for each subscale and its items.

In responding to items on the STEBI, subjects indicated agreement or disagreement with each item. The possible responses varied from "Strongly Disagree" to "Strongly Agree." The numeric range for these responses was 1 through 5, with 5 being the indicator of strongest efficacy beliefs. Items with negative phrasing were scored highest for disagreement.

Outcome Expectancies Subscale

Descriptive analysis of the outcome expectancies subscale yielded a mean of 39.2 and a standard deviation of 5.7. Minimum and maximum values for outcome expectancies were 18 and 56. As shown in Figure 6, the distribution for the outcome expectancies variable approximates the normal curve. Means and standard deviations were computed for each item on the outcome expectancy subscale. These values are displayed in Table 10. While the STEBI was divided almost evenly between positive and negative

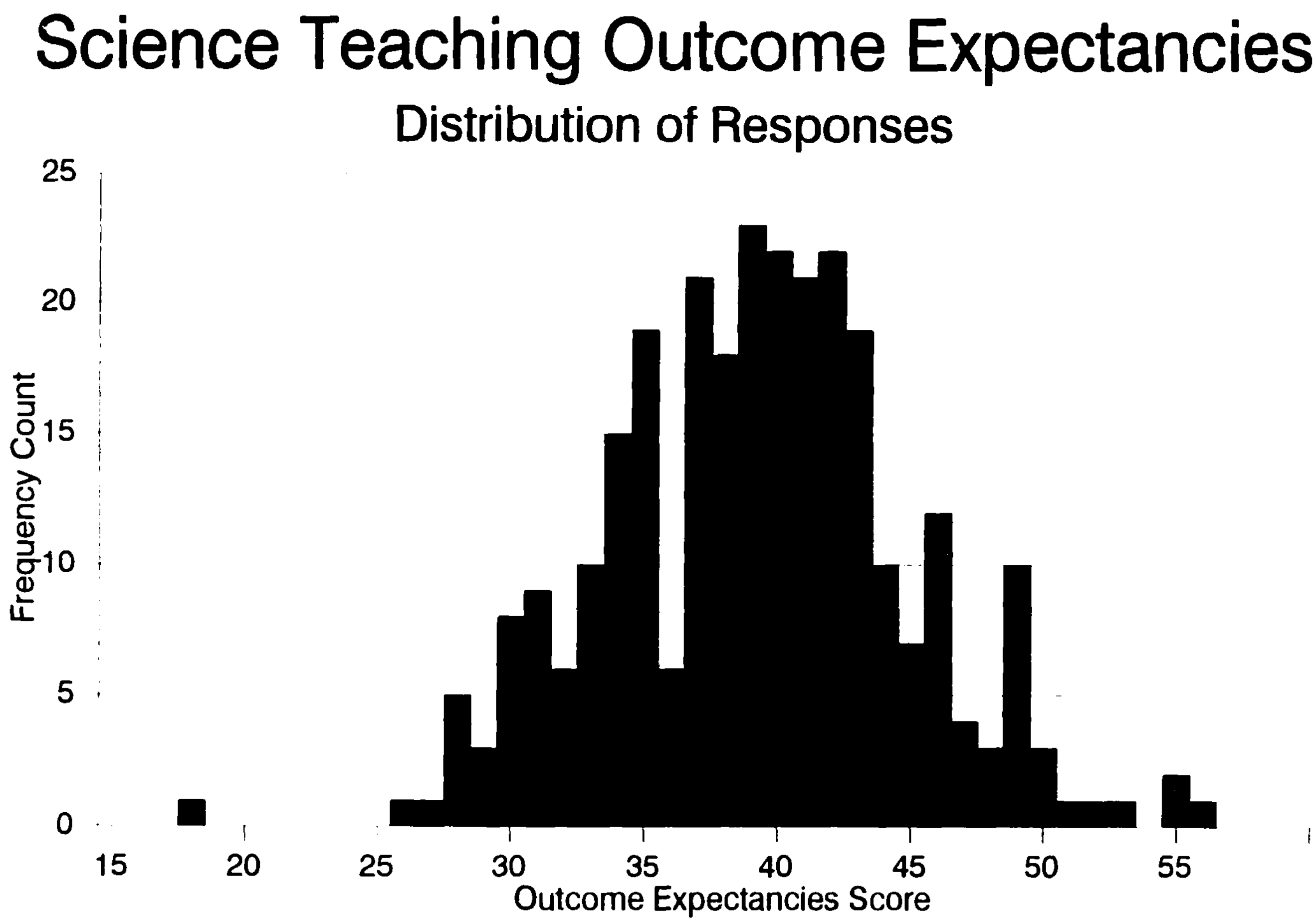


Figure 6. Science teaching outcome expectancies: Distribution of responses.

TABLE 10

MEANS AND STANDARD DEVIATIONS FOR OUTCOME EXPECTANCIES

Item	Phrasing	N	Mean	SD
1	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	285	3.59	.87
4	When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	285	3.59	.82
7	If students are underachieving in science, it is most likely due to ineffective science teaching.	284	2.61	.98
9	The inadequacy of a student's science background can be overcome by good teaching.	284	3.63	.79
10	The low science achievement of some students cannot generally be blamed on their teachers.[a]	285	2.45	.92
11	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	283	3.62	.77
13	Increased effort in science teaching produces little change in some student's science achievement.[a]	285	3.06	1.11
14	The teacher is generally responsible for the achievement of students in science.	285	3.38	.91
15	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	285	3.42	.89
16	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	283	3.68	.74
20	Effectiveness in science teaching has little influence on the achievement of students with low motivation.[a]	282	3.59	.99
25	Even teachers with good science teaching abilities cannot help some kids learn science.[a]	285	2.71	1.13

[a]These negatively phrased items were scored in reverse. A high score resulted from disagreement with the item.

items, with 12 negative items and 13 positive items, the outcome expectancies subscale had only 4 of 12 items phrased negatively.

No items on the outcome expectancies subscale had means greater than 3.75. This sample of teachers had lower levels of belief about the efficacy of science teaching in general than they did about their personal efficacy expectations.

All items on the outcome expectancies subscale had lower means than those on the efficacy beliefs subscale. The items with the lowest means were numbers 7, 10, and 25. Item 7 read "If students are underachieving in science, it is most likely due to ineffective science teaching." Item 10 was similar: "The low science achievement of some students cannot generally be blamed on their teachers." In addition to having a low mean, item 25, "Even teachers with good science teaching abilities cannot help some kids learn science," had the largest standard deviation of any item.

All items on the outcome expectancies subscale with relatively large standard deviations (items 7, 13, 20, & 25) dealt with responsibility for student failure or underachievement. The items on this subscale with the lower standard deviations (items 9, 11, & 16) dealt with responsibility for student success.

Efficacy Beliefs Subscale

Descriptive analysis of the efficacy beliefs subscale resulted in a mean of 55.1 and a standard deviation of 6.3. Minimum and maximum values for efficacy beliefs subscale scores were 27 and 65 respectively. As shown in Figure 7, the distribution for the efficacy beliefs subscale scores is negatively skewed.

All items on the efficacy beliefs subscale had greater means than those on the outcome expectancies subscale. Item 23, "When teaching science, I usually welcome student questions" had the highest mean score (4.54) and the lowest standard deviation (0.53) of any item. Item 12, "I understand science concepts well enough to be effective in teaching seventh- and eighth-grade science" had the second highest mean, 4.49 (SD = .71).

Six additional items on the efficacy beliefs subscale had means of 4.25 or greater. In all, 11 of the efficacy beliefs items had item means of 4.00 or larger (see Table 11). The other two items on this subscale had means approaching 4.00 -- 3.95 and 3.99 respectively. Two items on the efficacy beliefs subscale had standard deviations greater than .90. These items solicited a greater range of responses than other items on this subscale. One item concerned monitoring science experiments, and the other was about the principal evaluating the teacher.

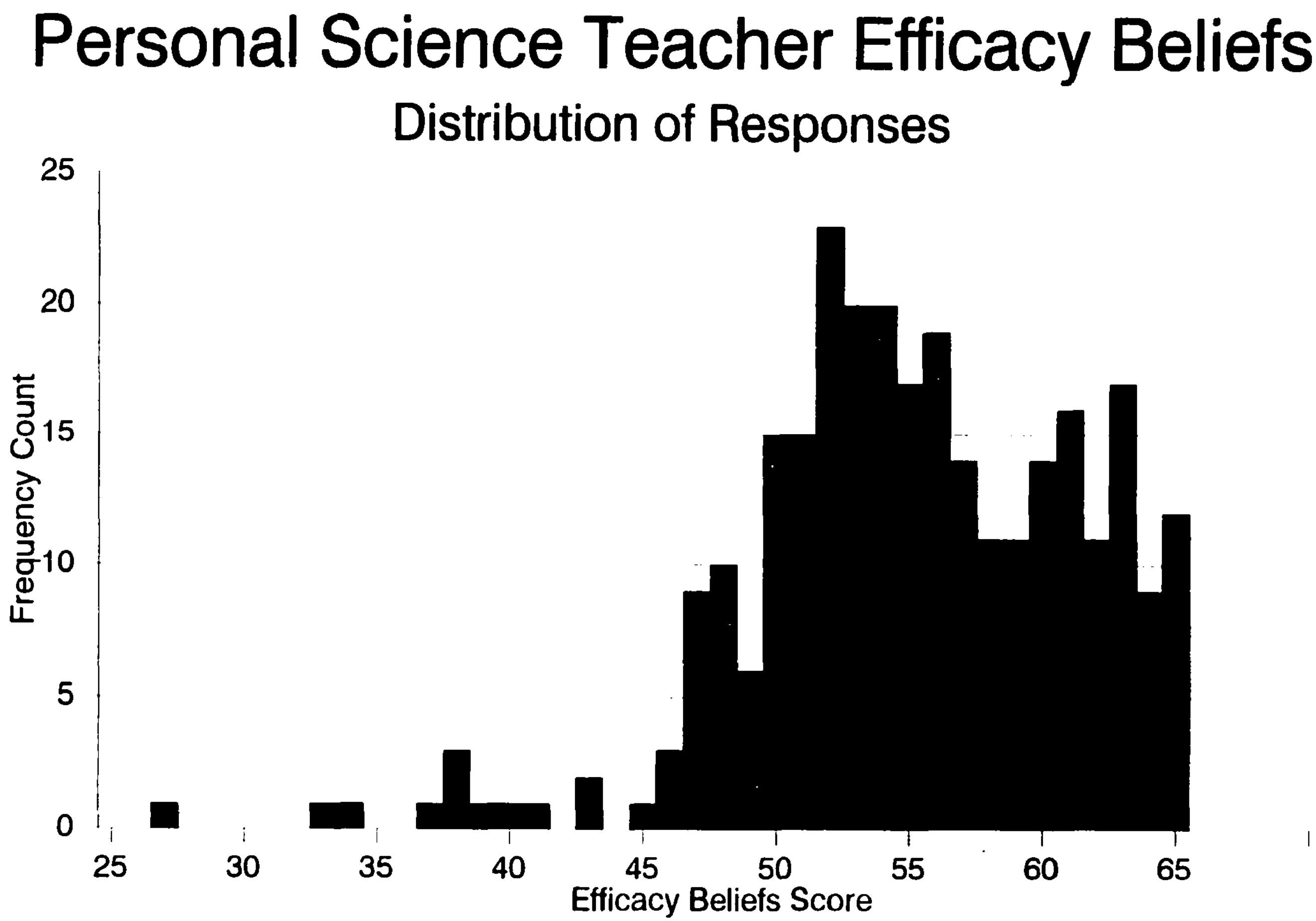


Figure 7. Personal science teaching efficacy beliefs: Distribution of responses.

TABLE 11

MEANS AND STANDARD DEVIATIONS FOR EFFICACY BELIEFS

Item	Phrasing	N	Mean	SD
2	I am continually finding better ways to teach science.	285	4.34	.68
3	Even when I try very hard, I don't teach science as well as I do most subjects.[a]	276	4.35	.89
5	I know the steps necessary to teach science concepts effectively.	285	4.09	.69
6	I am not very effective in monitoring science experiments.[a]	285	3.95	.99
8	I generally teach science ineffectively.[a]	285	4.35	.79
12	I understand science concepts well enough to be effective in teaching seventh- and eighth-grade science.	285	4.49	.71
17	I find it difficult to explain to students why science experiments work.[a]	285	4.25	.62
18	I am typically able to answer students' science questions.	285	4.11	.80
19	I wonder if I have the necessary skill to teach science.[a]	285	4.29	.78
21	Given a choice, I would not invite the principal to evaluate my science teaching.[a]	284	4.17	.95
22	When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.[a]	285	4.28	.54
23	When teaching science, I usually welcome student questions.	285	4.54	.53
24	I don't know what to do to turn students on to science.[a]	285	3.99	.82

[a]These negatively phrased items were scored in reverse. A high score resulted from disagreement with the item.

Instructional Practices in Seventh- and Eighth-grade Science Education

The primary research question guiding this study asked: What instructional practices are used by seventh- and eighth-grade science teachers? The second research question extended the inquiry by asking to what extent the practices were used. The answers to these questions were found in the data collected in the second section of the survey instrument.

The five items on the Methods and Materials Scale collected data on teachers' science instructional decisions. The first two of these items gathered data related to the teacher's use of textbooks. The vast majority (88.8%) of science teachers in grades 7 and 8 use textbooks. These teachers vary in degree of textbook use, with the largest proportion, 32.3%, using approximately 50 to 74% of the selected textbook. Approximately one-fifth of the sample reported using 25 to 49% of the text, while almost one-fourth reported using between 75 and 90% of the textbook. The smallest percentages of teachers reported using less than 25% of the textbook or more than 90% of the text. Almost 11% of the respondents, however, do not use any textbook.

Table 12 presents responses to the items on textbook usage, including teachers' responses as to the percentage of the textbook covered in their class during the school year. Table 13 presents a comparison between

TABLE 12

USE OF TEXTBOOKS BY SEVENTH- AND EIGHTH-GRADE SCIENCE TEACHERS

Degree of textbook use	*f*	%[a]
Do not use a textbook	31	10.9
No response	1	0.4
Use less than 25%	17	6.0
Use 25-49%	61	21.4
Use 50-74%	92	32.3
Use 75-90%	69	24.2
Use more than 90%	14	4.9
Totals	285	100.0

[a]Column may not sum to 100 due to rounding.

TABLE 13

PERCENTAGE OF TEXTBOOKS COVERED FROM THREE NATIONAL SURVEYS OF SCIENCE EDUCATION

	Percentage of Teachers		
Percentage of textbook "covered"	1985-86	1993	1995
Less than 25%	1	9	7
25 - 49%	9	19	24
50 - 74%	27	30	36
75 - 90%	42	33	27
More than 90%	20	10	6
Missing	1	0	0
Sample N	615	na	254

Note. Similar data was not available from the 1977 national study.

the data from this study and those of the 1985-86 national study of science education.

The third item in the Science Methods and Materials section of the survey instrument collected data on the frequency of teacher use of specific science teaching methods. These teaching methods were divided into two broad categories as explained in chapter 3: constructivist methods and absorption methods.

In analyzing these data for descriptive presentation, response categories were collapsed in an effort to make the data and its interrelationships more meaningful. Responses of "less than once a month," "never," and no response were collapsed into a category labeled "rarely or never." Responses of "at least once a month" were kept as a separate category and labeled "monthly." Responses of "at least once a week" and "just about daily" were collapsed into a category labeled "weekly." Table 14 summarizes the process used to collapse the data categories.

Discussion, classified as constructivist in this study, was reported as the most used methodology by these seventh- and eighth-grade science teachers (see Tables 15 and 16). Over 94% of teachers in this study reported weekly use of discussion. Lecture, an absorption method, was ranked second of the methods used at least weekly. Almost three-fourths (72.3%) of the teachers reported using lecture on at least a weekly basis.

TABLE 14

STRATEGY FOR COMBINING ANSWER CLASSIFICATIONS FOR INSTRUCTIONAL PRACTICES

Original classification	New classification
No response Never Less than once a month	Rarely or never
At least once a month	Monthly
At least once a week Just about daily	Weekly

TABLE 15

TEACHERS' USE OF SPECIFIC CONSTRUCTIVIST SCIENCE TEACHING METHODS

Teaching Methodology	Rarely or never	Monthly	Weekly
Discussion	1.4	4.2	94.4
Student projects	50.5	36.1	13.4
Hands-on or lab work	6.0	25.3	68.7
Cooperative learning	14.7	23.5	61.7
Inductive thinking	13.0	23.2	63.8
Simulations	51.9	31.6	16.5
Role play	75.1	21.1	3.9
Field trips	91.2	8.1	.7
Inquiry	27.7	33.3	39.0
Discovery	27.0	29.5	43.5
Problem solving	11.6	25.6	62.8
Learning cycle	63.2	18.2	18.6
Application to real life	8.1	23.9	68.1

Note. All values are percentages. Rows may not total 100 due to rounding.

TABLE 16

TEACHERS' USE OF SPECIFIC ABSORPTION
SCIENCE TEACHING METHODS

Teaching Methodology	Rarely or never	Monthly	Weekly
Lecture	13.3	14.4	72.3
Reports	56.5	32.3	11.3
Seat work	25.6	17.9	56.5
Worksheets	10.9	23.5	65.6
Tests and quizzes	6.7	44.6	48.8
Teacher demonstrations	11.9	41.1	47.1
Programmed learning	61.1	21.8	17.2

Note. *All values are percentages. Due to rounding, rows may not sum to 100.

More than 60% of the teachers reported using five other constructivist methods at least weekly. These were hands-on or lab work (68.7%), application to real life (68.1%), inductive thinking activities (63.8%), problem solving (62.8%), and cooperative learning (61.7%).

More than half of the teachers reported using worksheets (65.6%) and seat work from the textbook (56.5%) on a weekly basis. Both of these methods were classified as absorption in this study. Two other absorption methods were used on a weekly basis by almost half of the study respondents: tests and quizzes (48.8%) and teacher demonstrations (47.1%).

