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THE EFFECT OF SCIENCE INSERVICE PROGRAMS
ON THE SELF EFFICACY BELIEF OF
ELEMENTARY SCHOOL TEACHERS

by

P.A. Mocre

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Education

University of San Diego

1990

Dissertation Committee

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ABSTRACT OF THE DISSERTATION

The Effect of Science Inservice Programs on the Self Efficacy Belief of Elementary School Teachers

The Problem: Science education at the elementary level has not been successful. As a nation we are producing fewer and fewer scientists and science teachers, as evidenced by the narrowing of the pipeline of students entering science classes in high school and beyond. Since a student's interest in science begins at the elementary level, any improvement in science education in these grades will help ameliorate the trend toward science illiteracy. Such an improvement rests on three critical areas: the teacher, the curriculum, and the methodology. Since preservice programs do not include rigorous science requirements, it is necessary to supplement teacher training with inservice programs addressing all three areas. What a teacher knows and believes has the most influence on what is taught in the classroom; hence the more the teacher's content and belief system are augmented, the greater the teacher's self efficacy. This research questioned the effectiveness of inservice programs on efficacy, and examined correlations of other variables such as gender, years teaching, and grade level taught. Subjective questions investigated qualities of inservice programs and what would facilitate greater involvement.

The Research: This study included three groups of teachers: a treatment group involved in an intensive science inservice program and two control groups. Data from a science efficacy belief instrument and a demographic questionnaire were analyzed using a variety of

statistical measures: central tendency, chi square, and analysis of variance.

The Results: The self efficacy of the elementary teachers involved in the intensive inservice program was significantly higher than that of the two control groups. In addition, these teachers taught more science and taught using different methods than the other two groups. They were also more active in sharing science information with their colleagues. Teachers agreed that the best inservice programs were relevant to their needs and that more flexible scheduling would increase teacher participation. For the group involved in this study, the science inservice program enhanced the teachers, the curriculum, and the methodology for the improvement of elementary science education

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CHAPTER ONE

Statement of the Issue

Introduction

The call for scientific literacy for all Americans is compelling. National defense has rested on our ability to create and maintain weapons systems for national security. Economic advancement has been spurred by American inventions in technology which are currently being usurped by Japanese entrepreneurs. Democracy itself is at stake unless citizens have the scientific literacy to vote intelligently on quality of life issues. "The ability to function adequately in a scientific, mathematical, and technological environment is a sine qua non for a responsible citizen of today's and tomorrow's world" (George, 1983, p.207). Issues which face today's world such as clean air and water, garbage disposal, preserving natural habitats, and disposal of nuclear waste all demand a degree of scientific awareness. Scientific literacy is equivalent to survival of life as we know it (Browder, 1982; Heath, 1983; Newell, 1982; Nicholson, 1983; Shakhashiri, 1985, 1988).

If it is true that "virtually all citizens must become scientifically and technologically literate" (Exxon, 1984, p.3, original emphasis), then we must look to science education in the schools as one means to ensure future generations of scientifically literate citizens. In the past,

this country was able to supply future generations with enough specialists and teachers to continue science progress. Recently, however, there has been a change in the supply and demand of science teachers. According to Spector (1986, p.8), "California undergraduate colleges are now only able to produce one-fifth the number of science teachers needed to supply the state ." Nationwide, we are faring no better, with a projected demand for elementary teachers in 1988-89 and an increased need for secondary teachers through 1995. School principals surveyed in 1985-86 reported difficulty in hiring qualified science teachers (United States Department of Education, 1988). The Rand Corporation, a Washington think tank, anticipates a need for 200,000 new teachers per year through 1995, while only half that number are graduating from teacher training colleges (National School Boards Association, 1988).

Several national studies have pointed to this lack of teachers as one reason why science has been found deficient (National Science Board, 1983; National Assessment of Educational Progress, 1988). This dearth of available instructors can be attributed in part to societal change as well as lack of incentives. One societal change which has occurred since the Second World War is women's entry into other careers beyond the traditional areas of teaching, nursing, and clerical support. With our most capable women shifting from education into law, medicine, finance, and other areas, fewer find teaching a viable alternative, especially when salaries are considered. Student values now reflect a need to earn money, partly because these are the people who grew up "during the high inflation of the late 1970s, the severe

recession of the 1980s, and the current restructuring of the American economy" (Green, 1989, p. 479).

Heath (1983) found that the salary of the average science teacher was 30 percent lower than for an auto assembly line worker. A science teacher at a federal Indian reservation school said she was paid \$6000 per year less than her state counterparts (Titch, personal communication, January 31, 1989). Compensation for jobs reflects society's attitude toward those jobs, and low starting salaries were cited as a deterrence to entering the teaching field (Heath, 1983). Some students reported that family and friends actively discouraged them from teaching (Evans, 1987). "Instead of encouraging our brightest students to commit themselves to the rigor of graduate training in science and engineering, our society tempts far too many to concentrate their talents in such lucrative fields as law and finance" (Atkinson, 1988, p. B-1).

These attitudes toward teaching in general, and to science in particular, are now part of the societal infrastructure which has become solidified over the past few generations; consequently, there is no quick fix. It will take generations to redress the issues, barring some cataclysmic event which permits radical restructuring of education. "As matters stand right now, our students come up through an elementary school system devoid of science, pass through high schools where there is little chance of competent instruction in physics, and arrive at college with the possibility of themselves choosing to major in physics and perhaps becoming high school physics teachers already foreclosed. There is no hope that this generation will produce enough physics teachers to teach the next

generation. The problem is self-propagating." This lament from David Goodstein (1988, p. 2), vice provost and professor of physics at the California Institute of Technology, while specific to physics, applies equally as well to all the sciences and to science education.

Sexual stereotypes are another type of foreclosure which dissuade females from entering the science field. Sex roles generally start early and research shows that while females often do better in elementary education, by high school those gains are lost and males tend to make academic advances. Females who demonstrate scientific interests are generally not encouraged and are told, directly or indirectly, that what they are doing is not appropriate (National Science Foundation, 1978). Gender bias is widespread and pervasive since men have traditionally held the positions of power and responsibility. It is difficult for women to gain credibility in male-dominated fields, and one could ask how much credence would be given to a woman physicist compared to a man, even in today's supposedly enlightened society. A recent survey indicated about 230,000 females in high school physics classes. That pipeline shrank to 1000 females with a BS in physics, and to 100 PhDs awarded to females (Neuschatz, 1989). The pool of women must be encouraged as part of the effort to increase science-related personnel.

Stereotypical male-female roles start in the family and become ingrained in elementary school. Part of it has to do with the way teachers treat students. In a survey by the Educational Testing Service, it was noted that in the lower grades, boys were chastised more often than girls. It was then theorized that "frequent scolding made boys less sensitive to negative feedback, giving them greater

self-confidence and assertiveness later in life" (NSTA Reports, 1989, p. 32).

Science instruction, or lack of it, at the elementary level can have a long term effect on both male and female students (Vannan, 1971). Individual teachers affect student achievement and "when teachers' sense of personal efficiency is enhanced, their expectations for increased student performance are also enhanced" (Good, 1979, p.58). With this early influence it is easy to see that the foundation for mathematics and science occurs in elementary school. "By the time the students reach high school, they have generally lost interest [in mathematics and science]" (Shakhashiri, 1985, p. 385). Some say that the attrition rate starts much earlier. The National Academy of Sciences reported that "by the end of the third grade about half the pupils in our schools do not want to take any more science. When they get to the eighth grade only one-fifth of the students still have positive attitudes toward science" (Pallrand & Lindenfeld, 1985, p. 46). By carrying this scenario forward, we can see that "many college students who choose to major in elementary education do so because that's the only major that doesn't require any science courses at all. To the extent that is true, our elementary school teachers are preselected for their hostility to science, and no doubt transmit that hostility to their pupils, especially (to) little girls for whom elementary school teachers must be powerful role models" (Goodstein, 1988, p. 2).

The lack of students interested in science has major ramifications: it diminishes the science literacy of people who will become voters or legislators or university deans; and decreases the

pool of future scientists and science educators. The pipeline of students studying science narrows considerably at the tenth grade level and continues to narrow through the doctoral level. For women and minorities the narrowing is even more pronounced, and entire groups of people are essentially discouraged from entering science professions (Berryman, 1983; Shakhshiri, 1988). Of the American minority groups, blacks and Hispanics are not pursuing science, but Asians are. According to a study by the Educational Testing Service (1989), the percentage of Asian high school students who studied biology in 1987 was about the same as the other ethnic groups. But with advanced science courses such as chemistry and physics, the numbers changed dramatically. Asians outnumbered whites by 3 to 2 in chemistry, and blacks and Hispanics, 3 to 1. In physics, the ratio increased to 5 to 2, Asians to whites, and 5 to 1, Asians to Hispanics and blacks.

"By 2006, Science magazine predicts that 675,000 science and engineering jobs will be vacant if we do not enlarge the pool of candidates from which these positions are filled. The question is urgent: How do we get underrepresented minorities (black, Hispanic, Native Americans, female, and so on) to study science and consider choosing science-related careers? How can we awaken the interest of nonwhite and female students in a subject that has been dominated so long by white males? This is especially true in the physical sciences, and we must begin in the elementary grades" (Andersen, 1989, p.1). To rectify this situation, one must examine where the pipeline starts and understand what elementary school science instruction looks like.

Today, in any elementary school across the nation, it is likely that the traditional text book approach is still being used to teach science (Mechling & Oliver, 1983); that an average of 18 minutes per school day is spent on science in grades K-3 (Weiss, 1987); and that the classroom teacher may be one of the 51 percent of primary educators who has had little or no science training (Heath, 1983). These observations center on three key ingredients in science education: the curriculum, the methods of instruction, and the teacher (Marek & Heard, 1983). The structure of the secondary school day in essence regulates the amount of time spent on science instruction since the class periods are composed of a set number of minutes and children move from classroom to classroom. In theory, the secondary school is able to meet science requirements given the structure of the school day. However, we must remember that the greater percentage of students have already opted out of science by the time they are in high school.

Ideally, the primary school educator has more control over instructional time than the secondary school teacher since students normally stay in the same room with the same teacher. To date, this system seems to have worked against the amount of time devoted to science instruction (Murnane & Raizen, 1988). In California, for example, elementary teachers in particular are faced with pull outs, students who are taken from the classroom for bilingual or special education purposes. The regularity of such pullouts impacts all instruction.

Science instruction is specifically endangered by the curricular emphasis on all other subjects (such as mathematics or reading) to the

exclusion of science. Sometimes an elementary school will develop a "theme" for the year, such as music, for example, which then preempts time from other standard subjects. Add to these circumstances a female teacher who has been socialized against science and who has had no science education. While these conditions are understandable, it is nonetheless not acceptable that science gets shortchanged in the elementary education process, because the ramifications of science illiteracy are so great.

At present, science learning has been assessed only at the eighth grade level on state achievement tests. This provides another reason for elementary teachers to rationalize their lack of priority regarding science instruction, since without assessment, there is no drive to teach science. However, field tests of both sixth and twelfth grade tests in science are being conducted in 1988 and 1989 with the goal of statewide implementation of these tests by 1990. Thus there is a growing concern about meeting statewide standards in science instruction in the K-12 range.