Valuable information was also obtained concerning what methods are not used by most teachers in seventh- and eighth-grade science. Five constructivist methods were rarely or never used by at least half of the respondents. These included field trips (91.2%), role play (75.1%), the learning cycle (63.2%), simulations (51.9%), and student projects (50.5%). Of the absorption methods, two were rarely or never used by more than half of the sample: programmed instruction (61.1%) and student reports (56.5%).

At least 25% of the teachers in the sample reported rarely or never using three additional methods. These included two constructivist methods, inquiry (27.7%) and discovery (27.0%), and one absorption method, seat work assigned from the textbook (25.6%).

The fourth item in the Science Methods and Materials section of the survey instrument collected data on the frequency of teacher use of specific computer techniques. Before administration of the instrument, these computer techniques were divided into two categories: constructivist techniques and absorption techniques. Table 17 presents a summary of teachers' responses to the constructivist computer sub-items, and Table 18 presents teachers' responses to the absorption computer sub-items.

The most noticeable finding for teacher use of computer techniques is the lack of use of computers in seventh- and eighth-grade science education. More than 79% of the teachers in this sample rarely or never use computers

TABLE 17

TEACHERS' USE OF CONSTRUCTIVIST COMPUTER PRACTICES

Practice	Rarely or never	Monthly	Weekly
Students writing programs	84.1	10.2	5.7
As a lab tool	83.7	12.7	3.5
Simulations	85.2	11.7	3.2
Problem solving	84.1	9.2	6.8
Interactive software	85.9	11.3	2.9
Databases	93.3	4.6	2.1
Robotics	97.5	1.8	.8
Networks	94.3	3.9	1.8

Note. All values are percents. Rows may not total 100 due to rounding.

TABLE 18

TEACHERS' USE OF ABSORPTION COMPUTER PRACTICES

Practice	Rarely or never	Monthly	Weekly
Teacher demonstration	85.5	8.8	5.7
Learning content	79.2	15.9	5.0
Drill and practice	90.5	6.7	2.9
Games	89.0	5.7	5.3
Testing/ evaluation	88.3	7.1	4.6
Multi-media, CD-ROM	85.5	8.5	6.0

Note. All values are percentages. Rows may not total 100 due to rounding.

in their science teaching. The least-used computer technique is robotics. In this study, 97.5% of teachers reported they rarely or never use robotics. More than 90% of teachers also reported rarely or never using three other computer practices: computer networks (94.3%), databases (93.3%), and drill and practice (90.5%). Use of robotics, use of computer networks, and use of databases are constructivist techniques, while use of the computer for drill and practice is absorption.

The computer practices most likely to be used on a weekly basis were problem solving (6.8%), use of multi-media or CD-ROM (6.0%), students writing programs (5.7%), teacher demonstrations (5.7%), and computer games (5.0%). Students' solving problems and writing programs on the computer are constructivist practices. Multi-media presentations, teacher computer demonstrations, and computer games are absorption techniques.

The final item in the Science Methods and Materials section of the survey instrument collected data on the frequency of teacher use of specific science teaching materials. Before administration of the instrument, these teaching materials were divided into two categories: constructivist materials and absorption materials. Table 19 presents a summary of teachers' responses to the constructivist materials sub-items. Table 20 presents a summary of teachers' responses to the absorption materials sub-items.

Two materials are used more regularly than the others on the instrument, lab supplies, and overhead projectors. Lab supplies, which are

TABLE 19

TEACHERS' USE OF CONSTRUCTIVIST INSTRUCTIONAL MATERIALS

Material	Rarely or never	Monthly	Weekly
Camcorder	94.0	6.0	0.0
Living plants or animals	59.3	24.2	16.5
Collections	48.8	33.3	17.9
Lab supplies	14.4	25.6	60.0
Telescopes, microscopes, or magnifying glasses	34.4	42.1	23.6
Models	34.0	40.7	25.3
Cameras	90.5	7.4	2.2

Note. All values are percentages. Rows may not total 100 due to rounding.

TABLE 20

TEACHERS' USE OF ABSORPTION INSTRUCTIONAL MATERIALS

Material	Rarely or never	Monthly	Weekly
Videos, filmstrips, etc.	30.9	50.2	19.0
Records, compact discs, tapes	79.6	13.3	7.1
Slides	90.5	7.7	1.8
Overhead projectors	30.9	20.7	48.5
Television or ITV	60.7	27.0	12.3
Games and puzzles	50.9	40.4	8.8
Guest speakers	91.9	7.0	1.1
Student workbooks	68.1	13.3	18.6
Activity cards	86.3	10.2	3.6
Laser discs	79.3	11.2	9.5

Note. All values are percentages. Rows may not total 100 due to rounding.

constructivist materials, were used weekly by 60.0% of the sample. Overhead projectors, from the absorption classification, were used weekly by 48.5% of respondents.

Teachers reported they were more likely to use the following items at least once a month: microscopes, telescopes, lenses (42.1%), models (40.7%), videos and films (50.2%), and games or puzzles (40.4%). Scopes and models were from the constructivist materials classification, while videos and games were from the absorption materials classification.

Materials indicated most often as rarely or never used included the camcorder (94.0%), guest speakers (91.9%), cameras (90.5%), and slides (90.5%). Between 50% and 90% of the respondents reported seven other items as rarely or never used. These included living plants or animals (59.3), recordings (79.6%), television (60.7%), games and puzzles (50.9%), workbooks (68.1%), activity cards (86.3%), and laser discs (79.3%). Almost half (48.8%) of the respondents reported they rarely or never used collections of objects in their teaching.

Hypothesis Testing

Both research hypotheses investigated in this study dealt with relationships between variables. Since most variables were ordinal, Spearman correlation procedures were used to test the significance of relationships. In tests involving nominal variables, chi-square tests were calculated.

Teacher Efficacy and Specific Instructional Practices

The first null hypothesis stated: There is no relationship between the use of specific instructional practices and teacher efficacy. This hypothesis was tested through Spearman's correlation.

Constructivist Practices

Table 21 presents a summary of the results of this statistical procedure for constructivist items. Calculation of correlation coefficients for constructivist teaching practices yielded 25 statistically significant relationships. All of these correlations were weak, but still significant. The greatest number of significant correlations were found for constructivist methods use.

The strongest of these weak relationships indicated for the efficacy beliefs subscale were between efficacy beliefs and lab work, $r(284) = .31$, $p < .00001$; efficacy beliefs and inquiry, $r(284) = .29$, $p < .00001$; and efficacy beliefs and problem solving, $r(284) = .27$, $p < .00001$.

Three additional significant relationships were indicated for efficacy beliefs and constructivist methods at $p < .0001$. The relationship between efficacy beliefs and inductive thinking was positive and significant, $r(284) = .25$, $p < .0001$. The relationship between efficacy beliefs and real-life applications was positive and significant, $r(284) = .23$, $p < .0001$. The

TABLE 21

CORRELATIONS FOR TEACHER EFFICACY
AND CONSTRUCTIVIST PRACTICES

Practice	Efficacy beliefs	Outcome expectancies
	Constructivist Methods	
Discussion	.01	.08
Projects	.16**	.18**
Lab work	.31*****	.18**
Cooperative learning	.11	.17**
Inductive thinking	.25****	.12*
Simulations	.08	.22***
Role play	.11	.12*
Field trips	.03	.11
Inquiry	.29*****	.08
Discovery	.23****	.16**
Problem solving	.27*****	.14*
Learning cycle	.03	.15*
Real life application	.23****	.15*
	Constructivist Computer Practices	
Computer programming	.04	.07
Computer as lab tool	.12*	.08
Computer simulations	.09	.06
Problem solving on computer	.12	.09
Interactive software	.07	.04
Computer databases	.04	.09
Robotics	.03	-.02
Computer networks	.01	.15*

Table 22--Continued.

Practice	Efficacy beliefs	Outcome expectancies
	Constructivist Materials	
Camcorder	-.01	.09
Plants and animals	.00	-.02
Collections	.11	.12*
Lab supplies	.38*****	.15*
Scopes	.21***	.08
Models	.22***	.11
Cameras	.08	.14*

*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$. *****$p < .00001$.

relationship between efficacy beliefs and discovery was also positive and significant, $r(284) = .23$, $p < .0001$.

The smallest significant correlation between efficacy beliefs and constructivist methods was for efficacy beliefs and student projects, $r(284) = .16$, $p < .01$.

On the outcome expectancies subscale, several weak relationships were indicated between outcome expectancies and specific constructivist methods. The strongest of these weak relationships for outcome expectancies and constructivist methods was between outcome expectancies and simulations. The correlation was positive and significant, $r(284) = .22$, $p < .001$. Other significant correlations were found for outcome expectancies and constructivist methods. These included projects, $r(284) = .18$, $p < .01$, lab work, $r(284) = .18$, $p < .01$, cooperative learning, $r(284) = .17$, $p < .01$, inductive thinking, $r(284) = .12$, $p < .05$, role play, $r(284) = .12$, $p < .05$, discovery, $r(284) = .16$, $p < .01$, problem solving, $r(284) = .14$, $p < .05$, use of the learning cycle, $r(284) = .15$, $p < .05$, and application to real life, $r(284) = .15$, $p < .05$.

Two weak relationships were indicated between teacher efficacy and constructivist computer practices. The relationship between efficacy beliefs and use of computer as a lab tool was positive and significant, $r(282) = .12$, $p < .05$. The relationship between outcome expectancies and the use of computer networks was positive and significant, $r(282) = .15$, $p < .05$.

The strongest of these weak relationships for constructivist materials and teacher efficacy was between efficacy beliefs and use of lab supplies. It was both positive and significant, $r(284) = .38$, $p < .00001$. Another weak relationship between efficacy beliefs and the use of scopes was indicated as positive and significant, $r(284) = .21$, $p < .001$. The relationship between efficacy beliefs and the use of models was also positive and significant, $r(284) = .22$, $p < .001$. Weak relationships were also supported between outcome expectancies and the use of lab supplies, $r(284) = .15$, $p < .05$, cameras $r(284) = .14$, $p < .05$, and collections, $r(284) = .12$, $p < .05$.

Calculation of correlation coefficients for constructivist teaching practices yielded several statistically significant correlations. In looking at efficacy beliefs and constructivist practices, the null hypotheses with respect to projects, lab work, inductive thinking, inquiry, discovery, problem solving, real-life application, use of computer as a lab tool, use of lab supplies, and use of scopes were rejected and the research hypotheses were supported.

In looking at outcome expectancies and constructivist teaching practices, the null hypotheses with respect to projects, lab work, cooperative learning, inductive thinking, simulations, role play, discovery, problem solving, learning cycle, real-life application, use of computer networks, use of collections, use of lab supplies, and use of cameras were rejected and the research hypotheses were supported.

Absorption Practices

To complete testing of the first hypothesis, an identical correlation analysis was run for absorption teaching practices and teacher efficacy. The results are presented in Table 22. Unlike the correlations for constructivist practices and efficacy beliefs, there were relatively few significant correlations, and they were typically smaller.

In looking at the correlations for absorption methods and efficacy beliefs, weak negative relationships exist for efficacy beliefs and seat work, $r(284) = -.19$, $p < .01$; and efficacy beliefs and programmed learning, $r(284) =$

TABLE 22

CORRELATIONS FOR TEACHER EFFICACY
AND ABSORPTION PRACTICES

Practice	Efficacy beliefs	Outcome expectancies
	Absorption Methods	
Lecture	-.06	-.06
Reports	.12*	.20***
Seat work	-.19**	-.07
Worksheets	-.07	-.12*
Tests and quizzes	.08	.02
Teacher demonstrations	.09	.08
Programmed learning	-.12*	.01
	Absorption Computer Practices	
Teacher demos on computer	.17**	.00
Learning content	.12*	.00
Drill and practice	.02	.02
Games	-.07	.01
Testing and evaluation	.02	.00
Multi-media, CD-ROM	.10	-.01
	Absorption Materials	
Videos, films	.01	.03
Recordings, compact discs, tapes	.01	.10
Slides	.14*	.15*
Overhead projectors	.11	-.03
Television or ITV	-.04	.08
Games and puzzles	.04	.00
Guest speakers	.07	.10
Student workbooks	.00	.01
Activity cards	.01	.11
Laser discs	.06	.05

*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$. *****$p < .00001$.

-.12, $p < .05$. A weak, positive relationship exists between efficacy beliefs and student reports, $r(284) = .12$, $p < .05$.

No significant correlations were found for outcome expectancies and use of absorption computer practices. Two weak relationships were found for efficacy beliefs and absorption computer practices. The relationship between efficacy beliefs and teacher demonstrations on the computer was positive and significant, $r(282) = .17$, $p < .01$. The relationship between efficacy beliefs and learning content on the computer was also positive and significant, $r(282) = .12$, $p < .05$.

In looking at absorption materials, the relationship between efficacy beliefs and the use of slides was positive and significant, $r(284) = .14$, $p < .05$. The relationship between outcome expectancies and slides was also positive and significant, $r(284) = .15$, $p < .05$.

Calculation of correlation coefficients for absorption practices and efficacy beliefs yielded nine statistically significant correlations. In looking at efficacy beliefs and absorption practices, the null hypotheses with respect to reports, seat work, programmed learning, teacher use of computer demonstrations, use of the computer for learning content, and the use of slides were rejected and the research hypotheses were supported. In looking at outcome expectancies and absorption practices, the null hypotheses with respect to reports, worksheets, and slides were rejected and the research hypotheses supported.

Context Variables and Specific Instructional Practices

The second null hypothesis stated: There is no relationship between the use of specific instructional practices and the following context variables: years of teaching experience, qualification to teach specific science classes, and gender.

Constructivist Practices, Teaching Experience, and Qualifications to Teach Specific Science Classes

For years of teaching experience and qualification to teach specific science classes, this hypothesis was tested through a Spearman's correlation procedure. Table 23 presents a summary of the results of this statistical procedure for constructivist items. This analysis yielded 41 statistically significant correlation coefficients.

In looking at the relationship between the use of constructivist methods and years of teaching experience, three weak, positive relationships were found. These correlations were for experience and the use of inquiry, $r(284) = .16$, $p < .01$; experience and the use of discovery, $r(284) = .17$, $p < .05$; and experience and the use of problem solving, $r(284) = .16$, $p < .05$.

Five statistically significant relationships were found between use of constructivist methods and qualifications to teach life science. These included life science and inquiry, $r(284) = .19$, $p < .05$; life science and discovery, $r(284) = .16$, $p < .01$; life science and inductive thinking, $r(284) = .14$, $p < .05$;

TABLE 23

CORRELATIONS FOR YEARS OF TEACHING EXPERIENCE AND QUALIFICATIONS TO TEACH SCIENCE CLASSES WITH CONSTRUCTIVIST PRACTICES

Practice	Years of teaching	Life science	Physical Science	Earth/ space science
Constructivist Methods				
Discussion	.07	-.05	-.03	-.01
Projects	.01	.02	.10	.09
Lab work	.11	.12*	.24****	.17**
Cooperative learning	-.03	-.02	.11	.12
Inductive thinking	.05	.14*	.21***	.18**
Simulations	-.08	.05	.06	.18**
Role play	-.08	.08	.00	.08
Field trips	-.07	.07	-.00	.06
Inquiry	.16**	.19**	.36*****	.25****
Discovery	.17**	.16**	.26*****	.17**
Problem solving	.16**	.14*	.27*****	.21***
Learning cycle	-.01	-.00	.01	.15*
Real-life application	.03	.06	.16**	.14*
Constructivist Computer Practices				
Computer programming	.02	.06	-.00	-.04
Computer as lab tool	.15*	.10	.20**	.22****
Computer simulations	.06	.05	.05	.14*
Problem solving on computer	.10	.08	.12*	.18**
Interactive software	.09	.07	.07	.14*
Computer databases	.07	.08	.09	.04
Robotics	.13*	.09	.08	.12
Computer networks	.06	-.05	.06	.08

Table 24--Continued.

Practice	Years of teaching	Life science	Physical science	Earth/ space science
	Constructivist Materials			
Camcorder	-.10	.02	.07	.08
Plants and animals	-.12*	.33*****	-.05	.02
Collections	.05	.12*	.01	.20***
Lab supplies	.11	.21***	.29*****	.16**
Scopes	.02	.18**	-.00	.04
Models	.12*	.11	.10	.14*
Cameras	-.07	.10	.08	.12*

*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$. *****$p < .00001$.

life science and problem solving, $r(284) = .14$, $p < .05$; and life science and lab work, $r(284) = .12$, $p < .05$.

In looking at correlations between use of constructivist methods and qualifications to teach physical science, six statistically significant relationships were found. These included physical science and inquiry, $r(284) = .36$, $p < .00001$; physical science and problem solving, $r(284) = .27$, $p < .00001$; physical science and discovery, $r(284) = .26$, $p < .00001$; physical science and lab work, $r(284) = .24$, $p < .0001$; physical science and inductive thinking, $r(284) = .21$, $p < .001$; and physical science and real-life applications, $r(284) = .16$, $p < .01$.

Eight statistically significant relationships were found between use of constructivist methods and qualifications to teach earth/space science. These included earth/space science and inquiry, $r(284) = .25$, $p < .0001$; earth/space science and problem solving, $r(284) = .21$, $p < .001$; earth/space science and inductive thinking, $r(284) = .18$, $p < .01$; earth/space science and simulations, $r(284) = .18$, $p < .01$; earth/space science and lab work, $r(284) = .17$, $p < .01$; earth/space science and discovery, $r(284) = .17$, $p < .01$; earth/space science and use of the learning cycle, $r(284) = .15$, $p < .05$; and earth/space science and real-life applications, $r(284) = .14$, $p < .05$.

Two positive relationships were found between the use of constructivist computer practices and years of teaching experience. These correlations were for experience and the use of the computer as a lab tool, $r(282) = .15$, $p < .05$; and experience and the use computers for robotics, $r(282) = .13$, $p < .05$.

In looking at correlations between use of constructivist computer practices and qualifications to teach life science, no statistically significant relationships were found.

In looking at correlations between use of constructivist computer practices and qualifications to teach physical science, two statistically significant relationships were found. These included physical science and use of the computer as a lab tool, $r(282) = .20$, $p < .01$; and physical science and problem solving on the computer, $r(282) = .12$, $p < .05$.

In looking at correlations between use of constructivist computer practices and qualifications to teach earth/space science, four statistically significant relationships were found. These included earth/space science and the use of the computer as a lab tool, $r(282) = .22$, $p < .001$; earth/space science and problem solving on the computer, $r(282) = .18$, $p < .01$; earth/space science and use of computer simulations, $r(282) = .14$, $p < .05$; and earth/space science and the use of interactive software, $r(282) = .14$, $p < .05$.

Two significant relationships were found between the use of constructivist materials and years of teaching experience. The correlation for experience and the use of models was positive and significant, $r(284) = .12$, $p < .05$. The correlation coefficient for experience and the use of living plants and animals was negative and significant, $r(284) = -.12$, $p < .05$.

In looking at correlations between use of constructivist materials and qualifications to teach life science, four statistically significant relationships were found. These included life science and the use of living plants and animals, $r(284) = .33$, $p < .00001$; life science and the use of lab supplies, $r(284) = .21$, $p < .001$; life science and use of scopes, $r(284) = .18$, $p < .01$; and life science and the use of collections, $r(284) = .12$, $p < .05$.

One statistically significant relationship was found between use of constructivist materials and qualifications to teach physical science. This was for physical science and use of lab supplies, $r(284) = .29$, $p < .00001$.

In looking at correlations between use of constructivist materials and qualifications to teach earth/space science, four statistically significant relationships were found. These included earth/space science and the use of collections, $r(284) = .20$, $p < .001$; earth/space science and the use of lab supplies, $r(284) = .16$, $p < .01$; earth/space science and use of models, $r(284) = .14$, $p < .05$; and earth/space science and the use of cameras, $r(284) = .12$, $p < .05$.

Calculation of correlation coefficients for these constructivist practices and selected context variables yielded many statistically significant correlations. In looking at teaching experience and constructivist practices, the null hypotheses with respect to inquiry, discovery, problem solving, use of computer as a lab tool, use of computer for robotics, use of plants and animals, and use of models were rejected and the research hypotheses were supported.

In looking at qualifications to teach life science and constructivist practices, the null hypotheses with respect to lab work, inductive thinking, inquiry, discovery, problem solving, use of plants and animals, use of collections, use of lab supplies, and use of scopes were rejected and the research hypotheses were supported.

In looking at qualifications to teach physical science and constructivist practices, the null hypotheses with respect to lab work, inductive thinking, inquiry, discovery, problem solving, real-life application, use of computer as a lab tool, problem solving on the computer, and use of lab supplies were rejected and the research hypotheses were supported.

In looking at qualifications to teach earth/space science and constructivist practices, the null hypotheses with respect to lab work, inductive thinking, simulations, inquiry, discovery, problem solving, learning cycle, real-life application, use of computer as a lab tool, use of computer simulations, problem solving on the computer, use of interactive software, use of collections, use of lab supplies, use of models, and the use of cameras were rejected and the research hypotheses were supported.

Absorption Practices, Teaching Experience, and Qualifications to Teach Specific Science Classes

Statistical procedures identical to those described above were calculated for absorption practices and selected context variables. Table 24 presents a summary of the results of the correlation coefficients for years of teaching experience, qualification to teach specific science classes, and absorption items. This analysis yielded 12 statistically significant correlations.

In looking at the relationship between the use of absorption methods and years of teaching experience, no statistically significant relationships were found. Similarly, in looking at correlations between use of absorption methods and qualifications to teach life science, no statistically significant relationships were found.

TABLE 24

CORRELATIONS FOR YEARS OF TEACHING EXPERIENCE AND QUALIFICATIONS TO TEACH SCIENCE CLASSES WITH ABSORPTION PRACTICES

Practice	Years	Life science	Physical science	Earth/space science
Absorption Methods				
Lecture	-.04	-.06	-.17**	-.10
Reports	-.01	.01	.08	.05
Seat work	-.04	-.09	-.11	-.04
Worksheets	.06	.06	.05	.01
Tests and quizzes	.04	.02	-.04	.05
Teacher demonstrations	-.00	.09	.14*	.19**
Programmed learning	-.01	-.02	.07	.10
Absorption Computer Practices				
Teacher demos on computer	.14*	.10	.14*	.23****
Learning content	.04	.09	.11	.16**
Drill and practice	.03	.04	.05	.10
Games	-.10	.01	-.03	-.03
Testing and evaluation	.02	.05	.07	.06
Multi-media, CD-ROM	.05	-.01	-.06	.08
Absorption Materials				
Videos, films	-.03	-.03	.01	.09
Recordings, compact discs, tapes	.07	.02	-.03	.08
Slides	.05	.07	.03	.17**
Overhead projectors	-.05	.00	.04	-.01
Television or ITV	.02	-.02	-.03	.19**
Games and puzzles	-.12*	.13*	.08	.02
Guest speakers	-.04	.04	.02	.08
Student workbooks	.09	.02	-.06	.02
Activity cards	.01	-.02	.02	.09
Laser discs	.06	-.02	.02	.12*

*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$.

Two statistically significant relationships were found between use of absorption methods and qualifications to teach physical science. The relationship between physical science and lecture was negative and significant, $r(284) = -.17$, $p < .01$. The relationship between physical science and the use of teacher demonstrations was positive and significant, $r(284) = .14$, $p < .05$.

One statistically significant relationship was found between use of absorption methods and qualifications to teach earth/space science. The relationship between earth/space science and the use of teacher demonstrations was positive and significant, $r(284) = .19$, $p < .05$.

In looking at the relationship between the use of absorption computer practices and years of teaching experience, one positive relationship was found. The relationship between experience and the use of the computer for teacher demonstrations was positive and significant, $r(282) = .14$, $p < .05$.

No statistically significant relationships were found between use of absorption computer practices and qualifications to teach life science.

In looking at correlations between use of absorption computer practices and qualifications to teach physical science, one statistically significant relationship was found. The relationship between physical science and use of the computer for teacher demonstrations was positive and significant, $r(282) = .14$, $p < .05$.

Two statistically significant relationships were found between use of absorption computer practices and qualifications to teach earth/space science. The relationship between earth/space science and the use of the computer for teacher demonstration was positive and significant, $r(282) = .23$, $p < .0001$, as was the relationship between earth/space science and learning content on the computer, $r(282) = .16$, $p < .01$.

In looking at the relationship between the use of absorption materials and years of teaching experience, one significant relationship was found. The correlation for experience and the use of games and puzzles was negative and significant, $r(284) = -.12$, $p < .05$.

One statistically significant relationship was found between use of absorption materials and qualifications to teach life science. The relationship between life science and the use of games and puzzles was positive and significant, $r(284) = .13$, $p < .05$.

No statistically significant relationships were identified between use of absorption materials and qualifications to teach physical science.

In looking at correlations between use of absorption materials and qualifications to teach earth/space science, three statistically significant relationships were found. These included earth/space science and the use of television, $r(284) = .19$, $p < .01$; earth/space science and the use of slides, $r(284) = .17$, $p < .01$; and earth/space science and use of laser discs, $r(284) = .12$, $p < .05$.

Calculation of correlation coefficients for these absorption practices yielded 12 statistically significant correlations. In looking at years of teaching experience and absorption practices, the null hypotheses with respect to teacher use of computer demonstrations and the use of games and puzzles were rejected and the research hypotheses were supported.

In looking at qualifications to teach life science and absorption practices, the null hypothesis with respect to the use of games and puzzles was rejected and the research hypothesis supported. In looking at qualifications to teach physical science, the null hypotheses with respect to the use of lecture, teacher demonstrations, and teacher use of computer demonstrations were rejected and the research hypotheses supported. In considering qualifications to teach earth/space science, the null hypotheses with respect to teacher demonstrations, teacher use of computer demonstrations, use of the computer to learn content, use of slides, television, and laser discs were rejected and the research hypotheses were supported.

Instructional Practices and Gender

Because gender was a nominal variable, chi-square tests were used to test its relationship to the use of specific instructional practices. Response categories for the various instructional practices were combined in an effort to ensure fewer than 20% of the cells would have frequencies less than five, and no cells would be empty (Table 15 shows the combining strategy). This resulted in a 2 x 3 chi-square matrix, with two classifications of gender and three classifications of instructional practices use.

This analysis strategy worked for most variables. However, some tests still had less than five expected frequencies for more than 20% of the cells. Since further combination of the response classifications would have distorted the data, no test statistic was reported for those variables and gender (see Table 25).

Cell size and proportions for each of these variables are shown in Table 34, in Appendix G. For these data, large numbers of responses (often more than 90%) tended to be clumped in the rarely or never used category. In one variable classification, discussion, this pattern was reversed, with more than 94% of responses in the weekly category.

Statistically significant chi-square results for gender and use of instructional practices are summarized in Table 26. (See Appendix G for complete chi-square tables.)

Chi-square results indicate two statistically significant relationships between gender and use of constructivist methods. For use of student projects and gender, x^2 (2, N = 284) = 7.0, $p < .05$. This result indicates female science teachers are more likely than male teachers to assign student projects. For the use of cooperative learning and gender, x^2 (2, N = 284) = 11.2, $p < .01$. Female teachers in this sample were more likely than male teachers to use cooperative learning. The chi-square analyses for level

TABLE 25

LIST OF VARIABLES FOR WHICH CHI-SQUARE TESTS WERE NOT REPORTED

Instructional practice	% of cells with fewer than 5 expected frequencies
Discussion	33.3
Trips	33.3
Computer simulations	33.3
Interactive software	33.3
Computer databases	33.3
Robotics	66.7
Computer networks	33.3
Cameras	33.3
Computer drill and practice	33.3
Slides	33.3
Speakers	33.3

TABLE 26

CONSTRUCTIVIST INSTRUCTIONAL PRACTICES
BY GENDER

Practices	x^2	*p*
	Constructivist Methods	
Projects	7.0	.05
Cooperative learning	11.2	.01
	Constructivist Materials	
Lab supplies	7.8	.05
Scopes	19.0	.0001
Models	6.5	.05
	Absorption Methods	
Reports	8.8	.05
Seat work from the textbook	7.4	.05
Tests and quizzes	9.2	.05
	Absorption Computer practices	
Computer demonstrations	7.8	.05

Note. Complete chi-square tables are located in Appendix G; $df = 2$, $N = 284$.

of use for constructivist computer practices and gender yielded no statistically significant relationships.

These results indicate three statistically significant relationships between gender and the use of constructivist materials. The strongest relationship is indicated between use of scopes and gender, x^2 (2, *N* = 284) = 19.0, $p < .0001$). A significant relationship was also supported between use of lab supplies and gender, x^2 (2, *N* = 284) = 7.8, $p < .05$. The third statistically significant relationship for constructivist materials and gender was for the use of models, x^2 (2, *N* = 284) = 6.5, $p < .05$. For all three of these relationships, female teachers were more likely than their male counterparts to use these constructivist materials: scopes, lab supplies, and models.

The chi-square analysis of absorption practices by gender identified four relationships that were significant at $p < .05$. In testing the association between absorption methods and gender, significant statistics were found for tests/quizzes and gender, x^2 (2, *N* = 284) = 9.2, $p < .05$; reports and gender, x^2 (2, *N* = 284) = 8.8, $p < .05$); and seat work and gender, x^2 (2, *N* = 284) = 7.4, $p < .05$. Male teachers reported higher degrees of use of textbook seat work and tests and quizzes than did female teachers. Female teachers were associated with greater use of student reports than were male teachers.

A statistically significant association was indicated for computer demonstrations and gender, x^2 (2, *N* = 284) = 7.8, $p < .05$. Male teachers were associated with greater use of computer demonstrations than were female teachers. No other significant relationships were indicated for absorption computer practices and gender. Also, no statistically significant relationships were identified for use of absorption materials and gender.

Discussion of the Findings

Descriptive Data

Descriptive data from the study provided a wealth of information on instructional practices in seventh- and eighth-grade science education in the United States. While textbooks are still used by approximately 90% of junior-high science teachers, the data on textbook usage seems to suggest a decrease in text dependence by teachers of seventh- and eighth-grade science. Whereas in 1985-86, the largest percentage of teachers used 75 to 90% of the text, the largest percentage of teachers in this study reported covering 50 to 74% of the text. This finding could indicate a shifting away from text-bound science education toward a more constructivist approach. Classroom observation would provide needed clarification on this issue.

In looking at the data on teaching methods used, nine different techniques were reported as being used at least once a week by more than 50% of the sample. This listing included six constructivist methods and three absorption methods (see Tables 15 and 16). It appears that teachers use a variety of methods in science education, and that they use a larger selection of constructivist methods than absorption methods.

Teachers reported using discussion and lecture more often than other methods. Classroom observation would be helpful in determining actual discussion techniques used by teachers. It is possible that what was reported as "discussion" was in fact "recitation." If this is true, then discussion could not be considered a constructivist practice. Goodlad (1984) found that lecture and recitation were the most used instructional practices in his national study of classrooms. He refers to recitation as any type of questioning that asks for information that has previously been supplied to the student, either by the teacher, the textbook, or another source. If, in fact, the primary teaching methodologies currently used in science classrooms are lecture and recitation, then little has changed since the late 1970s when Goodlad's team collected its data.

One of the most encouraging findings of this study was the fact that over 65% of seventh- and eighth-grade science teachers reported weekly use of hands-on or lab activities. In the 1977 National Survey of Science, Mathematics, and Social Studies Education, Weiss (1978) reported 61% of teachers in grades 7 through 9 used hands-on or lab activities at least once a week. In considering the use of lab activities at least weekly, my study showed a 4% increase use over the 1977 study results.

No direct comparison can be made with the 1985-86 study as it omitted this survey item. However, in the 1985-86 study fewer teachers reported using hands-on, lab activities in their most recent science lesson when compared to the 1977 study. It may be that a reversal of this trend in hands-on science teaching has begun, and teachers are using more laboratory activities now than in 1977 or 1985-86.

Since constructivist teaching stresses the use of active learning, the above finding signals some level of success for current science education reform efforts at the national level. It is also interesting to note that while the use of hands-on and lab activities increased from the 1977 national study, reported use of lecture decreased by almost 6%. This could also be indicative of a more constructivist approach to science education in current science classrooms.

In interpreting these results, one must remember that the Weiss study sampled public school teachers in grades 7 through 9, while my study was directed toward public and private school teachers of seventh and eighth grades. However, Weiss reported that her data was stable across the secondary grade levels with few exceptions. Therefore the comparison of my seventh- and eighth-grade data with Weiss's seventh-, eighth-, and ninth-grade data is quite acceptable.

The descriptive data for teaching methods use suggests that teachers use a variety of teaching approaches in their classrooms instead of depending on a few preferred methods. Two-thirds of the most used methods were classified as constructivist, while one-third was classified as absorption. Thus it appears that seventh- and eighth-grade science instruction tends toward the use of constructivist methods more than absorption methods. Actual classroom observations could provide valuable information about the amount of time devoted to constructivist and absorption strategies.

The most striking finding about use of computers in the seventh- and eighth-grade science classroom is that computers typically are not used. In all categories of computer practices, constructivist and absorption, more than 79% of teachers reported using computers less than once a month or never. Less than 7% of teachers reported using computers weekly for any type of computer practice. This finding is consistent with a recently released report ("Survey Finds," 1995). Only about one-third of public schools in the United States have access to the Internet, and half of those schools have access at only one office, lab, or classroom. It is also consistent with Weiss's (1987) findings in the 1985-86 national study that only 6% of students in grades 7 through 9 had worked on a computer for science class within the past week.

The computer item elicited a fairly large number of written comments. The content of these comments suggested three basic problems in computer use. The first group of schools could not afford to invest in the computer equipment. The second group of schools had computers, but they were placed in computer labs and reserved for use by special computer classes. The third group of schools had computers, but these were dispersed among teachers, resulting in one computer per classroom, or one computer to share among several teachers. Responses from teachers indicated dissatisfaction with all three arrangements. Creative solutions are needed if technology is to be integrated into science education to any significant extent.

Use of instructional materials somewhat reflected use of methodology. Teachers indicated a high use of lab work, and consequently they also reported a high level of use of lab supplies. Sixty percent of teachers use lab supplies at least weekly. The overhead projector, classified in this study as absorption, was second in the list of most used materials. Slightly less than 50% of teachers used the overhead at least weekly.

It is possible, as implied by some respondents' comments, that school budget constraints limit the use of certain items such as camcorders, cameras, laser discs, and scientific models. If this is true, teachers could perhaps enlist the help of parents concerned with science education to plan and execute an aggressive program to procure needed equipment.

It is doubtful that budget limits reduce the use of instructional television. The recently released study, Advanced Telecommunications in U.S. Public Schools (cited in "Survey Finds," 1995), reported that 74% of public schools have cable TV and 70% have broadcast TV.

One item that is not typically limited by budget is the use of guest speakers. Over 90% of teachers reported rarely using guest speakers. Getting "real" scientists into the classroom is usually a low-cost method of introducing students to the world of work available to those who pursue careers in the sciences. It is probable that the teachers' time constraints are limiting factors in securing guest lecturers for the science classroom. To have a successful visit from a scientist requires detailed planning by the teacher. It includes arranging the logistics of the visit, preparing the scientist for the students, preparing the students for the scientist, and debriefing after the visit. To do this well requires a significant time investment.

Teacher Efficacy and Specific Instructional Practices

The first null hypothesis in this study, "There is no relationship between the use of specific instructional practices and teacher efficacy," was rejected through hypothesis-testing procedures. Twenty-five of 56 (44.6%) correlations computed were found to be statistically significant for teacher efficacy and specific instructional practices. While these correlations were statistically significant, they were typically quite small. The descriptive data suggested the use of a variety of teaching practices by science teachers in the seventh- and eighth-grade classroom. The large number of small yet significant correlations supports this conceptualization.