While lack of time and lack of assessment provide ample rationalizations for not teaching science, there is a more personal problem expressed by many teachers -- the amount of time and the materials required for setting up science activities. Lack of preparation time has been cited as a major reason why teachers leave the field (Rosenholtz & Smylie, 1983). Without dedicated classrooms or laboratories for science, teachers must cope with the logistics of acquiring and storing supplies, setting up of materials, and the resultant activity (some might say confusion) which comes from doing science. While many elementary teachers have materials and supplies

funded by parent groups, a recent California study showed that 40 percent of teachers responding personally spent about \$100 per year for classroom equipment (Castori, 1989). For many, these obstacles to hands on science are only part of many frustrations and become too much to cope with when there are, for example, 30 students in a class, most of whom have special needs. And these special needs will get more pronounced, not less, in the future. According to the demographer Harold Hodgkinson, "Shortly after the year 2000, we will be a nation in which one of every three students will be non-white... The students who will be entering the schools will be the most difficult-to-educate group we have ever dealt with in terms of (1) poverty, (2) non-English speaking, and (3) physical and emotional handicaps" (Aldridge, 1989, p.4).

The foregoing examples assumed that at least there was a teacher in the classroom. However, another issue in quality science instruction is the lack of teachers which occurs with shifts in the population cycle. When there is an increase in school age population, as we are currently experiencing with elementary schools and will face in secondary schools by 1992, then the problem becomes one of lack of qualified teachers generally (National School Board Association, 1988). A lack of qualified teachers has a variety of spinoffs: there is little selection choice for schools or there are some classes that have to be cancelled. On the other hand, when there is a decline in the school age population, fewer teachers are needed. Those with seniority remain while new teachers, more recently educated, are frozen out.

Hence there is the situation of older teachers with "old" training; that is, they may have been poorly prepared initially and have had less updating since their teacher training (Johnston, 1984). Of 450 teachers surveyed in 1981, 79 percent reported they had no inservice program of ten hours or longer in ten years, and 69 percent indicated they had had no computer inservice training in an average of 16 years of teaching (Shymansky & Aldridge, 1982). Unless a teacher updates his or her knowledge base, that teacher will be less and less involved in the present. "Science is perennially obsolete, and those (teachers) already in the classroom must be retrained" (Wild, 1989, p.4). If not, students will be taught old content based on old skills, neither of which is appropriate in the rapidly changing world we live in today (Boyer, 1985).

There is also the reality of human nature. It can be unsatisfactory for an individual to take the time and energy to pursue inservice training on his/her own. Such efforts often go unrewarded and unrecognized by the district. So there is a call to shift the onus of retraining teachers from the individual to an organizational framework and thereby institutionalize the process (Exxon, 1984). To date, institutionalizing seems a limited possibility because of deficiencies in motivation and funding, topics which frequently reoccur.

Democracy, national security, and economic advancement seem far removed from the issues of teachers, curriculum, and instructional methods. But are they? There is a saying that for want of a nail a war was lost. The comparison is valid since the war currently being waged regarding science literacy has its inception in the skirmishes of day to day science instruction in the classroom. There are ways, however, to

insert nails where there are none or to replace or repair the faulty nails in science instruction. Rather than concentrate on large battlegrounds such as societal factors or issues of compensation, this study will look at the microcosm of the teacher in the classroom and the issue of self efficacy.

In order to achieve the National Science Foundation goals of 30 minutes per class day of science instruction for kindergarten through sixth grade (K-6); emphasis on hands-on science activity; a full year of science and technology in grades 7-8; and three years of mathematics, science, and technology in grades 9-12, we must begin at the elementary level and with the elementary teacher (National Science Board, 1983). "Most elementary school teachers are not certified in science, do not have an undergraduate degree in science, have taken a minimum or no college science courses, and suffer from science anxiety" (Spector, 1986, p.8). Universities must take some of the responsibility since "their programs for prospective teachers are, in the eyes of many, both intellectually shallow and irrelevant to practice" (Wise, 1988, p. B1). Preservice, then, has not made much of an effort to increase science expectations.

It is in the best interest of the universities to begin to take responsibility for K-12 science education and to reexamine preservice education as well. So far, the university awareness of the student pipeline problem has been negligible, possibly because the decline in American science students has been masked by the influx of foreign students. Thus the professor still has a full class, a regular teaching load, and a job.

With all these factors in play, it is easy to see why time spent on science instruction falls behind that of other subjects. The quantitative concept of teaching suggests that more science teaching will result in more science learning and recognizes that the quality as well as quantity of science must be improved (Murnane & Raizen, 1988; Preece, 1983). To remedy the situation and increase teacher knowledge of science and diminish anxiety, training programs are necessary. Until such time as preservice programs address the issues of science instruction, inservice courses will have to take up the slack (Bethel, 1982).

Inservice is considered an "important and necessary factor in improving teaching and learning" (Spector, 1986, p.13). Several things can be addressed with inservice programs: updating the out-of-touch teacher; training those with no science background; providing a forum for interaction and collaboration between teachers; providing a safe environment in which to learn and practice new skills. A key ingredient in all inservice programs is relevance (Holly, 1982). Those inservice programs which demonstrate relevance to the perceived needs of the teachers are those which have the most impact. When perceived needs are addressed, there is an increase in teachers' belief in their ability to teach science, and an increase in the quality and quantity of science taught.

Statement of the Problem

There are faulty nails in science instruction as well as some missing nails. Science instruction has had "limited success because

the nature and extent of science instruction in schools are determined primarily by what individual teachers believe, know, and do" (Haury, 1984, p.2). This problem is made manifest by teachers who lack a science background, are out of date with science progress, or simply dislike and so ignore science teaching. When proficiency in a subject is low, teachers are reluctant to expose themselves to potential loss of face in the classroom. The fear is for themselves and reflects the belief that they cannot teach science (Haury, 1984).

Preservice teachers had high self efficacy (Dembo and Gibson, 1985) which increased with more content education. Then efficacy decreased during student teaching and stayed low during the first five years. This substantiates reports that almost half of the new teachers leave the field within five years perhaps because the self efficacy gained in preservice is too fragile to withstand the rigor of real teaching. Between five and ten years of teaching, self efficacy again is high but then declines after ten years of service. "Teachers who left the profession were significantly lower in sense of efficacy than first or fifth year teachers" (Ashton, 1984, p.28).

Preservice programs, possibly because of their group support and collegiality, appear to enhance a teacher's belief in his/her ability to teach (Ashton, Webb, and Doda, 1983). The shock of student teaching erodes this belief and a full time teaching job continues to do so until the person either leaves or improves. The insulation and isolation experienced by the classroom teacher are harsh changes from the collegiality enjoyed during student days. During these critical first five years, inservice programs which address the efficacy issue can do much to halt this early erosion of teachers from the

profession. For the teacher with ten or more years of service, such programs can help prevent burnout and restore enthusiasm. The person with high self efficacy during the five to ten year period can be both a role model to the inexperienced teachers and a sympathetic colleague to those suffering from burnout.

Leaving the teaching profession, or any job, because of burnout is understandable. Unfortunately, in the teaching profession it is often the most capable who leave, those who are the best and the brightest, and those who are most capable of helping students learn, according to Rosenholtz and Smylie (1983). The authors also reported that teachers leave because they are stymied in a variety of ways: lack of time, lack of support, lack of professional growth, and lack of student control.

Recourse to expert opinion has generally been the primary means by which decisions have been made regarding teacher deficiencies (Zurub & Rubba, 1983). Of equal if not greater importance is to ask the teachers themselves what they need in order to restore their confidence in teaching science. More education in a subject is generally needed, especially in a subject changing as rapidly as science. With increased knowledge, a teacher has an internal locus of control (Haury, 1984). An intensive inservice program which is discipline based can address the need for increased subject matter. In addition, a program "which helps to clarify efficacy beliefs and adopt different behaviors should increase self efficacy especially in a strong collegial environment" (Ashton, 1984, p.29). Armed with a discipline based education and subject specific methodology skills, teachers can return to the classroom better prepared and more willing to teach

science. The increase in self confidence leads to a greater belief that the teacher is a capable science instructor. This can result in improved quality and quantity of science instruction, spark greater interest in the subject among students, and thereby expand and enlarge the pipeline of those interested in pursuing science careers. Eventually, such a trend would make a significant contribution to a more scientifically literate citizenry.

Research Questions

If what teachers believe, know, and do controls science instruction, and science instruction has been found lacking, then we must attempt to change teachers' beliefs, knowledge, and actions to improve science education. Inservice programs have been the traditional means to effect change. Therefore a study of the effect of inservice programs on self efficacy beliefs and on the quality and quantity of science instruction adds to our understanding of the dynamics of the teacher's role in science instruction.

Consequently, research questions which arise from the various problems currently being faced in science instruction are as follows:

1. What is the self efficacy belief of elementary teachers regarding science instruction?
2. How does self efficacy differ based on participation in a science inservice program?
3. How does self efficacy differ based on sub-groups in terms of gender, years teaching, and grade level taught?

4. How does the quality of science instruction differ based on participation in science inservice programs?
5. How does the quantity of science instruction differ based on participation in science inservice programs?
6. How does the sharing of science information among teachers differ based on participation in inservice programs?
7. What do teachers like best about science inservice programs?
8. What do teachers like least about science inservice programs?

These research questions were investigated with three groups of elementary educators some of whom had experienced an intensive science inservice and others no inservice. The population for the study and the methodology are addressed in detail in Chapter Three.

Significance of Outcome

The crisis in science education in the classroom must be addressed in order to provide this country with scientifically literate citizens, future scientists, and future science educators. One way to ensure a literate citizenry is to recognize the role played by schools in preparing students to be thoughtful and active participants in a democracy. The role of primary educators must be acknowledged in the efforts to increase scientific literacy, since these teachers have the opportunity to influence young children. Further, these teachers ought to be adequately prepared in teacher training schools, and if not, their training deficiencies ought to be remedied by staff development programs. Effective programs are those which give

teachers the subject knowledge and the methods to increase their belief in their ability to teach science.

Consequently, research which investigates correlations between inservice programs and efficacy can provide insights into both areas. Periodic assessment of self efficacy can contribute to inservice planning by revealing areas in which teachers feel deficient. Administrators can identify long term strategies to deal with what teachers know and do, as opposed to one-shot training efforts which are not considered successful in effecting change (Bimes-Michalak, 1988; Daresh & LaPlant 1984; Mechling & Oliver, 1983). Long range inservice planning can provide a base for a continuous, organized approach to retraining teachers. Future research can assess the outcomes of improved teacher efficacy through an analysis of student achievement, especially with analysis of scores from the state achievement tests for the sixth grade which begin in 1990, since "no other teacher characteristic has demonstrated such a consistent relationship to student achievement" (Ashton, 1984, p.28).

Concern for quality and quantity of elementary science currently exists, but little is done beyond wailing and hand wringing. With state assessment imminent, that concern for science instruction has the potential to initiate changes through increased education funds, new programs, mandated science staff development, or any number of other educational reforms.

Definition of terms

For the purpose of this study, definitions of key terms are given in order to clarify meanings and aid in interpretation of data.

Inservice. The term inservice was defined as "an individual activity intended for professional advancement on the job" (Elam, Cramer & Brodinsky, 1986, p.4). The terms staff development, continuing education, and training programs are used interchangeably.

The intensive inservice program for the science motivated treatment group in this study was the Science Teacher Institute at the University of California, San Diego, which consisted of a five week summer program and monthly Saturday seminars during the 1988-89 academic year. Traditional inservice referred to short, district sponsored training programs conducted on site by district personnel. These are usually one or two days in length. No inservice referred to an absence of any science specific training program during 1988-89.

Elementary school teachers. These were defined as teachers who were currently employed by a school in San Diego city or county districts and teaching in a kindergarten through sixth grade (K-6) classroom.