Correlations between teacher efficacy and absorption practices yielded only nine significant correlation coefficients from the 46 (20.0%) coefficients calculated, and three of these were negative. The relationship between teacher efficacy and the use of constructivist practices is supported more than the relationship between teacher efficacy and absorption practices. This is consistent with the findings of Treagust (1991); Tobin and Fraser (1990); Yager et al., (1988); and Searles and Kudeki (1987).

While all correlations were weak, with one exception the largest correlation coefficients (those greater than .20) were associated with efficacy beliefs and use of constructivist methods and materials. Given the lack of available computers for most teachers, it could not be expected to find much meaningful information about the relationship between efficacy and computer practices. These data suggest a stronger relationship between teachers' use of constructivist practices and beliefs about their personal science teaching abilities (efficacy beliefs) than for their beliefs about science teaching in general (outcome expectancies). The only correlation coefficient greater than .20 for the outcome expectancies subscale was found between outcome expectancies and use of simulations. Tracz and Gibson (1986) also found a greater number of significant correlations for efficacy beliefs as compared to outcome expectancies.

Positive correlations between teacher efficacy and absorption practices were found for reports, computer demonstrations, using the computer to learn science content, and use of slides. It is possible that teachers with higher levels of teacher efficacy assign more student reports to foster rudimentary research skills. It is also possible that these teachers make greater use of slides in an effort to expose students to information beyond their experience.

Negative correlations for absorption practices and teacher efficacy were found for use of seat work, worksheets, and programmed instruction. These results support the contention that high efficacy beliefs are related to use of active, constructivist practices.

Context Variables and Specific Instructional Practices

Qualifications to teach specific science subjects appear to have a stronger relationship to the use of constructivist instructional practices than do years of teaching experience. Of the 84 correlation coefficients for teaching qualifications and constructivist practices, 40.1% were positive and statistically significant, while only 21.4% of the coefficients between years of teaching experience and constructivist practices were both positive and significant.

This result was unexpected from the literature review which indicates a negative association between a teacher's content preparation and effectiveness as a science teacher (Yager et al., 1988). Clarification is needed on what these teachers meant when they said they felt adequately qualified to teach science courses. Feelings of qualification to teach may not necessarily be synonymous with in-depth content preparation.

While all correlations were weak, qualification to teach physical sciences typically had the strongest relationships with use of constructivist practices; seven of these correlations had coefficients over .20. Physical sciences, such as chemistry and physics, have traditionally been viewed as the "difficult" sciences. It appears that feelings of adequate ability to teach the "difficult" sciences is the best predictor of use of constructivist practices from this group of context variables.

Qualification to teach earth/space science had the largest number of significant correlations: seven more significant correlations than either life science or physical science. Four of these correlation coefficients were .20 or greater. These data suggest use of a greater variety of constructivist practice by teachers who feel prepared to teach earth/space science. Nothing in the literature suggests this relationship or an explanation for it.

Qualification to teach life science and use of constructivist materials had two correlation coefficients greater than .20. These were for use of living plants and animals and use of lab supplies. The relationship between use of living plants and animals and qualification to teach life science is logical and therefore expected.

The relationship between qualifications and use of lab activities and lab supplies was statistically significant for all three subject areas. This indicates teachers who feel adequately prepared to teach science classes use lab activities and supplies more regularly than teachers who do not feel adequately qualified to teach science. This would imply the need to strengthen both pre-service and in-service teacher training programs in science education in an effort to produce teachers who feel adequately prepared to teach science.

When examining the relationships between use of absorption practices and these context variables, 12 of the 92 (13.0%) correlations were statistically significant. Only 6 of those 12 (50.0%) were significant with $p < .01$ or $p < .0001$. For years of teaching experience, two of the 23 (8.7%) correlations were statistically significant. The positive relationship between years of service and use of computers for demonstrations was unpredicted from the literature review. This was also true of the negative relationship between years of teaching experience and use of traditional games and puzzles.

There is a significant negative relationship between teachers who feel qualified to teach physical sciences and the use of lecture. Increased feeling of qualifications to teach physical science is related to decreased use of the lecture method. Perhaps as teachers feel more qualified to teach physical science they also feel more competent in the use of constructivist methods.

The only absorption methods with a significant positive relationship to qualifications to teach science classes is the use of teacher demonstrations. This method is significantly related to qualifications to teach physical science and earth/space science. Demonstrations, students watching the teacher perform a laboratory experiment, are a traditional teaching approach in both of these subject areas. While this technique does not require the student to perform a procedure, it tends more toward the constructivist end of the continuum than lecture, and is consistent with the general finding of this study that teachers who feel qualified to teach science classes are more constructivist in their use of teaching methods.

As in the case of relationships between constructivist practices and qualifications to teach earth/space science, there are more significant correlations between qualifications to teach earth/space science and the use of absorption practices than qualifications to teach other subjects. Again, this trend is not explained or predicted from the review of the literature.

Analysis of relationships between gender and the use of instructional practices relied on the chi-square test of association. From 40 chi-square tests, nine statistically significant results were found at $p < .05$. This indicates a small number of differences in use of science instructional practices based on gender.

Of constructivist methods, females were more likely to assign student projects and to use cooperative learning. This higher degree of use of cooperative learning is supported by authorities who assert that women tend to be more relationship oriented than men (Smalley, 1988; Van Pelt,1985). Relationships between teaching/learning styles and gender have also been reported in the educational literature (Chang, 1988; Gorham, 1986). This finding is also consistent with practices in innovative all-female math and science classes that stress interaction between students and the concept.

The strongest relationship for gender was found with the use of microscopes, telescopes, and magnifying glasses. This relationship was not anticipated based on the literature review. Given that a relationship was also supported between qualifications to teach life science and the use of scopes, perhaps a significantly larger portion of life science teachers are female, if indeed life science is taught as a separate course of instruction at this level.

Summary

Chapter 4 presented the findings of the study. The chapter began with a discussion of the study's return rate. Total returns received were 303. This resulted in a gross return rate of 55.8%. Usable returns (N = 285) resulted in a 52.5% net return rate for this study.

The second section of this chapter presented a descriptive analysis of the context variables included on the survey instrument. Participants in this study averaged 16 years of teaching experience, and were almost evenly divided among males and females. The typical teacher taught as a science specialist, felt the organizational climate in the school was cooperative, and felt qualified to teach science subjects.

Descriptive statistics were also presented for the STEBI. Responses to the Outcome Expectancy Subscale approximates a normal distribution, while the distribution for the Efficacy Beliefs Subscale is negatively skewed. Teachers typically scored higher on the Efficacy Beliefs Subscale, with a mean score 55.1. The mean score for the Outcome Expectancy Subscale was 39.2. It should be noted that there was one more item on the efficacy beliefs subscale than on the outcome expectancies subscale. All individual items on the efficacy beliefs subscale had greater means than did items on the outcome expectancies subscale. This indicates beliefs about personal efficacy were greater than beliefs about teaching in general.

Data were presented concerning the reported use of specific instructional practices in seventh- and eighth-grade science education in the United States. Discussion and lecture are the two most commonly used instructional methods. Results show use of hands-on lab activities increased 4% over the 1977 national study. Use of lecture decreased almost 6% during the same time period. These results indicate current science reform efforts may be affecting science instruction at the national level.

Hypothesis testing resulted in the rejection of both of the study's null hypotheses. Significant relationships were found between 34 specific instructional practices and teacher efficacy. A greater number of correlations were found between use of constructivist practices and teacher efficacy, and these correlations coefficients were somewhat larger than those for use of absorption practices and teacher efficacy, although all correlations were weak.

Fifty-three statistically significant correlations were found between use of specific instructional practices and years of teaching and qualifications to teach science classes. Again, the larger number of correlations and the stronger correlations were found for use of constructivist materials.

The final section of analysis in chapter 4 presented the results of chi-square tests for the use of instructional practices and gender. Once again the hypotheses were rejected, as significant association was found for gender and student projects, cooperative learning, scopes, lab supplies, models, student reports, seatwork from the textbook, and tests and quizzes.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Major reforms are being promoted in the field of science education. These reform efforts are systemic in nature and herald major changes in all components of science education, including training, curriculum, instructional practices, and assessment of learning. In the pursuit of more effective science instruction, educators must not overlook related educational research. In the research literature, teacher efficacy has been shown to be closely related to effective teaching practices and increased student achievement.

One current emphasis in science education is the use of constructivist practices in the classroom. While teacher efficacy has been shown to be related to implementation of innovation after training, and a relationship has been shown between efficacy beliefs and use of hands-on science activities, no investigation had been done to investigate the relationship between teacher efficacy and use of other constructivist instructional practices prior to this study.

Purpose of the Study

Therefore, this study investigated teacher efficacy and the use of specific instructional practices, particularly constructivist instructional practices. It was the purpose of this study to provide a description of current instructional practices in seventh- and eighth-grade science classrooms in the United States. A second purpose was to identify any relationships between efficacy and specific instructional practices, and to determine if any of these relationships were statistically significant.

This descriptive study gathered data from seventh- and eighth-grade science teachers from across the United States, including teachers from both private and public schools. Through the use of a self-reporting survey instrument, data were collected on the science teacher's efficacy, the use of specific instructional practices, and teaching context (demographics).

Relevant Literature

The review of literature identified research in the areas of teacher efficacy and constructivist science education. Teacher efficacy has been shown to be significantly related to student achievement, effective teaching of reading, implementation of innovation, and humanistic approaches to discipline. Different methods of assessing teacher efficacy beliefs were identified in the review of the literature. These methods included the use of two Likert items, the use of a political efficacy scale, the administration of a

25-item Likert scale designed for teachers, and the administration of a series of teaching scenarios.

The literature on science education identifies characteristics of exemplary science teachers. Exemplary teachers tend to use constructivist practices in their classrooms. Constructivist practices are instructional techniques that enable students to build conceptual understanding through active interaction with each concept. Because of the relationship between exemplary science teaching and the use of constructivist practices, current science reforms attempt to increase the use of constructivist instructional practices.

While a few studies exist that explore the relationship of teacher efficacy to science education, including the development of an efficacy beliefs instrument for science teachers, little has been reported in the educational literature on the relationship of teacher efficacy to specific practices in the science classroom.

Research Design

This was a descriptive study completed in the quantitative/empirical tradition. Data were collected by the use of a self-reporting survey instrument consisting of three information sections. These sections were teacher context, science methods and materials use, and the Science Teaching Efficacy Beliefs Instrument.

The study population consisted of seventh- and eighth-grade science teachers from the United States. The sample of 543 teachers was obtained from the National Registry of Teachers, maintained by the National Science Teachers Association. Study participants totaled 285, for a return rate of 52.5%. The data from these respondents were analyzed through Spearman rho correlation and chi-square.

External validity of this sample was supported through a comparison of demographic features with Weiss's (1994) national probability sample. The only differences noted between the two samples were for years of teaching experience and qualifications to teach physical science. In my study and Weiss's study (1994), the responses for gender, qualifications to teach life science and earth science, and textbook usage were similar.

Conclusions

The major conclusions drawn from this study are directly related to the use of instructional practices, teacher efficacy, and the selected context variables. These conclusions include the following:

1. Teacher dependence on textbooks in seventh- and eighth-grade science appears to have lessened in the 9 years since 1986.
2. Discussion and lecture are the most used teaching methodologies in seventh- and eighth-grade science classrooms in the United States.

3. The reported weekly use of hands-on lab activities in seventh- and eighth-grade science classrooms in the United States has increased 4% since 1977.

4. The reported weekly use of lecture in seventh- and eighth-grade science classrooms in the United States has decreased by almost 6% since 1977.

5. More than two-thirds of seventh- and eighth-grade teachers in the United States do not use computers in science instruction. Many of these teachers do not have access to computers or computer labs. This is consistent with other released national surveys ("Survey Finds," 1995).

6. Statistically significant positive relationships exist between the use of specific constructivist instructional practices and teacher efficacy (see Table 21). Significant relationships were found between teacher efficacy and use of such constructivist instructional practices as lab work, inquiry, discovery, simulations, lab supplies, and models. These findings are consistent with studies that showed a relationship between teacher efficacy and effective teaching, and teacher efficacy and the implementation of innovation (Armor et al., 1976; Berman et al., 1977; Tracz & Gibson, 1986). While all correlations were weak, it appears the strongest of these relationships exist between the use of constructivist practices and personal efficacy beliefs. No causal

relationship was investigated in this study; however, it may be that a personal sense of teaching power results from the use of exemplary practices. Conversely, it may be that teachers choose to use constructivist practices because of strong beliefs about their personal teaching effectiveness. It is also possible this relationship could result from a complex interaction of many factors.

7. Statistically significant relationships, both positive and negative, exist between the use of absorption instructional practices and teacher efficacy (see Table 22). Significant positive relationships were found between teacher efficacy and use of absorption instructional practices such as student reports, use of slides, teacher demonstrations on computer, and using the computer to learn content. Significant negative relationships were found between teacher efficacy and assigning seat work from the textbook, use of worksheets, and use of programmed learning. There are fewer positive significant relationships between use of absorption practices and teacher efficacy than between constructivist practices and teacher efficacy. However, positive relationships between teacher efficacy and use of absorption instructional practices were not predicted from the review of the literature, which supported a relationship between teacher efficacy and effective teaching, and teacher efficacy and the implementation of innovation (Armor et al., 1976; Berman et al., 1977; Tracz & Gibson,

1986). However, it may be that effective teaching makes use of a wide variety of techniques, both absorption and constructivist, rather than depending on only one type of instruction.

8. There is a significant positive relationship between teachers' perceptions of their qualifications to teach science courses and their reported level of use of constructivist practices in their classrooms (see Table 23). Significant relationships were found for qualifications to teach science classes and such instructional practices as lab work, inductive thinking, inquiry, discovery, problem solving, use of collections, use of lab supplies, use of the computer as a lab tool, and problem solving on the computer.

9. Significant relationships, positive and negative, exist between the use of absorption practices and years of teaching experience (see Table 24). A significant positive relationship was found between years of teaching experience and the use of computer demonstrations. A significant negative relationship was found between years of teaching experience and the use of games and puzzles.

10. Significant relationships, positive and negative, exist between the use of absorption practices and qualifications to teach science classes (see Table 24). A significant negative relationship was found between qualifications to teach physical science and the use of lecture. Significant positive relationships were found between qualifications to

teach science classes and teacher demonstrations, computer demonstrations, learning content on the computer, slides, television, games and puzzles, and laser discs.

11. A significant relationship exists between gender and the use of cooperative learning in seventh- and eighth-grade science classrooms in the United States. Female teachers report greater use of this method than do male teachers.

12. A significant relationship exists between gender and the use of scopes in seventh- and eighth-grade science classrooms in the United States. Female teachers report greater use of various scopes in science education than do male teachers.

Related conclusions, which may be of lesser significance, include the following:

1. At the seventh- and eighth-grade level, science teachers are almost equally divided by gender. This represents a shift toward gender equity in junior-high science teaching positions since 1977.

2. Outcome expectancies scores for seventh- and eighth-grade science teachers approximate a normal distribution, while efficacy beliefs scores approximate a negatively skewed distribution.

3. In general, seventh- and eighth-grade science teachers perceive themselves as adequately qualified to teach science classes. This

could explain the negative skew in the distribution of efficacy beliefs scores.

4. Female teachers indicated a statistically significant greater use for 5 constructivist methods: student projects, cooperative learning, lab supplies, scopes, and models. Female teachers also indicated a statistically significant greater use of 1 absorption method, student reports.

5. Male teachers reported a statistically significant greater use for 3 absorption methods: textbook seat work, test and quizzes, and computer demonstrations.

Recommendations

1. A teacher efficacy instrument should be developed and validated for science subject-area specialists in grades 7 and 8 and science teachers in grades 9-12. This instrument should be tailored to the unique environment of the science education specialist.

2. Broad-based studies, encompassing the traditions of both quantitative and qualitative research, should be conducted to gather a wide range of data on science education, including observations of classroom practices, interviews, teacher efficacy assessment, and student achievement.

3. A longitudinal study should be conducted that traces science teachers' efficacy beliefs before training, during training, and throughout the implementation of a constructivist-based teacher-training program. This would provide empirical data on the stability or changeability of the teacher efficacy trait.

4. This study should be replicated using a sample of first through sixth grade teachers. This would enable researchers to explore similarities and differences between these two related but different educational levels.

5. An experimental study should be conducted using at least three different science education training approaches. This study could provide information as to whether teacher efficacy scores can actually be increased. This study could also provide information about the most effective procedure to ensure transfer of training and increase the use of constructivist classroom practices.

APPENDICES

APPENDIX A

HSRB APPROVAL

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 6, 1994

James R. Fisher, Director
Office of Scholarly Research
Room 130, Haughey Hall
Andrews University
Berrien Springs, MI 49104-0355

Dear Sir:

I have enclosed the materials I believe are needed to receive approval for my proposed research. However, since I have not been able to make direct contact with you, something may be missing from the packet. If additional forms or information is needed, please call me immediately as I hope to send out the instruments by October 3. My business number is 504-641-3577.

Thank you,

Larry D. Burton

ANDREWS
UNIVERSITY

November 1, 1994

Larry Burton
200 Eagle Lake Drive #206
Slidell LA 70460

Dear Larry::

The Human Subjects Review Board (HSRB) has reviewed your proposal, "Teacher Efficacy and the Use of Constructivist Materials and Methods by Seventh and Eighth Grade Science Teachers in the United States," under the Exempt Review Category. You have been given clearance to proceed with your research plans.

Some proposals and research designs may be of such a nature that participation in the project may involve certain risks to human subjects. If in the implementation of your project an incidence occurs which results in a research-related adverse reaction and/or physical injury, such an occurrence must be reported immediately in writing to the Human Subjects Review Board. Any project-related physical injury must also be reported immediately to the University physician, Dr. Loren Hamel, by calling (616) 473-2222.

All changes made to the study design and/or consent form after initiation of the project require prior approval from the HSRB before such changes are implemented. Feel free to contact our office if you have any questions. The duration of the present approval is for one year. If your research is going to take more than one year, you must apply for an extension of your approval in order to be authorized to continue with this project.

We wish you success as you implement the research project as outlined in the approved protocol.

Sincerely,

J. R. Fisher

James R. Fisher, Director
Office of Scholarly Research

c: Paul Brantley

Sorry to be so long in getting this approval letter to you. Best wishes on your project.

Berrien Springs, Michigan 49104 (616) 471-7771

APPENDIX B

CORRESPONDENCE WITH RESEARCHERS

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 1, 1994

Dr. Voss,

After I talked to you on the phone this summer, my dissertation proposal was approved by my committee. Dr. Paul Brantley wanted me to contact you again and get your reaction to and evaluation of my proposed study.

Dr. Brantley also thinks I should try to get NSTA endorsement of my study. He suggested that I ask you to suggest contact persons or departments at NSTA. Would that be possible? Are there particular persons to contact or specific procedures to follow in attempting to gain NSTA endorsement of a research study?

Thank you for your assistance.

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 9, 1994

Dr. Robert Poel
Center for Science Education
Western Michigan University
Kalamazoo, MI 49008

Dear Dr. Poel:

Dr. Paul Brantley recently contacted you about my proposed Ph.D. research project. I appreciate your willingness to take a few minutes to look at the enclosed materials. I look forward to your feedback. I will call you September 20 or September 21 to get your opinions. If you would rather contact me at a time of your choice, call 504-641-3577 between 9:00 am and 5:00 pm (eastern time), or the number above at other times.

Thank you for taking the time in your busy schedule to review this material.

Sincerely,

Larry D. Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 16, 1994

Dr. DeWall,

I am currently working on my dissertation which is in the area of science education. It deals with possible relationships between teacher efficacy beliefs and teacher use of science methods and materials.

Would it be possible for you to review this brief study overview and give me your reaction to its possible usefulness to science educators. Also, if you feel the study would be beneficial to science educators in general, would you consider writing an introductory/cover letter to be included in my instrument mailings?

Thank you for your time and assistance.

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 23, 1994

Dear Dr. Enochs:

I am presuming upon your interest in efficacy research. I am a graduate student at Andrews University in southwestern Michigan, and I am also interested in teacher efficacy, particularly in science education.

If you could find 30 minutes to peruse the accompanying documents I would appreciate it. I am particularly interested in your reaction to the usefulness of the study and any design flaws you may notice. This proposal synopsis indicates that I will use the Gibson efficacy instrument, but I have now received permission to use Iris Riggs' instrument.

I hope to contact you by telephone in the next few days to discuss my research.

Thank you for your time and assistance.

Sincerely,

Larry D. Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 27, 1994

Dear Dr. Riggs:

I am presuming upon your interest in efficacy research. I am a graduate student at Andrews University in southwestern Michigan, and I am also interested in teacher efficacy, particularly in science education.

If you could find 30 minutes to peruse the accompanying documents I would appreciate it. I am particularly interested in your reaction to the usefulness of the study and any design flaws you may notice. This proposal synopsis indicates that I will use the Gibson efficacy instrument, but I now plan on using the STEBI A. I will fax a copy of the rest of my instrument.

I hope to contact you by telephone in the next few days to discuss my research.

If you prefer to contact me through e-mail, my Internet address is 74617.1453@CompuServe.COM.

Thank you for your time and assistance.

Sincerely,

Larry D. Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

September 27, 1994

Dear Dr. Riggs:

Here is a draft of my instrument.

Thanks again.

Sincerely,

Larry D. Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

October 14, 1994

Jennifer Lane
NSTA
Official U.S. Registry of Teachers
1840 Wilson Blvd.
Arlington, VA 22201-3000
FAX (703)522-6295

Dear Ms. Lane:

I have talked to you on a few occasions about purchasing names from the Official U.S. Registry of Teachers for my doctoral research project. I have finally received the go-ahead from my committee chair. I hope I explain clearly what I need. If you have any questions about my request, I will be at the above number Monday morning. Beginning Tuesday, October 17, you can reach me or leave a message for me at (501)736-8610. I will be at (504)641-3577 during business hours beginning Monday, October 24.

I need 500 randomly selected seventh- and eighth-grade science teachers. I will need 4 pressure sensitive labels for EACH of the 500 teachers (a total of 2000 labels). I also need a phone list for these teachers to use during non-response follow-up at the end of the study.

Please ship my order UPS 2nd Day Air.

Thank you for your assistance.

Sincerely,

Larry D. Burton

National Science Teachers Association
1840 Wilson Boulevard
Arlington, VA 22201-3000
703-243-7100 Phone
703-243-7177 Fax

October 17, 1994

Mr. Larry D. Burton
1200 Eagle Lake Drive, #206
Slidell, Louisiana 70460

Dear Mr. Burton,

Thank you for sending your study overview to me. It sounds like it would have interesting implications for science teachers, particularly at the elementary level. I would be glad to write an introduction/cover letter for you. Could you suggest a format for the letter? Please let me know.

Sincerely,

Marily M. DeWall
Associate Executive Director

You Lead the Way with NSTA
43rd NSTA National Convention, Philadelphia, PA, March 23-26, 1995

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

October 24, 1994

Dr. DeWall,

I apologize for not responding to your letter of October 17 sooner, but I have been out of state at a teacher's convention for the past week. I appreciate your willingness to write an introductory cover letter for my study. As to the format, I think an expanded form of the letter you sent me would be fine, indicating your interest in the results and encouraging the participants to respond. When I say expanded, I don't mean terribly long. It will probably take only a few sentences to express your message.

I appreciate your assistance. I had planned on sending my first mailing Monday, October 31. If you are able to supply the introductory cover letter by this Friday, October 28, I will proceed with the October 31 mailing. If I do not receive your letter by Friday I will delay my mailing so as to include your letter.

Thanks again,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

December 8, 1994

Dr. DeWall,

In re-reading your October 17 letter, I realized I may have misunderstood what you meant when you asked me to suggest a format for the cover letter you agreed to write for my study. I have finally realized your time demands are probably far greater than mine. Therefore I am suggesting the following format for the proposed cover letter. Of course you can adapt the letter to suit your preferences.

Suggested format:

Dear Science Teacher:

Not since 1977 has detailed information on the use of science teaching methods and materials been collected from a national sample of science teachers. The enclosed study, while much smaller in scope than the 1977 National Study, will provide valuable information concerning current science education. Your time and effort to complete this short survey will add to our knowledge base on U.S. science education. I believe this study could have interesting implications for science teachers and teacher education programs. Thank you for your cooperation.

I will be mailing the instruments on January 16, 1995. If I could have your letter by January 9, that will provide sufficient time for printing the letter and stuffing the envelopes.

Thanks again,

Larry Burton

National Science Teachers Association
1840 Wilson Boulevard
Arlington, VA 22201-3000
703-243-7100 Phone
703-243-7177 Fax

January 6, 1995

Dear Science Teacher:

Not since 1986 has detailed information on the use of science teaching methods and materials been collected from a national sample of science teachers. The enclosed study, while much smaller in scope than the 1986 national study, will provide useful information concerning current science education.

Your time and effort to complete this short survey will add to the knowledge base of U.S. science education. This study, conducted by Larry Burton of Andrews University, could have interesting implications for science teachers and teacher education programs.

Thank you for your cooperation.

Sincerely,

Marily M. DeWall
Associate Executive Director

You Lead the Way with NSTA
43rd NSTA National Convention, Philadelphia, PA, March 23-26, 1995

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

January 18, 1994

Dr. DeWall,

Thank you so much for the cover letter you wrote to accompany my study. I received your letter on January 9, 1995 in ample time to get my initial mailing out. In fact I was able to mail out four days earlier than anticipated.

I appreciate your assistance more than I can say. I will send you a short version of my findings after my study is completed in late spring.

Thank you again.

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

Albert Bandura
Department of Psychology
Stanford University
Stanford, CA 94305

June 1, 1995

Dear Dr. Bandura:

I am in the final stages of work on my Ph.D., and I am preparing to defend my dissertation in July. My dissertation, "Teacher Efficacy and the Use of Specific Instructional Practices by Seventh- and Eighth-grade Science Teachers in the United States," deals with the construct of teacher efficacy and builds on the work of Sherri Gibson and Iris Riggs. Both of these researchers based their work on your conceptualization of self-efficacy. As a result, the conceptual framework of my study relies heavily on your work. In my dissertation I would like to include a figure from your 1977 article "Self-efficacy: Toward a Unifying Theory of Behavioral Change." I would also like to adapt this figure to the field of science education. I am enclosing copies of the two figures and a "permission to use and adapt" form letter. Thank your for your consideration of this matter.

Sincerely,

Larry D. Burton

Albert Bandura
Department of Psychology
Stanford University
Stanford, CA 94305

Larry Burton
1200 Eagle Lake Dr. #206
Slidell, LA 70460

June 2, 1995

Dear Mr. Burton:

I have read your request for permission to use and adapt the figure, " Diagrammatic representation of the difference between efficacy expectations and outcome expectations." I hereby grant you permission to use and adapt this figure for use in your dissertation.

Sincerely,

Albert Bandura

Albert Bandura, Ph.D.

APPENDIX C

MAILOUT MATERIALS

Andrews University
School of Education
Department of Teaching and Learning
Berrien Springs, MI 49104

Larry Burton
1200 Eagle Lake Drive, #206
Slidell, LA 70460
(504)863-2732

Dear Science Teacher,

I need your help! As a part of my doctoral studies, I'm conducting a survey of 543 randomly selected seventh- and eighth-grade science teachers in the United States. I am particularly interested in your decisions about instructional materials and methods. The information you provide will help national planners better understand some of the instructional decisions science teachers make about instructional materials and methods. I hope the results will be useful in revising and improving both pre-service and in-service programs for science teachers.

Please take the time to complete the enclosed questionnaire. As a fellow classroom teacher, I understand your time pressures, and the survey should only take a few minutes to complete. There are no correct or incorrect responses, only much-needed information describing your instructional decisions and efficacy beliefs.

This form contains an identification number that will be used for follow-up purposes only. All responses will be treated confidentially and will in no way be traceable to individual respondents. Once the survey process has been concluded I will destroy my mailing list and list of identification numbers.

Your participation is voluntary. Your return of the completed survey instrument will serve as a form of implied consent for participation in the study.

Please drop your postage-paid, pre-addressed envelope in the mail by **January 27**. As a **thank-you gift** for your participation in this study I have included an animal classification lesson in this packet. I believe you will find it useful.

Thank you for your assistance. If you have any questions, contact me at the above address and telephone number.

Sincerely,

Larry D. Burton
Researcher

Identification #________

Science Methods and Materials Survey

Your participation in this study is voluntary. All responses will be kept in confidence. The return of a completed survey instrument serves as a form of implied consent to participate in the study.

Part 1: Demographic Data

1. Including 1994-1995, how many years have you taught? _____ years

2. Indicate your gender. (Circle one.) Female Male

3. In what type of classroom do you teach? (Circle one.)
   - a. self-contained (responsible for all or most academic subjects)
   - b. subject-area specialist
   - c. Other: ________________

4. Many teachers feel better qualified to teach some subject areas than others. How qualified do you feel to teach each of the following (whether or not they are currently included in your curriculum)?

		Not Well Qualified	Adequately Qualified	Very Well Qualified
a.	Mathematics	1	2	3
b.	Life sciences	1	2	3
c.	Physical sciences	1	2	3
d.	Earth/space sciences	1	2	3
e.	Social studies, history	1	2	3
f.	Reading, language arts, English	1	2	3

5. How would you describe the climate at your school? (Choose one.)
   - a. teachers are cooperative
   - b. teachers are competitive
   - c. teachers are isolated
   - d. other: ______________

Part 2: Science Methods and Materials. *These questions relate to instructional decisions made during your science teaching. If you teach more than one class of science per day, please answer these questions about your first science class.*

1. Are you using one or more published textbooks or programs for teaching science to this class? (Circle one.)
   - a. Yes — Go to question 2
   - b. No — Go to question 3

2. Approximately what percentage of the textbook will you "cover" in this course? (Circle one.)
   - a. Less than 25%
   - b. 25-49%
   - c. 50-74%
   - d. 75-90%
   - e. More than 90%

3. How often do you use the following **TECHNIQUES** in teaching science to this class? If a technique does not apply to your class, please circle 1, "Never." (Circle one on each line.)

		Never	Less Than Once A Month	At Least Once A Month	At Least Once A Week	Just About Daily
a.	Lecture	1	2	3	4	5
b.	Discussion	1	2	3	4	5
c.	Student reports	1	2	3	4	5
d.	Student projects	1	2	3	4	5
e.	Hands-on or laboratory work	1	2	3	4	5
f.	Cooperative learning	1	2	3	4	5
g.	Seat work from the textbook	1	2	3	4	5
h.	Inductive thinking activities	1	2	3	4	5
i.	Use of supplemental worksheets	1	2	3	4	5
j.	Tests or quizzes	1	2	3	4	5
k.	Simulations	1	2	3	4	5
l.	Role play	1	2	3	4	5
m.	Teacher demonstrations	1	2	3	4	5
n.	Field trips, excursions	1	2	3	4	5
o.	Inquiry	1	2	3	4	5
p.	Discovery	1	2	3	4	5
q.	Problem solving	1	2	3	4	5
r.	Programmed instruction	1	2	3	4	5
s.	Learning cycle approach	1	2	3	4	5
t.	Application to real life situations	1	2	3	4	5

4. Please indicate how **COMPUTERS** are used in this science class. For those that do not apply to your class, please circle 1, "Never" (Circle one on each line.)

		Never	Less Than Once A Month	At Least Once A Month	At Least Once A Week	Just About Daily
a.	Teacher demonstration	1	2	3	4	5
b.	Students writing programs	1	2	3	4	5
c.	Learning science content	1	2	3	4	5
d.	As a laboratory tool	1	2	3	4	5
e.	Drill and practice	1	2	3	4	5
f.	Using simulations	1	2	3	4	5
g.	Problem solving	1	2	3	4	5
h.	Games	1	2	3	4	5
i.	Testing and evaluation	1	2	3	4	5
j.	Interactive software	1	2	3	4	5
k.	Computerized databases	1	2	3	4	5
l.	Multi-media, CD-ROM	1	2	3	4	5
m.	Robotics	1	2	3	4	5
n.	Networks (CompuServe, etc.)	1	2	3	4	5

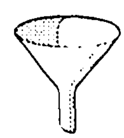
5. For the following **MATERIALS** and **RESOURCES** please indicate how often each is used in this science class. For those that do not apply to your class, circle 1, "Never. (Circle one on each line.)

		Never	Less Than Once A Month	At Least Once A Month	At Least Once A Week	Just About Daily
a.	Videos, filmstrips, etc.	1	2	3	4	5
b.	Records, compact discs, tapes	1	2	3	4	5
c.	Slides	1	2	3	4	5
d.	Overhead projectors	1	2	3	4	5
e.	Television or instructional TV	1	2	3	4	5
f.	Camcorder	1	2	3	4	5
g.	Living plants/animals	1	2	3	4	5
h.	Collections (rocks, etc.)	1	2	3	4	5
i.	Games and puzzles	1	2	3	4	5
j.	Lab supplies	1	2	3	4	5
k.	Telescopes, microscopes, or magnifying glasses	1	2	3	4	5
l.	Models	1	2	3	4	5
m.	Cameras	1	2	3	4	5
n.	Guest speakers	1	2	3	4	5
o.	Student workbooks	1	2	3	4	5
p.	Activity cards	1	2	3	4	5
q.	Laser discs	1	2	3	4	5

Part 3: Science Teacher Efficacy Beliefs Instrument

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree
A = Agree
UN = Uncertain
D = Disagree
SD = Strongly Disagree



1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA	A	UN	D	SD
2. I am continually finding better ways to teach science.	SA	A	UN	D	SD
3. Even when I try very hard, I don't teach science as well as I do most subjects.	SA	A	UN	D	SD
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA	A	UN	D	SD
5. I know the steps necessary to teach science concepts effectively.	SA	A	UN	D	SD
6. I am not very effective in monitoring science experiments.	SA	A	UN	D	SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	SA	A	UN	D	SD
8. I generally teach science ineffectively.	SA	A	UN	D	SD
9. The inadequacy of a student's science background can be overcome by good teaching.	SA	A	UN	D	SD
10. The low science achievement of some students cannot generally be blamed on their teachers.	SA	A	UN	D	SD

11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA	A	UN	D	SD
12. I understand science concepts well enough to be effective in teaching 7th- and 8th-grade science.	SA	A	UN	D	SD
13. Increased effort in science teaching produces little change in some student's science achievement.	SA	A	UN	D	SD
14. The teacher is generally responsible for the achievement of students in science.	SA	A	UN	D	SD
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA	A	UN	D	SD
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher	SA	A	UN	D	SD
17. I find it difficult to explain to students why science experiments work.	SA	A	UN	D	SD
18. I am typically able to answer students' science questions.	SA	A	UN	D	SD
19. I wonder if I have the necessary skill to teach science	SA	A	UN	D	SD
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA	A	UN	D	SD
21. Given a choice, I would not invite the principal to evaluate my science teaching.	SA	A	UN	D	SD
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA	A	UN	D	SD
23. When teaching science, I usually welcome student questions.	SA	A	UN	D	SD
24. I don't know what to do to turn students on to science.	SA	A	UN	D	SD
25. Even teachers with good science teaching abilities cannot help some kids learn science.	SA	A	UN	D	SD

Thank you for your participation!

Dear Teacher,

Now that you've finished that pile of report cards, I hope you will find the time to complete and return the Science Methods and Materials Survey I recently mailed to your attention. Your input is vital to this study. If your completed survey crossed paths in the postal system with this postcard, consider this card a thank-you note instead of a reminder!

Thanks for your participation,

Larry D. Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

Teaching and Learning Department
212 Bell Hall
School of Education
Andrews University
Berrien Springs, Michigan 49104-0100

Dear science teachers,

Much is being said about what science teaching should be, but who has provided a description of current junior high science education? Educators in administrative roles, college-level positions, and curriculum development sometimes have no idea what is going on in junior high science classrooms.