Self efficacy. This phrase referred to a person's belief in his/her ability to produce a desired effect; specifically, the ability to teach science and the students' ability to learn science. The concept of self efficacy was from Bandura's (1982) theory about what happens between the acquisition

knowledge and the execution of a response. Self efficacy was defined by Bandura as situation specific, so results of inservice programs which contribute to science content and methods can be tested.

Science instruction. Traditionally science instruction has been defined as the scope and sequence of a body of knowledge. Scope in this case referred to the quantity of science content, the amount of information included in the curriculum. Sequence is the order in which the content was taught, moving from simple concepts to the more sophisticated. Recently, the idea of process skills has been included in a definition of science instruction. The Science Framework Addendum listed content and process skills based on a foundation begun in elementary science and growing more complex the higher the grade level (California State Department of Education, 1984). Similarly, the American Association for the Advancement of Science has developed 13 progressive skills involved in the process of science (Yager, 1989). Therefore, the definition of science instruction used in this study included scope and sequence, as well as process skills. These included traditional textbook material, hands on activity, field trips, or related events and activities which were part of the science curriculum.

Quantity and quality of science instruction. Quantity referred to the amount of time spent on science instruction in the classroom. Quality referred to the teaching methods used, but did not necessarily place a value judgement on those methods except as referenced in the literature regarding which methods were considered more effective.

CHAPTER TWO

Literature Review

Introduction

In 1984 the Exxon Corporation called together a group of science educators, policy makers, researchers, and administrators from business and industry to encourage national consensus regarding the improvement of science education in the United States. One of the conclusions drawn was that good inservice programs should be identified and funded. How does one identify good inservice programs?

During the period 1977-1983, over 500 doctoral dissertations were written about inservice programs. A survey of these works by Daresh and LaPlant (1984) has resulted in identification of five models of inservice programs. The first, and most traditional approach, was for an individual to return to university for a degree in an academic discipline. Shorter, more content specific programs which arose were summer institutes, "effective when content is based on the perceived needs of the participants" (p.16). Closely allied with institutes, but with a slightly different focus, were the academy model and the competency based model. Daresh's last model was simply informal networking.

Simple as it may be, informal networking is a powerful means of providing teachers with a shared sense of vision which is too often

lacking in the organizational culture of a school. "A sense of joint venture must be encouraged, and opportunities and occasions for teachers to spend time working together and talking about teaching must be provided" (King, 1989, p. 40). When a principal or other instructional leader is able to foster an atmosphere of collegiality, the result is teachers whose "personal and professional being (is) enhanced" (Barth, 1980, p.27).

Boulanger (1981) reported that meta analysis of education research was difficult because the research was diverse, the results conflicting, and the methodology not well developed. A review of 130 documents regarding inservice education literature by Spector (1986) supported Boulanger's findings but indicated that while the literature was "vast and contradictory" there was also some agreement that inservice was "an important and necessary factor for improving teaching and learning" (p.13).

General Effectiveness Criteria

Despite the contradictions and conflicts, there was agreement among educators regarding ingredients for effective inservice programs, regardless of which model is used. A key word for teachers was relevance, a desire for information which is of immediate practical use in the classroom. Another key word is collegiality which, as peer feedback, "could help teachers solve recurrent problems and reduce their uncertainty about whether or not they are attaining their instructional goals" (McLaughlin, et.al., 1986, p. 425). The isolation of the teacher in the self-contained classroom can lead to a sense of

impotence when it comes to influencing the school's decision making process, the down side of the concept of autonomy (Tye & Tye, 1984). In fact, the insulation and isolation of the classroom "might be considered less as respect for the teacher, and more as indifference to the teacher" (King, 1988, p. 28).

Teachers also preferred activities with peers since colleagues were practical, helpful, and "understanding allies" (Holly, 1982, p.418). The idea of working in teams of teachers from the same school during inservice programs underscored the concept of allies. Once team members returned to the school site, they provided a support system which could dissipate some of the anxiety which surfaced while in the process of implementing change (Bimes-Michalak, 1988). Knowing that another teacher had done the same science activity contributed to a sense of confidence and generally was an encouragement for another teacher to experiment with the same activity. This type of activity was similar to Bandura's (1982) work with phobic patients who observed coping styles being modeled by others. This gave them confidence and they themselves began to experiment with new coping styles to deal with their afflictions.

Inservice programs which contributed to a teacher's confidence in his/her ability to teach that subject also had other spin-offs: a sense of ownership, a feeling of empowerment, the satisfaction of identifying and prioritizing one's own needs, and local involvement for individualized concerns (Bowyer, 1987; Burke, 1980; Burrello & Orbaugh, 1982; Daresh & LaPlant, 1984; Diotalevi, 1987). "People register notable increases in self efficacy when they gain new skills to manage threatening activities" (Bandura, 1982, p. 125).

There was also some agreement that successful inservice programs are not one time events, but sustained interaction over time (Bimes-Michalak, 1988; Daresh & LaPlant, 1984; Mechling & Oliver, 1983). Having more time for an inservice permits the process of teach, practice, test, and reteach, a valid precept for adults in continuing education as well as children in the classroom (McKown, 1985) as a means of increasing one's belief in the ability to do the task at hand.

Long term inservice programs which occur over an academic year provide an opportunity for coaching, considered by Joyce and Showers (1983) to be a critical element in terms of the ultimate impact of staff development activity. Coaching was defined as assistance or support by an experienced teacher for a beginning teacher who is experimenting with a new classroom behavior. Time is a critical element in coaching because of the need to develop rapport and trust between the new teacher and the experienced teacher. New teachers, feeling the anxiety of job performance, must recognize the process as an evolution, not an evaluation. "A skilled process of coaching can develop trust, build knowledge, and promote teachers who can function from an inner sense of authority" (King, 1988, p.43). The length of time and design of an inservice program can facilitate the coaching process, giving teachers time and opportunity for individual experimentation and observation by others, thus reinforcing the learning which has taken place. Coaching is especially important in programs which build on the multiplier effect, in which one teacher teaches another (Bowyer, 1987; Diotalevi, 1987).

District involvement can contribute to inservice effectiveness in a variety of ways. Support offered as stipends, scholarships, and release time were all manifestations of collaborative, integrated programs (Burrello & Orbaugh, 1982; Heath, 1983). Staff development programs which were scheduled during the school day at the school site were considered more effective since such logistics enhanced program accessibility and encouraged participation (Bowyer, 1987; Burrello & Orbaugh, 1982; Daresh & LaPlant, 1984). The difficulty here, of course, is the added expense of release time as well as the proximity to the problems at hand and the chance of being called away for an emergency, or merely a phone call.

In summary, researchers have developed checklists of criteria for effective inservice programs based on the literature. Daresh and LaPlant's (1984) study of doctoral dissertations came up with a list of 11 items. Spector's (1986) review of the literature yielded 22 guidelines. Other telescoped lists have five or six guidelines which repeat similar themes (Bowyer, 1987; Burrello & Orbaugh, 1982; Mechling & Oliver, 1983). With this information, one can address the Exxon Foundation's question and identify good inservice programs as those which take into consideration most of these guidelines for effective programs; and thereby single out these programs for funding through private foundations and public monies.

Science Specific Inservice Problems

The contradictions in the literature regarding general inservice programs cited by Spector (1986) were repeated concerning science

specific inservice programs. A study by the National Science Foundation (NSF) in 1980 showed 78 percent of elementary teachers surveyed felt inadequate to teach science (Levin & Jones, 1983). Another study in Texas in 1979 indicated that 68 percent of elementary teachers surveyed felt inadequate to teach science. A consequence of this inadequacy was that an average of only eight minutes a day was spent on science instruction, less than two percent of the school day. Sixty percent of the teachers surveyed indicated that they taught no science (Bethel, 1982). This finding was reinforced by the Exxon Corporation study (1984) when they reported "a virtual absence of science in the elementary schools" (p.5). Lack of teacher preparation was cited in a Kansas study as a key factor for ranking science instruction last in terms of how classroom time was used (Horn & James, 1981).

A study by the National Assessment for Educational Progress (NAEP) (1988) reported that 80 percent of grade three teachers did feel qualified to teach physical or natural science, yet when asked how much time was actually spent on science instruction, 70 percent indicated that the amount was less than two hours per week. This seeming contradiction was reinforced in the NAEP study when students were surveyed: 24 percent of students said they had a science lesson once a week or less, and 32 percent of students said they had no science homework during the week. Student responses, albeit questionable, tend to support the response rate of 70 percent of teachers who spend less than two hours per week on science instruction.

Accepting these reports at face value indicates that in the eight years between the NSF study in 1980 and the NAEP study in 1988 almost 80 percent of elementary teachers went from feeling inadequate concerning science instruction to feeling competent. Two things are important to note, however: first is that the two reports surveyed different samples, and second that there is a difference in what we espouse and what we actually do. These are examples of the contradictory research which both Spector (1986) and Boulanger (1981) found in their surveys. Weiss in a 1977 survey found that an average of 18 minutes a day was spent on science instruction in grades K-3; her survey ten years later showed that that figure had not changed (1978, 1987). While some teachers may say that they feel quite comfortable teaching science, when little science is being taught, there is reason to question the original statement. Operating on the assumption that teachers do in fact feel less than competent to teach science, how is that inadequacy made manifest in the classroom?

The inadequacies fall into three main categories, all of which influence a teacher's self efficacy. They are the personal knowledge base of the teacher; the limitations of the curriculum; and problems with methodology. The lack of a personal knowledge base has been described in the literature as a lack of interest (White, Raun, & Butts, 1967,); others have called it teacher inertia (Advul, 1970; Smith, 1970); and some have attributed the lack of knowledge to an attitude problem (Horn & James, 1981; Perkes, 1975). Bandura (1982) described low efficacy people as wailing about personal deficiencies, imagining problems larger than they were, and behaving ineffectually

even though they knew what to do. High efficacy people looked at obstacles and simply tried harder to overcome them using tools, skills, and other coping mechanisms.

Improving competence as a science teacher was one of the top three perceived needs in a study of secondary teachers (Zurub & Rubba, 1985); and the perceived need for more science knowledge was identified in a study of secondary school physics teachers (Rubba, 1982). The lack of teacher competence has been reported as "alarming for the self-contained classroom" (Perkes, 1975, p.86) since those teachers who are most in need of a science update are the least likely to seek such training, generally because of a negative attitude toward science, coupled with, or caused by, science anxiety. These attitudes must surely be conveyed either directly or indirectly to students and thus early antipathies to science begin.

Curriculum issues have been cited as reasons for science instruction limitations, especially when we compare American student test scores with those of students in other countries. A survey by the Educational Testing Service (ETS) in 1988 showed American students lagging in both mathematics and science, while Korea scored highest in both fields. Why Korea of all places? That country "features centralized control over curriculum, a system that routinely results in high achievement on standardized tests" (Byrne, 1989, p.729).

Curricula are "not relevant to today's students" and "exhibit confusion on the objectives of science literacy" (Heath, 1983, p.18). One reason for this confusion might be explained by the role of textbook publishers, who, according to Bill Aldridge, executive director of the National Science Teacher's Association, actually control

curriculum, instead of the state, counties, or districts. He asserted that publishers would willingly respond to cues from teachers, but that teachers have been reluctant to be proactive in dictating textbook content (1988). In the meantime, implementation of the curriculum often rests on the textbook as the basis for science instruction, with disastrous results. The textbook regulates time, decides the type of science, and determines the teacher's faith in science (Mechling & Oliver, 1983). Textbooks have another serious drawback as we move further along the age of technology, namely, the slowness with which textbooks are produced versus the speed at which science is increasing its knowledge base. A future science class, or class in any subject for that matter, may be structured entirely around the electronic media or disposable papers in lieu of textbooks, a reflection of the speed of the information surge. However, the current slavish devotion to textbooks, when placed in an environment of minimal expectations for elementary science and confusion about objectives, compounds the teacher competency problem (Murnane & Raizen, 1988).