That's where you come in. Your teaching experience is a priceless source of information about *REAL* science teaching in America. Your responses to this survey will provide this valuable information.

I understand your time pressures. I, too, am a classroom teacher. But you responses are the only way we can provide a true picture of science teaching across the United States. Don't waste your opportunity to provide input to this study. Please make time in your already-full schedule to complete and return this survey form by Friday, February 17.

I sincerely appreciate your participation in this study.

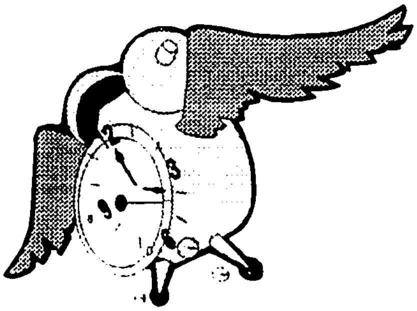
Larry D. Burton
Researcher/Science Teacher

P.S. If you don't teach 7-8 science, pass this survey on to someone in your building who does.

Dear Science Teacher,

I know you've been meaning to fill in and return that Science Methods and Materials Survey I recently mailed to your attention. Why not do it right now? I know your time is precious (I'm a classroom teacher too), but I really value your response.

If your completed survey and this reminder crossed in the mail, thank you for your participation!



Larry Burton
Teacher/Researcher

APPENDIX D

NON-RESPONDENT COMMENTARY

#051 postcard 1 returned by USPS marked "No such number"

#402 I do not teach science, I'm physical education

#417 I do not teach 7-8 science. I passed it on to the junior high teacher. (signed)

#168 no one at (school name) teaches 7-8.

#301 Dear Larry, I don't teach grades 7 - 8. I did pass the other on to another school.

#500 I don't teach science anymore.

#018 I am not interested. Get my name out of your file, please. (signed)

#525 I teach in a high school - grades 10-12, so I have no one to pass this on to. Sorry! (signed)

#492 *Not a 7th or 8th grade teacher - high school agriculture (survey completed but not included in data analysis.)

#029 Part 3, 10 & 25 = I assume "some" means very few?

General = I am high school, not middle school teacher. Thanks for the classification lesson! I'll share it with my department.

(Instrument completed but not included in data analysis.)

#007 General comments (on Marily DeWall's cover letter) respondent underlined the phrase "science teaching methods and materials" and commented = Too broad a scope?

On researcher's cover letter = I teach 10 & 11 grade chemistry at ____________ High School. Does it apply? (in reference to sample of 7th- and 8th grade teachers)

Respondent returned the survey uncompleted.

#035 Sorry, I do not teach 7th/8th grade science (Chemistry 10-12). I didn't know if you wanted me to pass it on!

#298 Written on researcher's cover letter = Although I am a 9-10 biology/11-12 advanced placement biology teacher I completed the survey. Best of luck to you. (Signed)

Part 1,5a = for the most part . . . a result of peer coaching in our district.
Part 3, 7 = motivation

#93 Yours was a middle school survey. I do not teach middle school. Sorry! (Signed)

#525 Since I teach high school (grades 10-12) I don't think responses from me would be of value. Sorry! (Signed)

#Someone in Massachusetts
Don't teach this level. Passed on survey!

#205 I do not teach science.

#260 Retired

APPENDIX E

RESPONDENT COMMENTARY AND CORRESPONDENCE

#173 Part 1, #5 Friendly
Part 2, #5g every day during unit??
Part 3 Questions - 1, 4,7,10,11,13,14, etc. can not be answered effectively as stated. There are other numerous factors to be considered.

#250 I am not teaching any junior high this year. My answers are for a lower level 9 & 10 grade physical science class.

#102 Part 2, #3j About every 2 weeks
Part 4 I have no access to computers!
Part 3, #6 depends upon the size of my class (I have one class of 11 and another of 32!)

#325 Part 3, #2 respondent struck out "finding" and wrote in "trying"

#264 Part 1, #5 Chose "a", but wrote in next to "c. teachers are isolated" = due to teaming

#339 Part 1, #3 subject-area specialist = 2 areas

#167 Part 1, #5 We try to cooperate in somewhat isolated conditions.
Part 2, #3a lecture just about daily for very short periods of time.

#214 Part 1, #3 c I move every period
Part 2, #4 I move every period and some rooms don't have a computer.

#042 Part 1, #3 self-contained afternoons, subject-area specialist mornings
Part 2, #4 Do not have (computers) in classroom. In the computer center -f-g, h-j are used!

#006 Part 1,#5 d. Some are cooperative, others competitive

#030 Part 1, #3 1/2 self-contained, 1/2 subject specialist
Part 2, #4 School unable to afford equipment
Part 2, #5, m-q
unable to afford

#134 Part 3, general comment
My question to you. I'd love a response, address or contact person to do away with inclusion! Now, why not

		address or direct me to an agency to show why inclusion (special ed kids in classrooms) is ruining science education? The inclusion students/coop learning are not learning because of sheer numbers and their handicaps!
#442	Part 1, #3	Circled b and c, comment by c = gifted/talented
	Part 2, #1	They are issued, but I seldom use the text
	#4	There is no computer in my class. I may share one of two multimedia computers with the entire staff of my school. The computer labs have classes that meet there - so I do not have access.
#148	Part 2, 4	Computers Not Applicable
#334	Part 1, #5	d. We are losing discipline
#258	Part 2, #4	Computers to be implemented soon!
#201	Part 2, #4	Computers not available except for Chapter I students and elective computer courses.
#305	Part 2, #3m	depends on unit
	Part 3, #9	depends on age
#309	Part 3, #7	If the whole class is underachieving I think it is the teaching.
	#9	If there is motivation and interest on the part of the student
#527	Post It note	I'd like to know the results if possible. (Followed by address)
#508	general comment	
		How many times did you repeat your questions?
#118	Part 1, #3c	Semi-self-contained
#519	Part 1, 3c	integrated, but not self-contained
#354	Part 1, 5c	with exceptions
#161	Part 2, 4	Our school dispersed computers to classrooms - only one computer per classroom - does not help!

#026	Part 3, 11	It can be . . .
#226	Part 1, 3c	A+B
	5d	Principal is isolated and unqualified
	Part 3, 21	See (question) 1-5
#427	Part 2, 4	We do not have computers in the classroom for the students to use. I have one that I keep my science programs on. I just got a CD-Rom for my computer and the students are learning how to use it occasionally.
#394	Part 2,4 a-d	old Apple IIe's
	e-n	newer IBM
		We are on a network but not much has been done - I have 1 station. Perhaps as I become more literate they will be used more.
	Part 3, 16	maybe
	21	He can come daily!

accompanying letter

You didn't ask for comments but I'm a poor survey taker - rarely do one of these choices really fit.

I agree that the teacher's ability, patience, effort, knowledge, is fundamental in teaching a child any subject. But so is love, caring, and dedication. And at that some students cannot be taught because they do not want to learn.

I can stand on my head, juggle and whistle - use the oldest trick in the book or newest innovation in computer science. Unless the child is wanting to learn they won't. Some of these will learn something thanks to me, in spite of their resolve! Some will begin to love me back and want to please me. But that is fragile and may not last.

Until we can understand all of our students' lives - we may never reach a kid!

And too - some of the poorest teachers I know had kids with the highest grades - if you don't care, they will cheat. Looks good in the average.

Some of the best teachers may not nave gotten the kids to excel now but some of my greatest success stories are the kids who come back later and say - you taught me to stick it out. I never did too well in your class but I learned - and now they are nurses or engineers and they credit the base you gave them.

Achievement has many measures - be careful of the which.

#032	Part 2, 4	don't have a computer in my room once a week children go to computer room
#353	Part 1, 5d	some cooperation
#371		I teach 9th grade biology in a high school.
#105	Part 2, 2b	(one semester course)
#342	Part 1, 3c	multi-grade 5-8 grade level
	Part 3, 11	depends
	17	some science experiments
#401	Part 1, 3c	multi-grade, 6,7,8 in one room
	5a	all 3 of us
	Part 2,2b	There is so much information, if you want to do any activities at all you will run out of time for the whole book.
	4l	CD-Rom - encyclopedia to look things up
	Part 3, 1	I'm always trying, it just doesn't always work.
	11	extra attentions given by anyone!
	14	Students at this level have to take some responsibility on themselves.
	15	(underlined "directly") = not entirely
	16	topic at the time
	17	when they work
	24	But I don't have the equipment. I have books.
	General part 3	
		This was hard. In the classroom, I see some students do better with more help from me, but some don't do better no matter what I try. I would need more space, equipment, and planning time to do more hands-on activities.

#516	Part 2, 4	There are no computers in any of the science rooms
#362	Part 3, 16	and methods
#341	Part 2, 4	None to use
#512	Part 1, 5d	A positive environment overall, but with components of all three you describe.
	Part 2, 3	g and i used in combination
	o and p	difference?
	q	different from induction?
	t	different from problem solving? Without knowing your definition of terms
	4	You should ask why - I don't use computers because we have one lab which has classes scheduled in it all day. I'm well-trained in using technology in the classroom however and would if I had the equipment available.
	Part 3, 1	definition of "does better"
	4	I don't like the wording - if you mean or imply that the grading system and standard remains unchanged then SD
	7	At my level (7th/8th grade) underachievement is most closely associated with lack of organization and study skills, which translates into incomplete assignments, day-dreaming in class, etc.
	11	same as #1 - only this time you qualified it!
	after question 11	"so who earned the grade?"
	23	always
	general	After completing this survey I feel as if my responses need clarification, as do some of your questions - if you would wish further information you may reach me evenings at home (number given) or through email (address given)
#055	Part 2, 4	not available
#171	Part 1, 3c	planetarium
#465	Part 2, 4	Note - This is the first year I have had a computer, and as yet, there has been no inservicing, nor software

purchases to make it much more than a dust-bunny shelter.

General comment at end of the survey

Much of the lack of science learning is due to inadequate supplies and materials (funding) and to overcrowded classrooms (funding).

#143	Part 1, 5d	cooperative but also competitive
#048	Part 1, 1	13 classroom and 12 years of administration = 25 total (researcher recorded 13)
	Part 3, 21	I find that a science supervisor provides better information for growth.
#453	Part 1, 3b	Science, social studies, sex education
	Part 2, 3r	What do you mean?
	Part 2, 4d	Our supplier went out of business
	4n	no phone line
#031	general	Larry, I have completed your survey, but it may be invalid due to the fact that it is based on 9th grade students. Hopefully it will be some help to you somewhere! (signed)
#176	Part 1, 3c	2 subjects
	5d	combination of a & b
#211	Part 2, 4	No computers at this time
#056	Part 1, 5d	This is hard. It is actually two answers. (Respondent marked both a and c.)
#191	Part 2, 4	Students use computers during their "free time".
	5o	sheets
#482	Part 1, 3c	partnership collaboration
#430	Part 2, 3n	1 per year
#125		Please be advised - I teach science to 5th graders in a middle school.
	Part 1, 3c	Team (Teach Language Arts, Math, Science)

#057 Part 2, 4m (everyday) for a two week project in class

#052 note enclosed
I wish your much luck and success!

#446 note enclosed
Mr. Burton,
I had trouble answering some questions about teaching science. So, here is my disclaimer . . .
I believe that appropriate curriculum taught by a motivated, enthusiastic teacher will involve 99% of students in science. Kids love science and we just have to cash in on this natural interest.

Thanks for <u>your</u> interest. (signature)

Part 1, 5 a or c depending on the teacher
Part 3, 7, (arrow pointing to underachieving)
poor curriculum! class size!

#507 Part 1, 4c Chemistry

#054 Part 2, 4n Accuweather

#208 Part 3, 8 Time, resources, and facilities

#363 Part 2, 4 Don't have computers

#181 Part 1, 3a students work independently, teacher is just there for the student when he/she needs help.

#349 Note change of address: (address given)
It took a while to be forwarded!

#390 general Sorry this is late! Have had some difficult situations.

#086 general Thanks for the free lesson <u>plan</u>!
Part 1, 5d Some teams are cooperative, while others are competitive. Teams are all isolated from each other.

#513 Part 3, stars by #10, 13, 14, 15, 20, 25

		"Teachers play a major role in the achievement of learning science, but it is critical that a student has parent support or failure is more likely to occur.
#255	Part 1, 3c	LA/SS/SCI Block classes
	5b	"a" in our block! We love it! (We are) working hard towards "a" (in the whole school).
#227	Part 2, e	We share books with 6th and 8th grades. We cover what chapters we are assigned.
	Part 2, 4m	Tech Ed
#217	Part 1, 3c	Special Ed Resource/Collaboration
#188	Part 1, 3c	We have interdisciplinary team teaching
	Part 4	We have a separate computer class where the teacher adapts his program to our subjects and topics.
#999	marked over the ID number, then wrote several other numbers around it and wrote "Take a guess"	
#142	Part 1, 1	23 years (6 part time)
	5	our competition is the "good" type
#099	Part 1, 3c	Social Studies, Science, Math
#318	Part 3, 12	I don't teach 8th
#275		"Sorry about the delay. I filled this out for the chemistry classes (senior high) and had to redo it. (signed)
#200	Part 2, 3g	Part of the time, 10 - 15 minutes max.
#345	Part 2, 4	I don't have a computer in my science lab.
#002	Part 1, 3c	3 subjects 6th, 2 subjects 7th.
#037	Part 1, 3c	Admin.
#441		"Sorry about the delay. We have a team coming to visit our school and we have been very busy."
#293	Part 1, 5d	poor morale

#532	Part 2, 3g	resource text
	4	We are just getting some computers!
	5i	circled "puzzles"
	Part 3, 2	I hope they are better!
	10	SD mostly!
	11	added to the end of the item "and parent"
	25	added to end of item "very few - but some!"
	Gave name and address at end of survey instrument.	
#241	Part 1, 3b	Language Arts and Science
#360		I'm sorry, but this tends to be a biased survey! With the insertion of some in the questions, I would doubt its validity. (signed)
#064	Part 2, 5g	N/A in earth science
#466		On cover letter "Good to hear from you. Great days at LBL! Best Wishes, (signed) (I think this was a case of mistaken identity)
	Part 2, 2	Earth Science - 1/2 of book in 8th, 1/2 of book in 9th Physical Science - 1/2 of book in 8th, 1/2 of book in 9th Prentice Hall editions
	3n	no time allowed (for field trips)
	Part 3, 6	In class lab of 40 students it's hard to find the "real" horseplay persons.
	7	Talking, disruptive behavior
	11	"or time" added after the word "attention in the survey item
	14	A if student cooperates, D if student doesn't care. (coded as UN)
	15	related to family values of WORK ETHIC
	20	"some" added after "achievement of" in survey item
#284		Teacher who responded was not the teacher on the mailing label. Respondent provided his name and address.
#348	Part 1, 3c	a - for the 6th grade b - 2 subjects 7-8
	5a	for the most part
# 127	Part 1, 5d	a - grade 8, b - grade 7, c - grade 6

#464	Attached note	
		Dear Larry, I have a very unique science teaching style. It's very "hands-on" and tied closely to the scientific research methods. You are welcome to observe or gather more info about it.
	Part 2, 3s	Don't know of it.
	5g	I teach physical science only.
#486	Part 2, 4	not available in this class
#501	Part 3, 3	NA
#139	Part 3, 3	N/A
#092	Part 3, 14	Basically it's 50/50 teacher/student
#132	Attached to instrument	
		Sorry this was delayed, it was routed to the wrong person.
#435	Part 1, 3c	Inclusion, vocational science

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

B

Dear B,

Thank you for your recent participation in my science education survey. I am greatly indebted to teachers like you across the nation for the success of my study. I hope it will be of some use to others besides me.

I was interested in the business card you inclosed in your reply. Do you have an informational brochure on the FAST program that you could mail to me. I am always interested in adding new 'tools' to my teaching 'toolbox'.

Once again, thank you for your participation.

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

L
K J H

Dear L,

I appreciated your recent response to my science education survey. I especially appreciated the note you enclosed qualifying your responses. While I did not indicate so on the survey instrument itself, I welcome comments from participants. I agree with you that some of the questions are difficult to answer as written.

I also agree with you that kids naturally love science and we have to find better ways cash in on that interest. I send my best wishes for continued success in your quest to turn students on to science. Keep up the good work!

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

M
P N E School

Dear M,

I want to thank you for your recent participation in my science education study. Thanks to cooperative science teachers like you I am nearing the completion of this phase of data collection.

I particularly was encouraged by the personal note you placed in your survey. Your wishes for my success were very welcome in the middle of a long, hard day. So now I want to return the favor. I send you best wishes for success. May you truly make a difference in your students' lives!

God bless you,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

K
FVJH

Dear K,

Thank you for your recent response to my science education survey. I am greatly indebted to teachers like you who took the time to supply me with valuable information.

I will gladly honor your request for knowledge of the results. I am hoping to conclude data collection by March 10. After that date I must do the final statistical analysis and preliminary writing. I hope to have a fairly good version of the results chapter of my dissertation by the end of March. I will be glad to send you a copy of that. I also have plans to publish my findings in various professional journals during the coming months.

Again, thank you for your participation and your interest.

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

E
B School

Dear E,

Thank you for your recent completion of my science education survey and for your note concerning your teaching level. I think I should be able to include your responses in my study given the fact that many "Junior High" schools in the US include grades seven through nine. I will have to clear that with my committee, but I do not foresee any problem.

Again, thank you very much for your willingness to respond to the survey.

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

E
B S School

Dear E,

I want to thank you for your recent response to my science education survey. I just discovered as I looked up your address on my mailing list that I had not marked off your name. That means I have been sending you follow-up material asking for your response, but you have already responded. Sorry for that mix-up.

I appreciated you taking the time to complete the survey <u>and</u> write the letter you included with the survey. You were right, I did not ask for comments, but I probably should have. I am glad some teachers sent their comments anyway. I am including all written comments (anonymously) in an appendix of my dissertation. Some comments, including a few of yours, will become part of the main text of the 'Results' chapter of my dissertation.