Problems with the curriculum lead inevitably to problems in implementation involving a host of methodological factors: time, space, equipment, materials, and, of course, money. The noise and confusion inherent in carrying out hands on science activities bring up other concerns regarding student health and safety. Teachers become sensitive to how their classroom appears to the principal or parent who happens to be walking down the hall. To play it safe, the teacher concentrates on traditional textbook methods, eschewing the process-oriented approach which brings with it the fear of "mess, noise,

reorganizing the room, and bringing in supplies" (Harlen, 1984, p.8). Unfortunately, a class dominated by a teacher in a traditional method of science instruction which is didactic and not inquiry-oriented results in minimal student interaction (Winkeljohn, 1972).

Proposed Solutions for Science Instructional Problems

It is common to try to legislate or mandate change. The California State Department of Education issued its quality criteria for various academic disciplines as a guideline for schools stating that "students experience science as a regular part of the curriculum" and stipulated that at least 30 minutes a day on average be devoted to science instruction in which students "observe and conduct experiments to learn scientific processes, including: observing, comparing, organizing, inferring, relating, and applying information" (1985, p. 8).

However, as we have seen, what is taught often depends a great deal on the comfort level of the person teaching. Hence, a variety of continuing education programs must address the problem of altering lack of confidence regarding science instruction. Some educators suggested that continuing education programs include professional programs located in university science departments, taught by scientists and science educators (Johnston, 1984; Rowland, 1987). Others advocated similar ideas but specified that universities adapt to the needs of the K-12 population (Mechling & Oliver, 1983). More interaction between college faculty and high school teachers was a suggestion (Bybee & Yager, 1982). Recommendations also included

college classes on Saturdays (Rickettes & Kissinger, 1982), summer institutes, and on-going inservice programs (Gerlovich & Howe, 1983; Neill, 1982).

The concept of universities taking more responsibility for K-12 education is one which has strong advocates (George, 1983). The rationale is that the university must send a signal to high schools that science is necessary, and in turn, high schools will demand more accountability from elementary level science education. By setting core standards, expectations will rise. In addition to taking responsibility and setting standards, university faculty can be more involved in joint teaching, inservice, or instructional materials. It is ironic that decreased enrollments in university level science have not been felt by faculty since the drop in American enrollments has been offset by a bulge of foreign students. With the resultant attitude of "nothing's wrong, so why fix it?" faculty have not been proactively engaged in efforts to secure a pipeline of American students in order to protect their jobs. Lists of future Nobel prize winners will probably contain fewer Americans, and more individuals of other nationalities educated in America, or Europeans who invest more in science research and education (Glashow, 1983).

Other proposed solutions deal more with design topics instead of where programs should be located or who should teach them. Workshop formats which allow for process skills or the inquiry method are popular solutions. The workshop method accomplishes a number of different tasks which are important to implementing change in classroom science instruction: it allows for modeling good teaching, development of skills by the participant, and supervised

practice of the participant (O'Non, 1987). It permits time to reflect on the experience (Harlen, 1984); it decreases science anxiety by giving time to practice the new skills (O'Non, 1987); and the successful experience can induce a more positive attitude and enthusiasm for teaching (Stead, 1979). "Inservice must break the cycle and do science" (Harlen, 1984, p. 17, original emphasis). Self efficacy can be influenced by learning and practicing new skills because efficacy is situation specific (Bandura, 1982). Negative coping behavior can thus be isolated and altered with education. In fact, according to Haury (1984), the strength of the self efficacy is more important than the actual skill or knowledge itself.

Activity-based science is useful to increase teachers' confidence level since science teachers can have an opportunity to practice administration of science instructional facilities, equipment, and manipulatives (Horn & James, 1981; Zurub & Rubba, 1985). Interaction with other teachers in a laboratory setting generates ideas for creating storage space, organizing work space, and locating funding sources for supplies, all of which have been identified as useful to science instructors in classroom management. (Horn & James, 1981). In a study of a teacher training program involving the use of equipment, 74 percent of the teachers who participated were still using the equipment, materials, and methods taught in the training program one year later, thus indicating the staying power of something that is taught, practiced, and re-taught (Bartlett, 1971). In a study of another inquiry-based inservice program, the researcher found that teachers changed positively in behavior, attitude, and motivation (Kearns, 1981). An elementary school study which focused on the impact of students using

science materials compared to a traditional textbook approach resulted in more active student involvement working with equipment, doing the experiment, and interacting with each other (Baker, 1970), all of which are the positive side of the noise and confusion cited earlier as feared by insecure teachers. Wallen (1970, p. 1127A) found that the inquiry method produced a "wholesome attitude toward teaching science" which resulted in more time and resources spent on science instruction. In Bredderman's (1983) meta analysis of three activity-based science programs he found that there was a 10-20 percent increase on test scores and that attitudes had improved compared to results from groups in traditional science programs.

Finally, there are some conceptual matters which must be kept in mind as science specific inservice solutions are presented to rectify the crisis in science education. Two key considerations are (1) the recognition of links both among the sciences, and between the sciences and the humanities; and (2) the recognition of the role of ethics and values raised by science and technology (Exxon, 1984). While inservice programs are ideally meant to satisfy the perceived needs of the participants involved, there is also the need to include topics which are not of immediate classroom relevance, but which begin to identify some of the crucial questions of society. The role of ethics in biotechnology or the use of ultra-sophisticated weapons systems are the kinds of dilemmas which bring us back to the importance of science literacy for all in order to preserve democracy as we know it. By including such conceptual topics, in addition to more practical matters dealing with content, curricula, and methodology, inservice programs can move from a reactive mode in

which only teacher deficits are on the agenda, to a more proactive stance in which there is a shift to both personal and professional enrichment (Burrello & Orbaugh, 1982). Staff development remains "an obligation for the district to provide and a debt teachers owe their profession" (Elam, Cramer, & Brodinsky, 1986). Given all that we know about effectiveness of inservice programs, on-going assessment of self-efficacy can be very useful to the design and implementation of programs which will help alleviate the crisis in science instruction in our schools.

Attitudinal Measurement in Science Education

The Science Teacher Efficacy Belief Instrument (STEBI) was used in this research because it tested a measurable construct of teacher self-confidence. Validity and reliability were also critical factors in the choice of instrument. What Nader revealed about the inadequacies of the car industry, Munby similarly revealed about science measurements. Munby's (1983) survey of 56 science attitude instruments which were developed between 1967-1977 stated that most of those instruments were flawed. On one hand, they lacked validity and reliability; and on the other hand, they were conceptually confused. Too many did not make a distinction between attitudes to science (which are feelings) and scientific attitude (which is a way of thinking). Because of this conceptual error, the results emanating from such instruments were ambiguous and conclusions inconsistent. Munby summarized his survey by admonishing that future instruments be clearly designed and tested prior to implementation, since too

often instrument development was rushed to measure a project currently underway. Because of Munby's conclusions, this researcher was deliberate in the selection of a valid and reliable instrument, clear on its measurement goals.

The STEBI was developed by Riggs (1988) as her doctoral dissertation for three reasons: (1) there were no instruments available which measured efficacy of elementary teachers in science, (2) the available science instruments were flawed (Munby, 1983), and (3) the development of a valid and reliable instrument is "of such value that this alone can constitute a doctoral study" (Haney, Neuman, & Clark, 1969, p. 16). Two other belief instruments helped frame the development of the STEBI - these were locus of control (LOC) measures designed by Rotter in 1966 and Haury in 1983 (Riggs, 1988, p. 45).

The difference between locus of control and efficacy is explored by Riggs (1988). People with an internal LOC believe that they are in control of their lives and can determine their destiny. Those with an external locus of control believe that events happen over which they have no control and thus they are powerless in the hands of fate. Outcomes are thus determined either through personal control or, conversely, through luck. Efficacy, on the other hand, is a personal belief that the individual can act in such a way to produce a specific outcome, for example, effective science teaching methods will result in student achievement. Efficacy is context dependent, while LOC is a generalized belief. Thus the development of the efficacy instrument of Riggs tested a specific, measurable construct within a defined situation, and thus was chosen for this research.

Literature Summary

In summary, the literature previously cited referenced the problems of how a teacher stays current in a rapidly changing field, how a teacher must learn to manage classroom equipment with all the ramifications of student well-being in mind, and how a teacher must balance the demands of the curriculum with the real life issues of methodology. An available solution to the problems mentioned is to address all three concerns with staff development which is disciplined-based, offering both content and methodology, which fosters collegiality and networking, and which involves the participants in the process of science. In short, once the teachers themselves do science, their confidence in teaching science increases. Self efficacy can then be measured using a valid and reliable instrument. Once we have more clear and consistent data, then we can better address deficiencies in science education and begin to remedy the prevalent pattern of science illiteracy.

CHAPTER THREE

Research Design and Methodology

Introduction

A pseudo experimental design using three static groups was used for this research project (Huck, Cormier, & Bounds, 1974; Krockover, 1977). Using post-tests only, the three groups were surveyed regarding science self efficacy beliefs and science instruction. This use of a post-test only design was suggested since pre-testing was not possible and since there was a sufficiently large sample to make the design worthwhile (Borg and Gall, 1983). While there are limitations to a post-test only design, Huck, Cormier, and Bounds (1974) suggested that the post-test only design using comparison groups is superior to a pre-post test design using only one group since it provides for a control group. However, the use of the pseudo experimental design brings with it threats to internal validity which will be discussed in the limitations to the study.

The three comparison groups were considered static groups due to the lack of random assignment. The experimental group of 100 elementary school teachers involved in an intensive science inservice program was considered self-selected since they voluntarily sought exposure to the treatment. This treatment group was described as

highly motivated in science. A control group did not choose to be involved in the treatment although they originally expressed an interest. Hence this group is considered interested in science. The third group expressed no interest or motivation in the intensive science inservice program. Some of the science interested and the no science interest groups had exposure to local district or other science inservice during the 1988-89 academic year. This information will be included in the results and discussion.

Data Collection Site

The data collection site was San Diego County. The Science Teacher Efficacy Belief Instrument (STEBI) and a demographic survey were given to the highly motivated science treatment group at the University of California, San Diego, where participants were enrolled in a science inservice program for elementary teachers. The science interested control group were contacted by mail. The no science interest control group was given the instruments by district administrators during routine meetings.

Population

San Diego city and county schools serve a student census of approximately 250,000 children in grades K-8 with about 15,000 full time equivalent teachers (San Diego County Office of Education, 1987). From this teacher population, the three sample groups of elementary teachers (K-6) were drawn.

Sample Selection

Science Motivated Group. The science motivated group was composed of an initial cohort of 102 elementary school teachers who were enrolled in an intensive science inservice program at the University of California, San Diego. The goal of the program was to enhance the content and methodology skills of these 102 elementary school teachers. The criteria for selection was (1) a degree in science or a strong science background, (2) experience as a mentor teacher, teacher trainer, or other type of resource person, and (3) the endorsement of the principal.

Applicants were asked for a variety of general information for record keeping purposes. Information regarding school sites and districts were used to ensure both county-wide representation and involvement of participants from private, public, and church-related schools. Final selection of participants was made by the UCSD project directors in cooperation with the Science Institute Advisory Board, composed of science supervisors, teachers, and city and county administrators.

It is important to note that the final selection of applicants to the Institute was made prior to this research and the results of that selection process are described here as relevant to the study. There were spaces for 100 participants; there were 102 applicants. Hence all who applied were accepted and the pre-established criteria regarding science background and expertise were waived in order to have a full complement of participants when the Institute opened its doors. The consequence of the selection process for this research

project is that the science motivated group had a variety of individuals who differed very little from the other two comparison groups. For the purpose of this study all three groups may be considered similar since selection was not based on extreme scores, however, it is a limitation to the study that there may be a bias toward the experimental group regarding previous science knowledge.

Science Interested Group. The science interested group was composed of volunteers from a list of names of 143 persons who expressed an interest in the intensive inservice program but did not apply. An assumption of the study was that these people were similar to the treatment group since they had a degree of interest in the inservice program and perhaps some confidence that they qualified for acceptance. As a limitation to the study, this group may be equivalent to the experimental group except for procrastination when it comes to filling out forms. This control group of 143 persons received the STEBI and science survey by mail.

No Expression of Interest or Motivation. The third sample of science teachers came from a self-contained population of elementary teachers from Fallbrook, a district in San Diego's North County area. This district employs approximately 155 elementary teachers, none of whom were involved in the intensive treatment group nor were they on the list of 143 persons who expressed an interest in the intensive inservice program. As with the science interested group, participants in the no science interest group were asked if they have participated in a science inservice program. Thus each sample contained between 100 and 155 people. From these, valid responses were culled and analyses done on those responses.

Instrumentation

There were two instruments used in this research. One was the Science Teacher Efficacy Belief Instrument (STEBI) which was tested as valid and reliable for elementary teachers (Riggs, 1988). The instrument was a 25-item Likert scale which asked teachers if they believed they could teach science and if they believed that students could learn science. The instrument was assessed by expert judges on content validity. Item analysis, scale reliability assessment, and factor analysis of scale integrity were done. In the Riggs study, the instrument was piloted with a group of 71 persons and a revised instrument was repeated with a final sample of 308.

The theoretical construct for the instrument was from Bandura's (1982) psychological theory concerning the relationship of knowledge and action. Bandura studied phobic patients whose coping behavior was measured before and after treatment. Patients showed improvement based on both experimenting with new behaviors and observing others model new behaviors. Similar studies have been done with heart attack patients and people addicted to alcohol and other drugs. This concept has been extended by Haury (1983, 1984) regarding science locus of control. Ashton (1984) linked self efficacy with student outcomes. Dembo and Gibson (1985) concluded there were organizational factors such as isolation and lack of decision making which contributed to diminished self efficacy in teachers.

The second instrument was a demographic and science survey developed specifically for use with these three groups. It contained

questions of four types: biographical data on gender, years teaching, and educational background; the quality and quantity of science instruction; participation in inservice programs; and how teachers shared information with other teachers. A preliminary instrument was personally administered to a small sample of representative teachers to determine clarity of questions asked or to reveal other methodological problems. The results showed minimum difficulty with the questions asked and only minor changes were made in wording on the final instrument.

Data Collection

The data collection for the three groups occurred as follows. The intensive treatment group of 100 participants in the Science Teacher Institute met monthly for Saturday seminars as part of the academic year inservice program. The treatment group completed the STEBI and science survey at the April, 1989 meeting.

The control group of science interested persons was contacted by mail at approximately the same time. The initial mailing included a cover letter of explanation about the study, the STEBI, the demographic survey, a stamped return envelope, and a gift of a UCSD pencil. A 30-35 percent response was targeted from the list of 143 names, approximately 43-50 responses. It was planned that if this target number was not reached in the first round of mailings, a second round would be conducted. However, it was anticipated that a second round of solicitations would be conducted even if the initial response rate met the targeted figure in order to achieve as large a

representation as possible. A third round of inquiries using the telephone was considered if there were a low number of responses or if there were a high number of invalid responses.

The actual response rate on the first mailing was 54, which reflected 38 percent, a number which exceeded the anticipated response rate predictable in surveys of this type (Linsky, 1975). As planned, a second mailing was conducted in order to achieve wider representation. The second mailing gathered another 23 responses, which increased the total number to 77 and a final percentage response of 54 percent. Of the questionnaires mailed, another eight were returned as undeliverable.

Response rate is keyed to the salience of the questionnaire to the people involved and the number of contacts either before or after the mailing. In a study by Heberlein & Baumgartner (1978) questionnaires with high salience had 77 percent response rate. University-based surveys had a response rate of 62 percent, usually because of high salience and the ability to provide more follow-up contacts. A targeted response rate of 30-35 percent was considered a minimum goal and this goal was surpassed with the 54 percent response rate, even though it did not achieve the average response rate cited in the literature. Because the response rate achieved was adequate, telephone follow ups were not conducted.

According to Linsky (1975) response rate to questionnaires increased with one or more follow-ups; with a return envelope and postage paid; with token or cash rewards; and with the use of an organizational letterhead for the cover letter. All of these elements

were part of the packet mailed to the control group and support Linsky's claim of increased response rate.

The third group was given the STEBI and demographic survey during routine meetings conducted by district administrators. Hence the instruments were completed in a supervised group setting similar to the science motivated group. An assumed response rate of close to 100 percent of the approximately 155 subjects was not met because of administrative difficulties with scheduling meetings. Rather than delay the study, a response rate of approximately 50 percent was agreed on, and in fact was more suitable for the study since all three groups then had about 70 subjects which made the groups roughly equal in size.

Data Analysis

Descriptive and inferential statistics were used to calculate results for the three groups using data from both instruments. In addition to frequencies, means, and distributions, one way analysis of variance was conducted of STEBI results by a variety of variables dealing with quality and quantity of science. To look for significant differences in science instruction among other variables, a three-way ANOVA summarized the self efficacy score by gender, years teaching, and grade level taught (primary grades K-3 and upper grades 4-6). In addition, using a chi square formula, item analysis on the STEBI was conducted to analyze significant differences among the groups on the self efficacy scale.

Using the science survey, frequencies, range, and mean scores were calculated on the questions of quality and quantity of science instruction; how science information was shared among teachers; and biographical data. Subjective information regarding what participants liked and disliked about science inservice programs was analyzed and presented quantitatively, for an assessment of how widely spread the concerns were, and in narrative form to permit the teachers to speak for themselves.

Assumptions and Limitations of the Study

This study used a pseudo experimental design with three static groups. The groups differed in that one group was science motivated to increase content and methodology skills by volunteering for an intensive treatment; the second group was science interested to request information about an intensive treatment but did not volunteer for treatment; and, the third group appeared neither science interested nor motivated. Differences in the post-test results of the three groups may have been biased for reasons other than involvement in inservice programs and is an inherent weakness in the static group post-test only design.

As mentioned previously, the UCSD Institute accepted all who applied in order to have a full complement of participants. The 102 applicants were selected in April, 1988 and the summer program began in July, 1988. The research study surveyed the science motivated group in April, 1989. During the year from acceptance to testing, the Institute experienced some mortality in the original

group. Thirteen dropped out for a variety of reasons: sickness, other obligations, or appointment to year round schools.

Mortality was expected and planned for by implementing a "Bring A Friend" program in which participants could invite a colleague to attend any two sessions and receive a unit of credit at no charge. A number of visitors from the Bring A Friend program asked to enter the Institute and were accepted whenever a vacancy occurred. Acceptance criteria were waived in order to maintain a complete cohort and this substitution of participants supports the concept that the three groups were similar.

The science interested group was composed of a list of names of 143 persons who had expressed an interest in the UCSD program. These people were assumed to be a general cross section of K-6 teachers from San Diego city and county schools and were in no way involved with the research project prior to the survey.

The group of no science interest teachers from Fallbrook was chosen as a control group for two main reasons. First, the geographical distance of about an hour's driving time from San Diego meant that it was unlikely that there would be interaction between the treatment group and the control group. In addition, the group was an experimentally accessible population with administrative support for the survey. In other ways this control group is assumed to be similar to the other two groups with the exception that San Diego's North County is rapidly growing in population and has more jobs available each year. This might attract teachers wishing to make a change or new teachers needing to find a first job.

In conclusion, another assumption of the study must be control for researcher bias in the design and methodology. Using quantitative instruments which were administered by mail or by others, there was no interference by the researcher during testing. Interpretation of data reported in the discussion may be biased since the researcher was the administrator of the UCSD inservice program; however, it is hoped that any unintentional bias did not interfere with the conclusions reached.

CHAPTER FOUR

Research Findings

Introduction

The purpose of this research was to compare the effect of science inservice programs on the self efficacy of elementary teachers. In order to compare the effects, two tests were administered to elementary teachers: a demographic questionnaire and the Science Teacher Efficacy Belief Instrument (STEBI). Data from the two tests were analyzed using a variety of techniques to describe the population, to address the eight research questions, and to assess other areas of interest regarding inservice programs.

Population Description

Information from three groups of elementary teachers was obtained concerning gender, educational level, years teaching, and science education and inservice. This information is summarized in Table 1. The population of elementary teachers for this research was fairly equally distributed in the three interest groups surveyed; it was predominantly female with the majority reporting 11 or more years of teaching. A third or more of each group had an advanced degree,

however, of particular interest to this study was the amount of science education reported.

Table 1
Summary of Descriptive Information

Variable	No Science Interest (N=74)	Science Interested (N=77)	High Science Motivated (N=70)
Sub-Group	33%	35%	32%
Gender			
Male	1%	17%	12%
Female	99%	83%	88%
Education			
Bachelor's degree	70%	57%	55%
Advanced degree	30%	43%	45%
Years Teaching			
0 to 5 years	16%	29%	32%
6 to 10 years	43%	27%	13%
11 or more years	41%	44%	55%
Number of Science Courses Taken			
0 to 4	80%	50%	45%
5 to 7	12%	26%	27%
8 and above	8%	24%	28%
Hours of Inservice Training			
None	88%	32%	8%
1 to 5	10%	35%	13%
6 to 15	1%	18%	35%
16 to 35	1%	7%	24%
36 and above	0%	7%	20%

The majority of the no science interest group indicated less than four science courses, compared to about half in the other two groups. Have the science-deficient teachers attempted to compensate through inservice programs in the past year? The table shows that 88 percent of the science uninterested teachers reported no inservice

Results of Research Questions

RESEARCH QUESTION #1: What is the self efficacy belief of elementary teachers regarding science instruction?

Self efficacy was tested using the Science Teacher Efficacy Belief Instrument (STEBI) developed and validated by Riggs (1988). This is a 25 item Likert scale instrument in which teachers indicated degree of agreement on items related to self efficacy. Respondents were asked to circle the corresponding letters if they strongly agreed (SA), agreed (A), were uncertain (U), disagreed (D), or strongly disagreed (SD) with the statement. There were both positively and negatively worded statements to control for acquiescent responding which is the tendency to answer yes to positively worded statements (Riggs, 1988).

The letters were scored with the numbers from 1 to 5. The highest possible score was $5 \times N$, with N being the number of statements on the scale. There were 13 statements on the efficacy scale and 12 statements on the outcome scale, so the corresponding total scores were 65 for efficacy and 60 for outcomes. This research is limited to the relationship between the efficacy subscale and other variables.

To analyze the responses, frequency distribution was calculated for the total number of cases ($n=221$). The raw scores ranged from 17 to 65. The scores revealed a fairly normal distribution except for two cases on the extreme low end with scores of 17 and 29. The mean self efficacy for the total population was 52.05 (SD 7.17). The Riggs study (1988) of 308 elementary teachers in Kansas City and the surrounding area had a mean efficacy score of 48.1 (SD 8.31). The sample was 88 percent female and 12 percent male which approximated the gender differences in the San Diego study which was 89 percent female, 10 percent male, and 1 percent no response.