Again I thank you for your input - survey and letter. I wish you the best as you continue work with your students, and don't forget those success stories!

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

I
H J H School

Dear I,

I appreciated your recent response to my science education survey. I particularly found your written comments to be valuable. Thank you for your willingness to communicate further concerning my study. Unfortunately I do not have access to the Internet at the current time so I am sending this snail mail.

Your comment on asking "why" for computer use was much needed. I dropped the question about computer access because of space considerations. Now I wish I hadn't. This appears to be the one question with the most written-in comments. Many teachers do not have access to computers for use in teaching science.

Again, thank you for your willingness to respond. I hope in my next study on science education to actually visit teachers' classrooms to observe and converse with teachers personally. I think that would be a valuable source of information, too.

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

M
S C School

Dear M,

Thank you for your recent participation in my science education survey. I am greatly indebted to teachers like you for providing the valuable information about science teaching in your classrooms.

You asked at the end of the survey instrument, "How many times did you repeat your questions?" I, personally, repeated none. That is because I did not develop the instrument. I compiled the instrument used in my study from two separate instruments. The first two parts of my instrument, which collected demographic information and data on teaching techniques and materials, was taken from a national study of science education conducted by Iris Weiss of the Research Triangle Institute in North Carolina.

Dr. Weiss conducted two of these studies, one in 1977 and the other in 1985. Since the information requested was descriptive in nature, none of these items was repeated in the instrument. Weiss did establish reliability for her instrument through test/retest procedures.

The last section of my instrument was the Science Teachers Efficacy Beliefs Instrument developed by Iris Riggs of Cal State, San Bernadino. This scale includes 12 items which assess an individual teacher's belief in the ability of science teachers in general to affect student achievement. Thirteen items assessed the teacher's belief in their personal ability to increase student learning in science. Of these 25 items, some assess teacher responsibility for student success while others assess teacher responsibility for student failure.

I hope this adequately answers your question. I'm afraid I am not an expert in scale construction, which is why I used instruments already available.

Sincerely,

Larry Burton

Larry D. Burton
1200 Eagle Lake Drive #206
Slidell, Louisiana 70460
504-863-2732

February 11, 1995

D
A M School

Dear D,

Thank you for your recent participation in my science education survey. I appreciated your prompt return of the instrument and your comments about inclusion.

I personally know of no group officially opposing inclusion. As you well know, it is on the crest of the current educational wave. Therefore it is not popular to oppose it. I would think that perhaps someone from James Dobson's Focus on the Family group would be able to direct you to someone who is working to protect the rights of "average" students. I know his group promotes active parental involvement in education, and therefore I would think they would know someone who is opposed to inclusion.

You can reach Focus on the Family at

Focus on the Family
Colorado Springs, CO 80995

I hope this will be of help to you. Thanks again for your participation in my study.

Sincerely,

Larry Burton

APPENDIX F

DATA BASE

Column Numbers	Variable Name	Variable Code
1-3	Identification number	ID
5-6	years of teaching experience	YEARS
8	gender	GENDER
9	classroom type	CLASTYPE
11	qualification for teaching math	MATH
12	life sciences	LIFESCI
13	physical sciences	PHYSSCI
14	earth/space science	EARTHSCI
15	social studies	SOCSTU
16	reading, language arts	LANGART
18	school climate	CLIMATE
20	textbook use	TEXTBOOK
21	per cent of textbook used	AMTUSED
23	lecture	LECTURE
24	discussion	DISCUSS
25	student reports	REPORTS
26	student projects	PROJECTS
27	hands-on or laboratory work	LAB
29	cooperative learning	COOP
30	seat work from the textbook	Seat work
31	inductive thinking activities	INDUCTIV
32	use of supplemental worksheets	WORKSHET
33	tests or quizzes	TESTQUIZ
35	simulations	SIMULATE
36	role play	ROLEPLAY
37	teacher demonstrations	TDEMOS

Column numbers	Variable name	Variable code
38	field trips, excursions	TRIPS
39	inquiry	INQUIRY
41	discovery	DISCOVER
42	problem solving	PROBSOLV
43	programmed instruction	PROGRAMD
44	learning cycle approach	LEARNCYC
45	application to real-life situations	REALLIFE
47	teacher demonstration	COMPDEMO
48	students writing programs	COMPPROG
49	learning science content	CONTENT
50	as a laboratory tool	COMPLAB
52	drill and practice	DRILL
53	using simulations	COMSIMU
54	problem solving	COMPPROB
55	games	COMPGAME
56	testing and evaluation	COMPTEST
58	interactive software	INTERACT
59	computerized databases	DATABASE
60	multi-media, CD-ROM	MULTMEDI
61	robotics	ROBOTICS
62	networks (CompuServe, etc.)	NETWORKS
64	videos, filmstrips, etc.	VIDEO
65	records, compact discs, tapes	RECORDS
66	slides	SLIDES
67	overhead projectors	OVERHEAD

Column number	Variable name	Variable code
69	television or instructional TV	TV
70	Camcorder	CAMCORDR
71	living plants/animals	PLANTANI
72	collections (rocks, etc.)	COLLECT
74	games and puzzles	GAMES
75	lab supplies	LABSUPP
76	telescopes, microscopes, or magnifying glasses	SCOPES
77	models	MODELS
79	cameras	CAMERAS
80	guest speakers	SPEAKERS
81	student workbooks	WORKBOOK
82	activity cards	ACTCARDS
83	laser discs	LASERDSC
85	1 = science teaching outcome expectancies (stoe)	S1
86	2 = personal science teaching efficacy beliefs (psteb)	P1
87	3 = psteb	P2
88	4 = stoe	S2
89	5 = psteb	P3
91	6 = psteb	P4
92	7 = stoe	S3
93	8 = psteb	P5
94	9 = stoe	S4
95	10 = stoe	S5
97	11 = stoe	S6
98	12 = psteb	P6
99	13 = stoe	S7
100	14 = stoe	S8

Column number	Variable name	Variable code
101	15 = stoe	S9
103	16 = stoe	S10
104	17 = psteb	P7
105	18 = psteb	P8
106	19 = psteb	P9
107	20 = stoe	S11
109	21 = psteb	P10
110	22 = psteb	P11
111	23 = psteb	P12
112	24 = psteb	P13
113	25 = stoe	S12

359	18	12	313111	1	13	44424	54333	11413	[illegible]	1112	11111	11111	3113	1111	1512	11411	34544	44443	44444	44444	54442	34	[illegible]	12	54	44
256	13	11	233311	1	13	55124	44344	31411	23112	1111	11113	11111	2112	1123	2432	11113	54534	44444	41233	44444	44432	32	8	16	49	42
405	12	12	333323	1	13	34235	43333	21214	34334	1111	11111	11111	3113	2112	1521	12111	45545	24532	45424	55553	45542	41	8	13	60	41
388	16	12	331111	1	14	55323	34443	44422	24214	1121	12111	11111	3112	2132	1333	11111	34433	23441	33233	44442	44522	40	10	16	47	33
173	14	12	333221	1	13	20034	43433	22324	34224	1111	11111	11111	3213	2255	1423	12311	34434	43442	34333	34444	44423	38	8	22	50	37
138	13	12	232212	1	14	54334	44444	33425	44214	1311	11111	11111	2224	2144	3443	12411	35525	51542	45542	45554	55554	45	10	21	65	39
165	18	12	233312	3	12	54325	44444	22423	44223	3444	23313	32311	4115	3233	1544	12411	35544	42444	45222	44442	44442	41	21	22	55	35
265	18	22	233321	3	15	45223	25444	11323	33113	2122	22221	11111	3313	2233	1322	22421	34434	42442	34232	32443	44444	33	11	17	50	34
[illegible]	[illegible]	12	122312	1	12	45334	43133	22323	33134	1134	12111	31511	3425	3112	1324	12314	34534	22442	25444	44154	54542	39	14	14	55	38
[illegible]	[illegible]	22	223211	3	13	45234	34433	11322	23234	2333	23322	32411	3225	3214	1433	21222	24424	42442	44222	24542	54542	37	14	19	55	28
[illegible]	[illegible]	12	123232	3	13	55334	44444	11213	41313	1112	11111	11111	3113	1112	1311	11111	34544	24543	34233	34442	44442	36	[illegible]	10	52	35
221	14	13	233112	3	12	34234	42443	33514	45455	1111	11111	11111	2211	2123	3411	11111	44123	42542	44222	34434	55541	49	8	15	50	32
533	17	22	222222	1	13	55223	35344	33423	[illegible]	1111	11111	11111	3203	3122	2333	12411	24434	22522	35242	34444	44541	37	8	15	53	36
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417	[illegible]	22	232311	1	13	44224	44444	43423	44224	1133	33311	31111	3134	3133	1433	12211	35545	42542	35244	44452	34443	44	16	18	57	37
47	[illegible]	12	132211	1	14	55344	52434	32425	45125	1111	11111	11111	4112	3144	3544	1121	55555	55554	55455	54554	55553	50	8	23	64	55
[illegible]	[illegible]	22	232131	1	12	44114	34444	21314	44313	1111	11111	11111	2111	2122	3333	11111	34544	44532	35244	44453	54442	36	8	15	57	37
236	1	12	233312	1	14	34444	51443	33311	14314	1112	12112	11113	4215	4142	1333	11121	45434	43442	44233	44444	54432	39	12	18	53	38
325	[illegible]	21	221233	1	12	44323	[illegible]	11221	[illegible]	1111	[illegible]	11111	3111	3131	2212	11111	24122	44244	44244	44121	44422	[illegible]	8	11	41	40
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

148	65	12	333312	1	14	14224	24233	23325	64114				3111	0133	3333	22411	44545	53532	45224	35554	35553	35		18	62	38
392	24	22	231211	3	13	34224	34444	21323	33313	1111	11121	11211	4313	1133	3433	11112	44444	44442	44243	44444	44433	35	8	18	51	42
334	21	22	132311	4	20	55113	11134	11312	24112	2122	13311	11113	3112	1113	1422	11112	44535	53542	45444	45154	55554	24	15	14	60	44
319	06	12	232212	1	12	44223	35423	22211	33333	1221	11112	11111	2121	2121	1234	11111	24544	41532	44244	44444	44541	34	9	14	55	35
316	16	22	233211	1	14	55223	34243	12322	23113	2222	11111	11111	4213	2122	2322	12112	34544	52542	35222	44454	45542	31	10	13	59	34
244	27	21	133211	1	20	44225	44443	31324	45444	1122	11211	12111	3133	2131	2443	12321	44644	42442	44244	44444	44442	46	11	17	48	40
258	25	21	332333	1	14	45333	34444	33324	44164	1111	11111	11111	3123	3233	2332	12411	43433	23443	44344	44444	44442	42	8	17	48	42
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121	18	12	333312	1	14	55223	44424	21324	43135	1111	12221	21111	3111	1112	1333	11414	45545	55544	45224	44454	5555[illegible]	42	12	14	63	43
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221	15	12	232322	1	14	55334	54544	32424	55125	1111	11111	11111	4343	5355	4544	33414	45544	42542	44344	44554	54552	50	8	29	60	41
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[illegible]	[illegible]	12	233332	3	[illegible]	25225	51642	42425	[illegible]	2222	21121	11111	2124	1211	4534	43131	45555	43541	54245	54456	55551	44	16	20	61	37
[illegible]	[illegible]	12	332311	3	11	43125	22554	41224	45413	1241	13323	41111	3124	1131	2443	11111	25534	42524	45222	24454	55542	40	14	17	66	31
[illegible]	15	12	232323	1	13	55334	52532	43323	[illegible]	2534	[illegible]	31311	3424	3134	4544	[illegible]	45544	43532	35443	34444	44443	48	20	23	56	35
115	4	13	322232	1	13	44321	41354	12424	24345	4451	44443	21311	4224	2145	2114	12141	25354	32521	45222	24245	55531	38	18	17	53	30
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145	16	12	233222	1	14	45334	32544	44424	45445	1122	22234	22111	3224	1111	4433	12322	44545	44542	45444	45454	44544	50	13	14	59	46
[illegible]	[illegible]	12	222311	1	14	45224	43343	22212	34423	1111	11111	11111	3314	1122	4443	12213	44434	32443	35433	34544	44533	36	8	17	53	39
354	[illegible]	22	334432	3	14	55233	24443	41423	12114	1111	11111	11111	3111	2122	3411	11114	24524	42524	25432	35553	13541	35	8	12	55	30
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91	[illegible]	12	234211	3	13	45223	34353	11324	24113	1111	11111	11111	3315	2221	4322	12111	24533	13424	35443	44442	44541	33	8	13	51	35
[illegible]	[illegible]	12	233312	1	14	44444	34533	52424	44444	1111	11111	11111	4224	2222	4443	22222	45545	54542	45444	45553	55553	51	8	14	65	44
24	24	22	232322	1	15	45224	44443	33424	44444	4444	34443	32211	2223	4234	4444	12432	45544	44442	45244	44444	44444	45	20	21	55	44
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[illegible]	4	12	233211	1	12	34435	33443	52424	44225	2411	12111	22212	3224	3242	4533	22221	44545	52531	45322	25152	55552	45	14	19	60	31
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[illegible]	[illegible]	22	232312	3	14	25223	31444	44534	44335	2222	13221	22511	2115	1355	2344	11114	44544	42542	44233	44443	54542	48	15	24	56	36
83	[illegible]	22	223311	1	15	55444	44443	22313	[illegible]	1111	11111	11111	2211	2112	1424	11512	45545	52543	55555	55555	55551	39	8	16	65	49
427	17	12	122331	1	13	44324	44434	33422	24454	1111	11111	11211	2114	3113	4433	13312	55525	51542	44244	55454	55444	41	8	16	61	41
14	41	22	233311	1	13	15225	44433	41435	54215	2131	23322	42211	3122	2212	2422	22114	44535	51542	35223	45552	54542	47	15	16	62	32
235	24	22	131111	1	13	55214	11334	11414	35111	1111	11111	11111	4135	1111	1444	11411	44344	53533	34443	35453	54443	29	8	15	56	38
14	26	12	232223	1	12	25224	52444	33325	55344	1122	12211	11111	4125	2141	1131	11112	44433	51533	44423	44444	34442	51	11	15	52	36
72	31	22	334411	1	15	55115	51554	11414	44133	1111	11111	11111	2125	1214	2522	11411	45555	51543	55554	35555	55555	42	8	17	65	49
334	24	12	134422	1	14	55224	34443	22325	44444	2123	22222	22222	1112	1133	4344	12431	45525	51522	45222	45155	55542	43	16	18	60	26
376	18	22	222411	1	12	45434	44434	33423	[illegible]	1111	11111	11111	4425	4124	[illegible]	12311	45544	42441	45244	44444	24441	44	8	16	53	38
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448	[illegible]	22	213213	1	13	45224	33333	24423	34113	4144	33422	11111	4113	3323	4433	12211	45443	44442	44244	44434	43532	38	15	19	50	41
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462	[illegible]	22	221212	1	14	55233	45214	21422	[illegible]	1111	11111	11111	4112	1241	2422	21111	45444	42432	44433	44443	44542	31	8	12	54	35
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[illegible]	[illegible]	22	234211	2	14	55222	13233	22411	22124	1211	11112	11111	4411	1124	2424	11224	14424	42542	45134	45152	34551	29	8	18	53	34
[illegible]	[illegible]	22	222211	1	20	44235	42344	11411	44124	1212	11111	11111	2414	1121	2211	11111	14444	44444	44234	44444	45433	33	10	9	52	42
[illegible]	2	12	224212	1	13	45224	33443	11424	[illegible]	1211	11111	11111	4213	1152	2444	11111	44424	24522	45234	45444	44544	34	8	17	56	41
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371	13	12	132111	1	11	55334	34254	21223	11111	1112	12111	11311	4122	1124	4443	11111	34535	32541	15333	25552	55532	29	16	19	60	29
[illegible]	16	22	313211	1	12	54113	11154	11411	13113	1111	11111	11111	1113	1111	1313	11111	45525	51533	25134	35551	55531	22	8	11	63	28
[illegible]	22	22	130011	3	12	45245	44444	42423	34144	2222	22221	31131	2123	2133	1433	11112	44444	44242	44443	34443	44442	48	16	16	58	41
319	23	22	131211	1	12	54133	35554	22215	44114	1111	11111	11111	3215	1123	1223	[illegible]	24524	51542	25144	45554	55541	41	8	14	62	31
335	15	22	232311	1	13	44224	44443	41423	34224	2121	22211	21211	3111	3133	1323	11111	45544	53532	45544	45455	55454	41	11	16	62	46
362	12	22	232311	1	14	44224	34243	31322	33315	3133	33233	31311	3112	2122	2222	11214	34534	33542	25333	34453	44522	35	15	12	54	34
342	[illegible]	13	211122	2	13	15115	55213	11322	22133	1211	11121	11211	2111	1123	1532	12522	42121	12332	32123	12422	13321	34	9	17	27	26
[illegible]	[illegible]	13	321233	1	12	45223	45343	11211	13113	1111	11221	11211	1111	1122	[illegible]	11111	21142	24452	44222	24442	14251	[illegible]	9	13	38	[illegible]
[illegible]	[illegible]	22	232211	1	13	55323	44444	32422	34345	1111	11111	11111	3221	3132	2334	11311	44444	44442	34444	34444	44541	43	8	16	53	44
285	15	22	233323	1	2	15344	31344	11333	43134	2412	11114	11111	1111	1143	1441	11111	44534	51542	35433	45454	55453	41	11	18	61	38
[illegible]	[illegible]	22	133211	1	[illegible]	[illegible]	34243	11412	13113	2121	11111	12111	3112	1112	2422	12111	43544	42542	45423	44554	44542	[illegible]	[illegible]	12	57	[illegible]
516	3	12	232231	3	11	24335	52543	33423	45244	1111	11111	11111	3111	1151	3334	31111	55454	52554	44445	44445	45542	51	8	23	57	49
313	4	12	232122	2	11	45225	43412	11413	43315	1221	12121	12211	3115	2111	3332	11111	45544	42442	45423	44455	54542	33	11	14	58	39
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[illegible]	22	22	233321	1	14	45224	42433	[illegible]	34214	[illegible]	11111	11211	2224	2233	[illegible]	[illegible]	54544	52544	45254	55555	55544	41	11	[illegible]	62	48
[illegible]	[illegible]	12	122211	1	2	14224	41343	21322	33422	1111	11111	11111	3113	1122	2222	11111	45544	42232	44444	43212	44443	34	8	12	49	[illegible]
[illegible]	[illegible]	22	[illegible]	1	[illegible]	[illegible]	[illegible]	1112	[illegible]	[illegible]	[illegible]	11111	3112	[illegible]	[illegible]	[illegible]	45545	52542	45212	[illegible]	[illegible]	[illegible]	12	11	65	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	11411	44434	[illegible]	34225	[illegible]	[illegible]	41	8	18	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	14455	11411	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	34	8	17	63	45
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45244	[illegible]	[illegible]	48	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	233311	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44544	[illegible]	45511	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	44444	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	1111	[illegible]	1111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44544	[illegible]	44244	[illegible]	[illegible]	[illegible]	8	15	[illegible]	41
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	45112	13112	43444	[illegible]	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	111	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44	[illegible]	14	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44444	44444	[illegible]	11	[illegible]	54	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	11111	[illegible]	[illegible]	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45244	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	[illegible]	[illegible]	1111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	14	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44444	44444	[illegible]	[illegible]	12	[illegible]	41
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	44444	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	1111	[illegible]	11141	[illegible]	[illegible]	45223	[illegible]	[illegible]	38	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	44444	[illegible]	[illegible]	[illegible]	[illegible]	41	[illegible]	11	[illegible]	38
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54244	44444	[illegible]	[illegible]	11	13	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11111	11111	[illegible]	1111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	1	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4325	[illegible]	[illegible]	[illegible]	[illegible]	44234	[illegible]	[illegible]	44444	[illegible]	11	18	[illegible]	42
381	23	22	132321	1	13	45333	34443	33423	33223	4141	14315	13411	3223	3212	3322	22124	44544	42543	45444	45454	44544	40	15	14	58	45
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125	21	[illegible]	222233	1	13	55334	44444	22423	33113	2122	[illegible]	22211	4414	4155	1554	[illegible]	44444	53522	47443	25453	55555	33	13	26	59	41
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236	25	12	[illegible]	3	14	55334	54444	33424	55335	[illegible]	11111	11111	4423	4245	3445	[illegible]	[illegible]	22542	45343	44444	34554	51	[illegible]	25	64	40
[illegible]	[illegible]	[illegible]	[illegible]	1	13	[illegible]	42453	21125	[illegible]	2121	[illegible]	21211	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	53542	35434	44552	55542	42	11	18	63	38
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[illegible]	[illegible]	12	[illegible]	1	13	55235	54444	[illegible]	24224	[illegible]	[illegible]	11111	4435	[illegible]	[illegible]	[illegible]	[illegible]	54542	45244	44442	44442	46	13	27	58	39
[illegible]	[illegible]	[illegible]	232233	1	14	54322	[illegible]	2232	23114	[illegible]	[illegible]	22411	4212	2223	[illegible]	32411	55444	44442	44244	44444	44442	[illegible]	18	17	53	43
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[illegible]	[illegible]	12	232311	1	23	45334	44544	33425	45655	2322	22221	11111	3115	3233	3433	22131	44444	42443	45445	44444	44444	53	13	20	53	46
[illegible]	15	[illegible]	222211	2	20	54324	44444	33523	45445	5453	33544	33333	2214	5143	[illegible]	[illegible]	[illegible]	42424	24444	44444	44442	47	27	16	48	39
[illegible]	3	12	[illegible]	3	[illegible]	34444	44443	11414	[illegible]	1111	11111	11111	2114	1122	3433	[illegible]	[illegible]	42242	44244	34443	44432	38	08	16	49	[illegible]
[illegible]	[illegible]	12	232233	1	14	[illegible]	45444	[illegible]	[illegible]	[illegible]	11121	21111	2235	1145	[illegible]	12311	[illegible]	42541	45222	45551	55541	43	11	23	[illegible]	[illegible]
416	[illegible]	12	111212	1	[illegible]	55333	35354	21311	[illegible]	1111	11111	11111	4111	3112	[illegible]	11111	[illegible]	21531	34442	34444	44542	34	08	14	[illegible]	[illegible]
345	[illegible]	12	133222	3	12	45225	44443	11314	54154	1111	11111	11111	[illegible]	[illegible]	[illegible]	[illegible]	45444	42434	34444	34444	44443	45	08	16	[illegible]	42