The purpose of this research question was to establish a reference point for the population on the efficacy subscale in order to have a basis of comparison for analyses of other variables such as group, gender, years teaching, and grade level taught which are addressed in the remaining research questions.

RESEARCH QUESTION #2: How does self efficacy differ based on participation in a science inservice program?

The population surveyed for this research was in three groups. The highly motivated group was participating in an intensive science inservice program. Of the two control groups, one had indicated an interest in science while the other did not. The self efficacy mean scores by group are presented in Table 2. The science motivated group scored highest on the efficacy scale (56.7, SD 5.9). These results indicate a difference of 7.8 points between the score of the no science interest group (48.9, SD 4.4) and the science motivated group. The mean efficacy score of the science interested group was 50.3 (SD

8.2). Between the two control groups, the science interested and the not science interested groups, there are only 1.4 points, reflecting that both groups are closely related in their efficacy beliefs and considerably less efficacious than the science motivated group who have had science training and education.

Table 2
Group Mean Self Efficacy Scores

Group	Mean	SD
No science interest	48.9	4.4
Science Interested	50.3	8.2
High science motivated	56.7	5.9

An analysis of variance of these scores is summarized in Table 3. The differences among the three groups was statistically significant. Post-hoc Tukey Tests indicated that the mean for the high science motivated group was significantly higher than either the science interested group ($p < .05$) or the no science interested group ($p < .05$), while the difference between the latter two groups was not significant.

Table 3
Summary of Analysis of Variance of Self Efficacy Scores

Source of Variance	SS	DF	MS	F	P
Between Groups	2593.4214	2	1296.7107	32.5072	.0000
Within Groups	8658.1240	217	39.8900		

Table 4
Summary of Kruskal-Wallis One-Way ANOVAs by Groups for STEBI
Items

Item	No Science Interest		Science Interested		Science Motivated		Kruskal Wallis H(3)	P Value
	Mean	SD	Mean	SD	Mean	SD		
Item 01	4.0	.8	4.2	.8	4.4	.8	12.54	.0019
Item 02	4.0	.5	4.1	.7	4.8	.4	88.49	.0000
Item 03	3.0	1.0	3.8	1.1	4.3	.8	52.36	.0000
Item 04	3.9	.6	4.2	.7	4.4	.6	25.54	.0000
Item 05	3.9	.6	3.7	.8	4.2	.6	19.67	.0001
Item 06	3.2	1.0	3.6	.9	4.1	.9	27.84	.0000
Item 07	3.0	.9	2.6	1.0	2.4	1.0	16.14	.0003
Item 08	3.8	.9	4.0	.9	4.5	.6	28.05	.0000
Item 09	3.7	.8	3.9	.8	4.3	.7	27.12	.0000
Item 10	2.5	.9	2.8	.9	3.1	1.1	14.19	.0008
Item 11	3.8	.6	3.8	.7	4.0	.8	4.83	.0893
Item 12	4.0	.4	3.9	.9	4.3	.8	16.07	.0003
Item 13	3.5	.8	3.7	1.0	3.8	1.1	8.40	.0150
Item 14	3.8	.9	3.7	.8	4.0	.8	6.07	.0482
Item 15	3.4	.7	3.8	.8	4.2	.8	39.10	.0000
Item 16	3.5	.7	4.1	.7	4.2	.7	43.23	.0000
Item 17	3.9	.5	3.9	.8	4.2	.6	16.90	.0002
Item 18	3.7	.6	3.8	.8	4.2	.6	24.07	.0000
Item 19	3.9	.5	3.8	1.0	4.1	.9	12.67	.0018
Item 20	3.7	.6	3.8	1.1	4.1	.8	14.88	.0006
Item 21	3.6	1.0	3.9	1.1	4.5	.8	40.81	.0000
Item 22	3.9	.5	4.0	.7	4.3	.6	17.93	.0001
Item 23	4.1	.6	4.3	.7	4.7	.4	40.07	.0000
Item 24	3.9	.5	4.1	.8	4.7	.5	62.49	.0000
Item 25	3.3	.8	3.0	1.1	3.4	1.1	5.50	.0638

Inspection of the 25 instrument items was done using the nonparametric Kruskal-Wallis tests as summarized in Table 4. All but two of the items (items 11 and 25) yielded significant differences among the three groups. Both of these items were on the outcome subscale and did not reflect efficacy beliefs. The differences which occurred were between the highly motivated group and the other two groups for all significant items.

RESEARCH QUESTION #3: How does self efficacy differ based on sub groups in terms of gender, years teaching, and grade level taught?

Using a three way ANOVA in a 2 x 3 x 2 factorial design (see Table 5) tests were calculated by gender, by years teaching (0-5, 6-10, and 11 or more), and by grade level taught (lower grades from K-3 and upper grades from 4-6). Overall there is no statistical significance in the results.

Table 5

Summary of Analysis of Variance of Self Efficacy Scores
by Gender, Years Teaching, and Grade Level Taught

Source of Variance	SS	Df	MS	F	P
Gender (A)	159.919	1	159.919	3.199	.075
Years Teaching (B)	222.215	2	111.108	2.223	.111
Grade Level (C)	37.358	1	37.358	.747	.388
A x B	247.769	2	123.885	2.478	.087
A x C	.729	1	.729	.015	.904
B x C	136.639	2	68.320	1.367	.257
A x B x C	100.293	1	100.293	2.006	.158
Within Cell Error	9348.166	187	49.990		

Compared to the mean efficacy score of the population (52.05, SD 7.17), males scored higher (54.9, SD 8.25) and females lower (51.6, SD 7.05), a trend which, while not statistically significant, does reflect an interesting area for future research. However, the sample size is a consideration, since there were only 22 male subjects and 197 females.

Those who had been teaching 0-5 years had a self efficacy mean of 52.9 (SD 6.5). Those who had been teaching 6-10 years had a mean of 50.2 (SD 8.0). Those with the most years teaching experience, over 10 years, had a mean of 52.7 (SD 6.9). Once again, these differences were not statistically significant, but the trend observed in this research contradicts the literature (Ashton, 1984) that efficacy was low during the first five years, higher during 6-10 years teaching, and then declines again after ten years on the job.

Testing for grade level differences was done by grouping teachers into two categories: the lower grades (K-3) and the upper grades (4-6). Those who taught the lower grades had a self-efficacy mean of 52.2 (SD 6.9), while those who taught the upper grades had a mean of 51.5 (SD 7.4). Again, this difference was not statistically significant, but the downward trend substantiated a common theme that as a subject gets more complex, efficacy declines.

The ANOVA (Table 5) also tested for interactions among these three independent variables. None of the interactions achieved statistical significance. Since gender, years teaching, and grade level taught were not able to account for a significant proportion of self efficacy scores, a four-way ANOVA tested for interactions by including

the group each participant was in, using a 3 x 2 x 3 x 2 factorial design. Once again there were no significant differences.

RESEARCH QUESTION #4: How does the quality of science instruction differ based on participation in science inservice programs?

Quality of science instruction was indicated by nine teaching modalities: lecture, discussion, demonstration, hands on use of laboratory materials, use of computers, small groups, seatwork, worksheets, and homework. Teachers were asked to indicate which method(s) was used in a recent science lesson. Based on the calculated chi square test, there was no relationship in seven of the nine variables between the teacher subgroups and the teaching modality used. The two significant variables were the prevalence of seatwork and the use of worksheets.

Table 6
Percentage of Subjects in Each Group Employing Each Method of Instruction

Method	No Science Interest N=74	Science Interested N=67	High Science Motivated N=76	Chi Square
Lecture	83.6%	80.9%	83.1%	.20
Discussion	93.2	98.5	93.5	2.65
Demonstration	75.3	77.9	79.2	.33
Hands On	90.4	80.9	92.2	4.98
Computer Use	1.4	1.5	0.0	1.11
Small Groups	68.5	73.5	80.5	2.87
Seatwork	32.9	16.2	7.8	15.89*
Worksheets	9.6	32.4	35.1	15.04**
Homework	17.8	29.4	31.2	4.01

*p. = .0004

**p. = .0005

A 3 x 2 chi square analysis was performed investigating the relationship of the groups and the use of seatwork (chi square = 15.89, $p < .0004$). The science uninterested group reported a greater use of seatwork than either the science motivated or the science interested. There were 24 in the science uninterested group who reported seatwork as a teaching modality, with the science interested group reporting 11, and the science motivated group only 6 (see Table 6).

The results of the 3 x 2 chi square analysis on the relationship of the groups and the use of worksheets is also significant (chi square = 15.04, $p < .0005$). Of the total population, there were 25.7 percent (56 subjects) who reported the use of worksheets. Of these, the science motivated group was most active, with 27 subjects, followed by the science interested group (22 subjects), with only seven of the no science interest group reporting the use of this teaching method (see Table 7).

Table 7

Summary of Distribution of the Use of Worksheets by Group

Group	No Worksheets	Worksheets
No Science Interest	66	7
Science Interested	46	22
High Science Motivated	50	27

Chi square = 15.04, $df = 2$, $p = .0005$

In comparing the prevalence of inservice hours for the group that preferred students to do seatwork, the inservice hours were clearly deficient: less than six hours of science training were reported by 97 percent of the teachers in this group. Of the subjects in this group, 88 percent reported no science inservice at all. On the other hand, the teachers in the science motivated group which favored the use of worksheets had substantial science training with 79 percent reporting six or more hours of inservice.

Naturally enough, the data on the seven variables which did not have any statistically significant differences showed fairly homogeneous teaching techniques. For example, teacher/student talk was still reported as a major part of the classroom activity, with 82.6 percent reporting the use of the lecture method and 95 percent reporting student-teacher discussions. Cooperative learning was evident with 74.3 percent reporting the use of small groups as a teaching/learning tool. Homework, however, was apparently not considered a learning tool, since only 26 percent reported assigning students homework.

Reflecting the need for an activity based science lesson, 77.5 percent of teachers reported doing demonstrations. However, this data (as well as other information) was collected via self-report, and there were no parameters to delimit the word "demonstration." Hence, teacher definitions of demonstration may not be consistent. Another 88.1 percent of respondents had students practice hands on science activities, again, a term not defined in the instrument and assumed to have commonly acceptable limits in educational circles. Therefore, it would appear that activity-based science was in the

ascendancy, however, the use of technology as an instructional technique lagged among the teachers in this survey, with only two of them reporting the use of computers, less than one percent of those surveyed.

RESEARCH QUESTION #5: How does the quantity of science instruction differ based on participation in science inservice programs?

Quantity of science was measured by asking respondents to state the number of total minutes dedicated to a recent science lesson. The question was then subdivided to determine the number of minutes spent on specific items during the lesson. Frequency counts and means were calculated for the population and for the three groups. A one way analysis of variance was calculated to determine relationships between the groups and the number of minutes spent on various classroom tasks and posthoc Tukey tests were calculated to validate differences.

The amount of total minutes spent on science ranged from 12 to 100 with a mean of 44.03 minutes for the population (SD 14.65). Teachers reported allotting the most time to hands on activities, a mean of 22.29 minutes (SD 11.48). Despite the repeated emphasis on "doing science," the range of minutes reported varied from 0 minutes to 75. Didactic presentations were second in amount of time spent, with teachers reporting a mean of 9.18 minutes (SD 6.79). While hands on science is espoused, the reality of reading as a means of teaching science is still practiced. Reading was reported as third in time priority with a mean of 4.83 (SD 6.30). The range was 0 to 50

minutes spent on reading. The balance of the lessons included testing, routine activity, and other miscellaneous tasks.

The mean number of minutes spent on each lesson item by the group of teachers appears in Table 8. In reviewing the quantity of science instruction for the three groups, the science motivated group reported a higher number of minutes overall in science instruction (48.3, SD 16.5). This is the group in which 79 percent reported more than six hours of inservice; thus there is a positive relationship between the amount of inservice hours and the amount of science instruction.

Table 8
Group Means for Minutes of Use of Various Lesson Items

Lesson Items	No Science Interest		Science Interested		High Science Motivated		F(2,210)	P
	Mean	SD	Mean	SD	Mean	SD		
Total	38.4	10.6	45.3	14.5	48.3	16.5	9.5987	.0001
Routine	2.7	2.0	4.7	4.0	3.9	3.2	6.8587	.0013
Lecture	7.9	4.5	8.2	5.3	11.3	9.0	6.0393	.0026
Hands On	21.0	9.4	20.4	12.8	25.1	11.6	3.7278	.0257
Reading	4.8	5.5	5.9	8.1	3.9	5.0	1.8666	.1572
Testing	1.2	2.8	.7	2.5	1.5	3.2	1.3899	.2514
Other	.8	2.4	4.3	7.8	3.3	5.9	7.0911	.0010

In second place regarding quantity of science instruction was the science interested group (45.3, SD 14.5), followed by the uninterested group (38.4, SD 10.6). Based on an analysis of variance,

the likelihood of the observed differences occurring in the population by chance was a probability of .0001. In these two groups, the majority reported less than six hours of science inservice programs.

Significant results were also found in the ANOVAs for the number of minutes in routine activity, a technique favored by a group with minimal inservice hours, reporting 4.7 minutes (SD 4.0). Conversely, the number of minutes spent on lecture was highest for the group which had the greatest amount of inservice, a mean of 11.3 minutes (SD 9.0). In addition, the amount of time spent on activity based science was greatest for the highly motivated science group as seen in Table 8. The mean scores of the two remaining activities reported during the science lesson, reading and testing, were not statistically significant among the three sub groups of teachers.

Posthoc Tukey tests revealed a variety of results regarding the groups and how time was used during science instruction. Two groups, the highly motivated and science interested, both had statistically significant results regarding total mean time of science instruction ($p < .05$). However, the way in which this time was used is different since the highly motivated science group had a greater mean time in both lecture and hands on activity than either of the other two groups ($p < .05$), while the science interested group reported using more time in routine activity ($p < .05$). A conclusion could be that with more science knowledge and pedagogical skills, the motivated group taught using more effective methods, while the interested group resorted to routine to fill the time. Consequently, interest alone is obviously not sufficient to change science instruction, but knowledge is also required.

RESEARCH QUESTION #6: How does sharing of science information differ based on participation in inservice programs?

Using chi square tests to determine relationships between the three groups of teachers and the various methods of sharing science information, three methods showed statistically significant differences: the coaching method, presenting at local meetings, and presenting at regional meetings. The science motivated group in which 79 percent of the participants had more than six hours of inservice programs did the most to share the information they had gained in the three statistically significant areas. Chi square results for sharing information via mentor teaching and conversation were not significant (see Table 9).

The coaching method was reported by 13.8 percent of the total population ($n=221$), with 34 percent from the science motivated group using this type of sharing, and only one percent from the no science interest group and six percent from the science interested group reporting use of the coaching method. The chi square was 32.05, $p < .001$.

Another method of sharing science information which was most prevalent in the high science motivated group was presenting at local meetings, reported by 34 percent of the subjects in this subgroup. In contrast, only one percent of the subjects in the least science interested group reported giving presentations at local meetings; 12 percent of the subjects in the science interested group reported this method of sharing. The obtained chi square of 26.29 had a probability of .0000 and was therefore highly significant.

Table 9
Percentages in Each Group Engaging in Each Method
of Sharing Science Information

Method	No Science Interest N=74	Science Interested N=77	High Science Motivated N=70
Conversations	93.2	85.1	94.7
Coaching	1.4	7.5	31.6
Mentor	6.8	9.0	10.5
Local presentations	1.4	13.4	31.6
Regional presentations	0.0	3.0	13.2

The next level of sharing science information was presenting at regional or national meetings of professional organizations. The result of the chi square test was a calculated value of 13.63 with $p < .0011$. The no science interest group reported no activity in this area; three percent of the science interested group reported presenting; and 14 percent were from the more motivated science teachers participating in the intensive inservice program.

RESEARCH QUESTION #7: What do teachers like best about science inservice programs?

This was an open ended question with space available for participants to write in subjective answers. The answers were tabulated and then codified for key word responses which were found repeatedly in the respondents' comments. Often times a respondent

listed only one key word; those persons who listed two or more were coded as multiple responses. Of the total valid cases of 217, there were 125 responses to the question about what was liked best about science inservice programs, reflecting 57.6 percent of total population.

The majority who responded were in the high motivation group with 74 reporting; 42 responded from the science interested group, and only 9 in the least interested group. This is understandable since the no interest group had little experience with science inservice programs (with 64 of a total of 73 reporting no science inservice programs). Of the nine who reported having participated in science training, seven indicated they had had under six hours of instruction; one with 6-15 hours; and one with more than 16 hours.

The use of resources gained the highest percentage of responses with 15.8 percent (n=35) emphasizing this item as most important (see Table 10). When this number of responses was added to the group who mentioned dual choices, the total of persons choosing resources as most valuable is 21.8 percent (n=48). "Resources" was the code word assigned to represent activities which teachers could immediately use in the classroom. Also included in this category were field trips as another type of local resource for additional activities. Cited again and again by teachers were the words hands on and practical which reflected the perceived need of teachers to leave an inservice program with concrete activities for immediate use in the classroom rather than theoretical models. These results primarily

reflected the opinions of the interested and motivated groups; however, in the least science interested group, the practical aspects were cited by seven of the nine who responded as being of primary importance.

The second best liked choice of teachers was the content of the inservice program. The number of teachers who chose this reason was 37, reflecting 17 percent of the total, including both single and multiple responses. "Content" was the code word chosen to include teacher comments such as new information, new ideas, knowledge, leading edge topics, and up to date content. The preference for leading edge content issues was totally the result of answers from the interested and motivated groups. The subset of nine cases from the no science group wrote only of liking the practical, hands on applications and did not reflect on the need to place those activities into a broader conceptual framework.

Quality lectures or presentations was the third choice with 12.8 percent ranking this as a component they liked best (n=28). With the exception of one case, the preference for quality lectures or presentations was a reflection of the highly motivated group who were aware of the reputation and expertise of the presenters enough to comment and to be appreciative of them. No one in the least science interested group cited this as a preference; however, one person in the science interested group cited the "enthusiasm and upbeat quality" of a presenter at an inservice she attended.

Table 10

Rank Order of Inservice Items Liked Best and Least by Participants

Rank	Liked Best	Liked Least
1	Resources	Poor quality lectures
2	Content	Personal issues
3	Quality lectures	Inconvenient scheduling
4	Networking	Poor hands on activities
5	Motivational aspect	Lack of time

Do teachers like networking? Yes, and this was fourth in preference, chosen by 11.2 percent (n=24). This result was entirely from the science motivated group. As part of the format of the intensive inservice program which they attended, these teachers had an opportunity to mingle with each other and share information. Comments were that they enjoyed "interaction with other teachers at the elementary level;" "meeting and discussing with other teachers;" "support among colleagues;" and "the camaraderie, the network-resources being created." Networking was not cited as a preference by anyone in the other two groups, probably a reflection of the lack of inservice overall and the lack of a program design which specifically permitted or encouraged networking.

Sixteen teachers (7.5 percent) specified the motivational factor of science inservice programs as the most likeable part of the session. Enthusiasm was a key word often repeated. Others used words like "challenging," or "refreshing," and one person appreciated the "positive attitudes of the leaders and presenters." While the majority

of responses were from the highly motivated group, the motivational aspect was mentioned to some extent by teachers in all three groups.

RESEARCH QUESTION #8: What do teachers like least about science inservice programs?

Like the previous research question, this was open ended, soliciting subjective responses from the participants which were then tabulated and codified based on key words repeated throughout the responses (see Table 10). The lack of quality presentations or lectures was cited by most as the critical negative aspect of inservice programs with 13.6 percent reporting this item (n=30). In the group surveyed by mail, one teacher seemed angered by content which was "irrelevant" and another teacher upset "when (she) was stuck with an unprepared presenter or with something (she) already knew." Still another teacher commented that she disliked "archaic ideas that would not challenge children." The number of teachers responding to this question was 70 percent (n=155). In the motivated group, the comments about quality materials were specific to one particular laboratory session which they felt was "restrictive" and in need of more extensions to other grade levels. In the no science interest group there was a complaint from one person about the "handling of creatures," while another person wanted "more hands on."

What does one teacher dislike? "Sitting too long." This type of response was classified as a personal reason and like others of this type was cited by 7.8 percent (n=17). There were a variety of issues which were individual or idiosyncratic: the amount of driving time to

the site, traffic, or having to get up at 5 o'clock in the morning to get to class at 8:30 a.m.

Fifteen teachers (6.9 percent) cited scheduling as an issue for them which made this issue third in order of frequency. In the no science interest group, a teacher thought the inservice "could have been condensed more." In the interested group, a teacher "wished it (the inservice) could be during school hours."

The motivated group complained the most about the schedule, which was logical since they had the most intensive inservice program and there were more responses from that group. One didn't like the hours: "Start at 9 am [instead of 8:30] and end by 2 pm [instead of 2:30] and have a shorter lunch [instead of the 30 minute lunch]." Five weeks during the summer was considered too long, with three to four weeks preferred. "Give up Saturdays!" was the rallying cry of one teacher in reaction to the one Saturday a month during the academic year.

The lack or poor quality of hands on labs was fourth in frequency of complaint with 5.9 percent reporting (n= 13). One teacher from the no science interest group wanted more activity based science. Of the interested group, one teacher complained that she was already familiar with most of the activities. "They (the presenters) insisted we try every single experiment when often they were self explanatory - demonstration is nice sometimes." The motivated group repeated their comments about one laboratory being too simple for the teachers in the K-2 grade level and wanted extensions to the activities to encompass other curricular areas.

"Not enough time for networking." "Not enough time for lunch." "No time for restroom breaks." "No time to coordinate science activities with my text book." Finally there was a wistful remark from a teacher who listed her complaints as "none" but added, "I just wish we had more time." Time was the fifth most cited complaint with 5.1 percent of the teachers reporting this item (n=11).

Additional Analyses

Reported in this section are results of two additional analyses which were ancillary to the main study of the effect of inservice programs on efficacy. They are (1) the relationship of the number of college or university science courses taken to efficacy and quantity of science instruction; and, (2) how the University of California San Diego (UCSD) could facilitate the involvement of a greater number of teachers in its science inservice programs.

Science Courses Taken

The demographic questionnaire asked respondents to report the number of science courses taken at the college or university level in order to determine relationships between that variable and others. Respondents were asked to circle 1 if they had from 0-4 science courses, 2 if they had 5-7 courses, and 3 if they had 8 or more courses. The mean for the population was 1.63 (SD .8). In the category of 0-4 courses, there were 122 subjects, representing 57.8 percent; the middle category of 5-7 courses had 46 subjects, or 21.8

percent; and the highest number of science courses, 8 or more, was reported by 43 subjects, or 20.4 percent.

There were two statistical tests which had significant results. A chi square test which compared groups by the number of science courses was highly significant ($p=.0004$), with the motivated and science interested group both having more science courses than the no science interest group (see Table 11).