129	18	22	131111	1	12	43324	34343	22333	32223	1111	11111	11111	3225	3236	2444	12111	44544	42444	34243	44454	54544	35	8	24	55	41
348	18	23	322222	1	14	44334	32232	11323	34104	1111	13121	11111	3213	2252	2342	12112	45434	43444	34243	44434	33542	34	10	19	51	40
100	13	22	232222	1	13	44334	44444	33423	34544	1111	11111	11111	3224	2153	2433	22221	44444	43442	44234	44444	44442	41	8	21	52	40
127	24	22	233321	4	20	45234	44444	11314	44443	3333	23332	31121	3114	1112	2424	21111	44044	42532	34344	44442	55452	42	19	16	52	37
343	34	21	233222	1	14	44234	55322	11223	44105	3222	22231	11212	2211	2122	1331	11111	42434	43444	44444	44444	44444	39	13	13	50	46
196	19	22	333331	1	20	15434	54544	41424	44455	1111	11111	11111	4223	4243	4443	32411	44444	43443	44244	44444	44442	51	8	23	52	42
464	18	21	233211	1	13	24224	41434	23525	54103	3113	12211	21111	2213	2111	2534	21111	24524	43442	45444	45444	44542	39	13	17	56	39
486	17	12	233322	1	23	55525	52522	52415	55125	1111	11111	11111	2115	2115	1545	11111	44535	53543	45234	45553	55553	52	8	22	64	40
498	2	22	232212	1	2	53222	24344	32213	23332	1444	41443	41311	4122	1133	4332	13324	44544	43532	44444	44445	44455	31	10	16	55	46
231	3	22	233311	1	12	35215	52332	31315	55214	1111	11111	11111	4314	2211	2413	11113	55451	44244	44433	54444	14544	41	8	13	43	49
164	2	12	132211	1	13	44334	42444	33424	24114	1111	11111	11111	3424	3133	4444	12114	24534	52533	25422	45445	44444	42	8	20	57	36
531	19	22	333322	1	12	35224	23343	32323	33103	1111	11111	11211	4122	2122	1333	23111	44544	43442	34233	45442	44433	35	8	16	48	37
399	3	22	233311	1	12	44224	44343	13315	44234	2111	11111	21111	2112	2233	4444	11111	23343	42442	25412	24341	44432	42	9	20	48	28
159	1	12	132111	1	11	55334	53443	12324	44 14	1222	21221	22212	3114	2112	3521	12521	25343	42422	24222	34444	44442	42	12	16	48	29
134	2	12	232212	1	2	35323	32343	22123	33214	2221	12111	11311	2213	2221	2222	12211	44444	42533	44244	44444	55444	36	1	12	55	41

APPENDIX G

CHI-SQUARE TABLES

TABLE 28

LEVEL OF USE OF CONSTRUCTIVIST METHODS BY GENDER

Method	*Rarely or never*	*Monthly*	*Weekly*	x^2
Projects				7.0*
Female	58(42)	59(43)	20(15)	
Male	85(58)	44(30)	18(12)	
Lab work				5.3
Female	8(6)	26(19)	103(75)	
Male	9(6)	45(31)	93(63)	
Cooperative learning				11.2**
Female	14(10)	25(18)	98(72)	
Male	28(19)	42(29)	77(52)	
Inductive thinking				1.1
Female	15(11)	31(23)	91(66)	
Male	22(15)	34(23)	91(62)	
Simulations				0.4
Female	72(53)	41(30)	24(18)	
Male	75(51)	49(33)	23(16)	
Role play				1.3
Female	100(73)	30(22)	7(5)	
Male	113(77)	30(20)	4(3)	

Table 28 -- Continued

Method	Rarely or never	Monthly	Weekly	x^2
Inquiry				3.5
Female	38(28)	39(28)	60(44)	
Male	40(27)	56(38)	51(35)	
Discovery				4.2
Female	38(28)	33(24)	66(48)	
Male	39(27)	51(35)	57(39)	
Problem solving				2.4
Female	15(11)	30(22)	92(67)	
Male	18(12)	43(29)	86(59)	
Learning cycle				1.6
Female	82(60)	28(20)	27(20)	
Male	98(67)	23(16)	26(18)	
Real-life application				0.3
Female	12(9)	34(25)	91(66)	
Male	11(7)	34(23)	102(69)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2, N = 284.
*$p < .05$. **$p < .01$.

TABLE 29

LEVEL OF USE OF CONSTRUCTIVIST COMPUTER PRACTICES BY GENDER

Practice	*Rarely or never*	*Monthly*	*Weekly*	x^2
Computer programming				3.9
Female	113(84)	11(8)	11(8)	
Male	124(84)	18(12)	5(3)	
Computer as lab tool				1.7
Female	117(87)	14(10)	4(3)	
Male	119(81)	22(15)	6(4)	
Problem solving on the computer				2.7
Female	118(87)	11(8)	6(4)	
Male	119(81)	15(10)	13(9)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2, N = 282.

TABLE 30

LEVEL OF USE OF CONSTRUCTIVIST MATERIALS BY GENDER

Material	*Rarely or never*	*Monthly*	*Weekly*	x^2
Camcorder				0.4
Female	128(93)	9(7)	na	
Male	140(95)	7(5)	na	
Plants/Animals				2.3
Female	82(60)	29(21)	26(19)	
Male	87(59)	40(27)	20(14)	
Collections				2.5
Female	67(49)	41(30)	29(21)	
Male	71(48)	54(37)	22(15)	
Lab supplies				7.8*
Female	15(11)	28(20)	94(69)	
Male	25(17)	45(31)	77(52)	
Scopes				19.0**
Female	33(24)	58(42)	46(34)	
Male	64(44)	62(42)	21(14)	
Models				6.5*
Female	41(30)	52(38)	44(32)	
Male	55(37)	64(44)	28(19)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2, N = 284.
*$p < .05$ **$p < .0001$

TABLE 31

LEVEL OF USE OF ABSORPTION METHODS BY GENDER

Method	Rarely or never	Monthly	Weekly	x^2
Lecture				1.4
Female	19(14)	23(17)	95(69)	
Male	19(13)	18(12)	110(75)	
Reports				8.8*
Female	66(48)	55(40)	16(12)	
Male	95(65)	36(24)	16(11)	
Seat work from the textbook				7.4*
Female	35(26)	33(24)	69(50)	
Male	37(25)	18(12)	92(63)	
Worksheets				3.3
Female	19(14)	33(24)	85(62)	
Male	11(7)	34(23)	102(69)	
Tests and quizzes				9.2*
Female	15(11)	63(46)	59(43)	
Male	4(3)	63(43)	80(54)	
Teacher demonstrations				5.2
Female	22(16)	55(40)	60(44)	
Male	11(7)	62(42)	74(50)	
Programmed instruction				1.0
Female	84(61)	32(23)	21(15)	
Male	90(61)	29(20)	28(19)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2, N = 284.
*$p < .05$

TABLE 32

LEVEL OF USE OF ABSORPTION COMPUTER PRACTICES BY GENDER

Practice	*Rarely or never*	*Monthly*	*Weekly*	x^2
Computer demonstrations				7.8*
Female	123(91)	9(7)	3(2)	
Male	118(80)	16(11)	13(9)	
Learning content on a computer				0.3
Female	106(79)	23(17)	6(4)	
Male	117(80)	22(15)	8(5)	
Computer games				5.7
Female	119(88)	5(4)	11(8)	
Male	132(90)	11(7)	4(3)	
Computer tests or quizzes				3.7
Female	121(90)	11(8)	3(2)	
Male	128(87)	9(6)	10(7)	
Multi-media, CD-ROM				1.0
Female	113(84)	13(10)	9(7)	
Male	129(88)	10(7)	8(5)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2, N = 282.
*$p < .05$

TABLE 33

LEVEL OF USE OF ABSORPTION MATERIALS BY GENDER

Material	*Rarely or never*	*Monthly*	*Weekly*	x^2
Video, films, filmstrips				0.2
Female	44(32)	67(49)	26(19)	
Male	44(30)	75(51)	28(19)	
Records, compact discs, tapes				2.0
Female	106(77)	19(14)	12(9)	
Male	121(82)	19(13)	7(5)	
Overhead projectors				4.6
Female	38(28)	24(18)	75(55)	
Male	50(34)	35(24)	62(42)	
Television				1.3
Female	88(64)	34(25)	15(11)	
Male	85(58)	42(29)	20(14)	
Games				3.5
Female	62(45)	63(46)	12(9)	
Male	82(56)	52(35)	13(9)	
Workbooks				0.2
Female	94(69)	19(14)	24(18)	
Male	99(67	19(13)	29(20)	

TABLE 33 -- Continued

Material	*Rarely or Never*	*Monthly*	*Weekly*	
Activity cards				1.3
Female	115(84)	16(12)	6(4)	
Male	130(88)	13(9)	4(3)	
Laser discs				1.7
Female	110(80)	12(9)	15(11)	
Male	116(79)	19(13)	12(8)	

Note. Numbers represent cell n, numbers in parentheses represent cell percentages, df = 2, N = 284.

TABLE 34

CELL MEMBERSHIP AND CELL PROPORTIONS FOR VARIABLES
WITH FEWER THAN 5 EXPECTED FREQUENCIES
IN MORE THAN 20% OF CELLS

Instructional practice	*Rarely or never*	*Monthly*	*Weekly*
Discussion			
Female	3(2)	5(4)	129(94)
Male	1(1)	7(5)	139(95)
Field trips, excursions			
Female	129(94)	7(5)	1(1)
Male	131(89)	15(10)	1(1)
Computer simulations			
Female	119(88)	11(8)	5(4)
Male	121(82)	22(15)	4(3)
Interactive software			
Female	117(87)	13(10)	5(4)
Male	125(85)	19(13)	3(2)
Computer databases			
Female	128(95)	5(4)	2(1)
Male	135(92)	8(5)	4(3)
Robotics			
Female	131(97)	2(1)	2(1)
Male	144(98)	3(2)	0(0)

Table 34--Continued

Method	*Rarely or never*	*Monthly*	*Weekly*
Computer networks			
Female	127(94)	5(4)	3(2)
Male	139(95)	6(4)	2(1)
Cameras			
Female	119(87)	13(9)	5(4)
Male	139(95)	7(5)	1(1)
Computer drill and practice			
Female	125(91)	7(5)	3(2)
Male	130(88)	12(8)	5(3)
Slides			
Female	127(93)	7(5)	3(2)
Male	131(89)	14(10)	2(1)
Speakers			
Female	123(90)	12(9)	2(1)
Male	139(95)	7(5)	1(1)

Note. Numbers represent cell n, numbers in parentheses represent cell percentages; df = 2. N = 284.

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VITA

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PLACE OF BIRTH: Malvern, Arkansas

EDUCATION

1995	Doctor of Philosophy Curriculum & Instruction Andrews University, Berrien Springs, MI
1992	Master of Education Elementary Education, emphasis in English Southwestern Adventist College, Keene, TX
1982	Bachelor of Science Elementary Education and General Science Andrews University, Berrien Springs, MI

TEACHING EXPERIENCE

1993 - 1995	Teacher/Administrator, Slidell SDA Education Center, Slidell, LA
1992 - 1993	Special Contract Teacher, Andrews University Lab School Ruth Murdoch Elementary, Berrien Springs, MI
1989 - 1992	Teacher/Administrator, Ewing Adventist Junior Academy Bonnerdale, AR
1985 - 1989	Teacher/Administrator, Beacon Hill Junior Academy, DeQueen, AR
1982 - 1985	Teacher/Administrator, Zanesville SDA School, Zanesville, OH

CURRICULUM PRODUCTS

Models of Teaching - Science, a book of 24 science lessons

Whole Language Activities to Use With Any Piece of Literature

Teaching With Twain: The Prince and the Pauper, an interdisciplinary literature unit

Life in the Middle Ages, a thematic unit integrating all curriculum areas for grades 5 and 6

PUBLICATIONS AND PRESENTATIONS

"Bringing Powerful Teaching to the Small School", *The Journal of Adventist Education*, Volume 57, Number 2, December 1994/January 1995.

"Curriculum and Teaching in Adventist Elementary and Secondary Schools: The Fourth Biennial Poll of NAD Educators", Paul S. Brantley and Larry Burton, *The Journal of Adventist Education*, Volume 56, Number 5, Summer 1994.

"Models of Teaching in a Small School", *The Synergist*, Volume 1, Number 1, Fall 1993.

'Introduction to Cooperative Learning", Staff Development Session, Slidell SDA Christian Education Center, Slidell, LA, September, 1994.

"Using the Question Matrix in a Cooperative Classroom", Staff Development Session, Jones Creek Adventist Academy, Baton Rouge, LA, November 1993.

"Practical Techniques for Implementing Cooperative Learning", Arkansas-Louisiana SDA Teachers' Convention, Camp Yorktown Bay, AR, October, 1993.

"The Use of Curriculum Materials in Documentary Research", Documentary Research Class, Andrews University, Spring 1993.

TEACHING CERTIFICATES

Seventh-day Adventist Administrator's Certificate
Endorsement: Supervisor of Instruction

Seventh-day Adventist Professional Teacher's Certificate
Endorsements: Elementary
Junior Academy: Bible, General Science, Social Studies
Secondary: English

Michigan Provisional Teacher's Certificate
Endorsements: K-8 All Subjects
9 General Science

PROFESSIONAL AND HONORARY MEMBERSHIPS

Association for Supervision and Curriculum Development
National Science Teachers Association
Pi Lambda Theta, past president, Gamma Omega Chapter
Phi Kappa Phi