Table 11

Number of Science Courses Taken By Group

Group	Number of science courses			
	0-4	5-7	8 plus	N
No Science Interest	53	8	5	66
Science Interested	35	18	17	70
High Science Motivated	34	20	21	75
Totals	122	46	43	211
Percentage	57.8%	21.8%	20.4%	100%

Chi-square = 20.65, $df = 4$, $p = .0001$

A one way ANOVA which compared self efficacy scores to the amount of science courses was also significant ($p=.0001$). Mean self efficacy scores were higher with the number of science courses taken. For example, those with minimal science had a mean efficacy score of 50.7 (SD 6.5); those with 5-7 science courses had a mean efficacy score of 52.2 (SD 8.9); and those with the highest number of science courses had a mean efficacy score of 56.1 (SD 5.3). (See Table 12).

Table 12

Mean Self Efficacy Scores by Number of Science Courses Taken

Number Science Courses	Self Efficacy Mean Score	SD	N = 211
0-4	50.7	6.5	122
5-7	52.2	8.9	46
8 plus	56.1	5.3	43

$F = 9.66$, $df = 2/207$, $p < .0001$

The Role of UCSD in Science Inservice Programs

There were three groups involved in this study. One was a group enrolled in the UCSD inservice program. The second group was from a small district to the north of San Diego. The third group was a group of elementary teachers from San Diego city and county who had at one time inquired about UCSD programs and thus were on the campus mailing list as being interested in the science programs offered. This third group, the science interested group, was surveyed by mail. For this group, a series of questions were included in the mail survey to inquire what UCSD could do to facilitate teachers' involvement in inservice programs and to find reasons why they did not participate when offered the opportunity. The UCSD inservice program was a three year program which consisted of a five-week summer session and eight Saturday meetings during the academic year. The results of the data indicated a number of interesting points.

The timing of inservice programs was a major issue for teachers responding to this question. For example, schedule conflicts emerged as the critical issue for 51.4 percent of the respondents (n=70).

Another 21.4 percent indicated they were involved in year round schools and thus unable to attend, while 10 percent said that attending Saturday sessions would be a difficulty. One teacher suggested a "choice of sessions, with options for partial attendance." With scheduling being such a serious issue, the result of 41.4 percent concerned about a three year commitment is more meaningful since "with small children it's hard to know what you will be doing in the following summer," as one teacher said. Another wrote: "5 weeks per summer x 3 summers was too big a chunk out of my life with my own 3 elementary aged children [sic]." Childcare was a problem related to the scheduling with 18.6 percent reporting this as an issue.

The purpose of stipends is to compensate teachers for potential lost income from summer jobs. "I attended the CLP (another project). I couldn't afford to NOT WORK (original emphasis) the entire summer. I lost money on the CLP and needed to survive the summer." Yet of those surveyed, only 18.6 percent indicated that the stipend was not enough. However, it was an issue for one teacher who said: "Increase the stipend!!! It's a real sacrifice for teachers to give up their summer. Make it financially worthwhile for us. I'd love to get involved but it has to pay better."

Fewer in number were those teachers who had another offer (7.1 percent), or who went to another program such as the California Language Project (CLP), or entered a Master's degree program instead (5.7 percent). A few (n=4, 5.7 percent) were concerned that they lacked sufficient science background to participate in the UCSD program. Some comments were: "Invite me again. Make it less

threatening" and "I was a first year teacher at the time and was unsure of acceptance. I thought you wanted people with more experience."

Of those surveyed, 85.7 percent indicated that they would be interested to participate in future programs if offered. "Offer it again. I still feel a need to improve my teaching of science." Several requested that the units earned be tied to a Master's degree program and others were interested only if the schedule were changed. "Please let me know if you will offer a brief, more condensed program." One comment prompted an image of a person standing by the phone, waiting, as she wrote "Just let me know!"

Summary

This purpose of this research was to investigate the effect of science inservice programs on elementary teachers. A test of self efficacy and a demographic questionnaire were administered to three groups of elementary teachers. Data were analyzed using a variety of statistical tests. Results of the tests were discussed in the sections dealing with the population description, the research questions, and additional analyses. In the next chapter are the conclusions to the findings of the research questions and additional analyses. Implications for future study will also be addressed.

Chapter Five

Summary and Discussion

Summary

Overall, science instruction at the elementary level has not been very successful according to many (Heath, 1983; Mechling & Oliver, 1983; Weiss, 1987). Poor test results, both nationally and internationally, reflect the lack of achievement in science education. The narrowing of enrollments in science as students progress from high school to college to graduate work is proof of lack of interest and motivation to pursue science as a field of study. Why are all these conditions specific to science education? Certainly, we could point to major sociological and cultural attitudes which pervade the American education system. Recognizing the macrocosm, however, does not solve the problem, but merely puts it into a larger context. A more specific context is the microcosm of the school and the three critical issues involved: the teacher, the curriculum, and the methodology (Marek & Heard, 1983).

Many teachers lack a science background; they may be out of touch with current science progress; or they may simply dislike science due to social conditioning and therefore ignore the science curriculum (Johnson, 1984). To disguise these inadequacies, many resort to convenient excuses to avoid teaching science: the problem

of setting up laboratory activities, the lack of supplies, concerns about student safety during hands on activities, and of, course, what the neighbors might think about the noise in the classroom during such activities. Extending Bandura's (1982) social learning theory to teachers, if teachers perceive themselves as lacking in subject matter proficiency, they will also lack self efficacy, a belief in their ability to produce a desired effect. In this case, they lack confidence in their ability to teach science and they lack belief in the desired effect of students to learn science. Consequently, one way to build confidence would be to bolster the teacher's science knowledge. Teachers who are better prepared in the discipline are then more willing to teach science.

The difficulty with this scenario is that the emphasis during preservice teacher training is in educational theory, with little emphasis on specific academic disciplines such as science. Thus preservice does not adequately prepare teachers for the practical demands of teaching science in the classroom. The English novelist Virginia Woolf is often quoted as saying that every woman needs a room of her own and 20 pounds a year in order to be independent. Benjamin Franklin considered himself a printer first, then a statesman, as indicated by his will: "I, Benjamin Franklin, Printer, late Minister Plenipotentiary from the United States of America to the Court of France, now President of Pennsylvania..." (Rigden, 1986). A room of one's own for a writer; a printshop of one's own for a printer; a discipline of one's own for a teacher - the latter, especially in the field of science instruction, is slow in coming. To remedy this condition, science specific inservice programs are necessary.

The purpose of this research was to determine the effects of inservice programs on the self efficacy of elementary teachers involved in science instruction. Three groups of elementary teachers were surveyed: a treatment group participating in an intensive science inservice program; a control group with a professed interest in science; and another control group with no expressed science interest. Each group contained approximately 70 or more subjects, with a total population of 221 in the research project.

All subjects were given two questionnaires: a Science Teacher Efficacy Belief Instrument (STEBI) and a demographic survey. The STEBI was a 25 item Likert instrument in which teachers indicated to what extent they agreed or disagreed with statements about teaching science. The demographic questionnaire asked for information regarding other variables which could influence on efficacy: number of college science courses, number of hours of recent science inservice, gender, years teaching, and grade level taught. Other open ended questions asked for subjective responses regarding what teachers liked and disliked about science inservice programs and what would facilitate participation in future inservice programs. Data were analyzed using frequency counts for the population and the three groups, chi square tests, and analysis of variance.

Conclusions

There are several areas in which this research provides conclusions based on statistically significant differences between the highly motivated science group and the other two groups; primarily,

differences in efficacy scores which were influential in determining differences in quality and quantity of science instruction. Items liked best and least regarding inservice and comments about what would facilitate participation in inservice programs are included in the discussion.

The highly motivated science group which is currently engaged in an intensive three year, discipline based science program at the University of California San Diego clearly showed that it was higher in self efficacy than the other two groups. While this research cannot claim that the inservice program caused the higher efficacy, it may be inferred that the program contributed to greater self confidence in teaching science. Having more science knowledge, these teachers spent more time imparting science instruction to their students than the other two groups. They favored more lecture based classes and more worksheets, but balanced those with more hands on activity. With more science information, these teachers were able to share more with their colleagues, using coaching, presenting at local meetings, and presenting at regional or national conferences as methods of sharing.

However, data on the two control groups did indicate some statistically significant features. Firstly, the group which was not interested in science did more seatwork. This group also reported the least amount of inservice hours and college science education. Secondly, the group which was interested in science reported spending more time in routine activities.

The factors teachers liked best and least about inservice programs have importance to teachers, administrators, resource

persons, and program specialists, since these preferences ought to be taken into account if successful program design and implementation is an objective. Teachers were critical of programs which had poor content and were not efficiently structured to make the best use of time. Programs which teachers praised were those with immediate relevance and plenty of hands on activity.

Lastly, the mail survey sent to the science interested group asked what UCSD could do to facilitate the recipients' participation in future inservice programs. The majority of responses indicated that scheduling was the critical issue and that UCSD could be more flexible to the needs of teachers in multitrack schools. Day, evening, weekend, and short seminars were mentioned as alternative schedules.

Discussion

The issues raised in chapter one centered around the unhealthy condition of science instruction in elementary schools today. Under scrutiny were the minimal quantity of instruction; the poor quality of instruction, including an archaic textbook-based curriculum and impractical methodology; and the teacher deficient in science knowledge. An issue which emerged from the problem of inadequately trained teachers was their lack of efficacy and their resultant reluctance to teach science. These items are reviewed in the following section.

Quantity of Science Instruction

In the area of quantity of science instruction, the literature on the subject suggested various reasons why the elementary teacher did not teach science: for example, science anxiety (Spector, 1986) or low science proficiency (Haury, 1984). Bandura's (1982) theory of efficacy stated that people avoid behavior in which they feel inadequate; they instead choose tasks for which they have high efficacy. He went on to state that people can build confidence through behavior change since efficacy is situation specific. Examples Bandura cited specified cardiac patients in rehabilitation as well as phobics, both of whom learned coping skills to counteract their fears and change their behavior. By extending this theory, researchers have shown that efficacy can be increased through situation specific education. Therefore, with increased science knowledge, there ought to be a corollary increase in the teacher's confidence, hence a greater propensity to teach science. Thus, the more comfortable a teacher is with his or her subject, the more likely that teacher will be to devote more time to the subject. The quantitative concept of teaching calls for more science teaching in the elementary classroom to encourage more science learning. In this way we influence the quality and quantity of science instruction (Murnane & Raizen, 1988).

According to this research, the amount of instructional time in science correlated positively and significantly with the self efficacy scores of the highly motivated group. Their mean instruction time was 48.3 minutes (SD 16.5), almost ten points higher than the group with no science interest. In addition, the total time was used predominantly in lecture or hands on activity, as reported earlier, and

while the science interested group also showed a greater amount of time in science instruction, this time was used in routine activity. It is apparent that interest in science must be supported by specific discipline based knowledge and the means to convey that knowledge in the classroom via teaching techniques. The motivated group had such information and used the time in more effective teaching methods, while the interested group merely filled the time. If these interested teachers can be more educated, there is the possibility that the science instruction time may be more carefully used.

This data supports the Riggs dissertation (1988) which reported a highly significant positive correlation between time spent on science and efficacy, and the amount of hands on science and efficacy. Results such as these conform to the theory of social learning of Bandura that more time is given to activities for which there is greater confidence and from which a positive outcome can be expected. (see Table 13).

Table 13

Comparison of Mean Efficacy Scores and Mean Time of Science Instruction by Group

Group	Mean efficacy score	Mean science time (minutes)
No science interest	48.89	38.4
Science interested	50.28	45.3
High science motivated	56.66	48.3

The amount of science instruction reported in this research, even by the group with no science interest, was more promising than

previous research which indicated that the average science instruction for grades K-3 was 18 minutes per day (Weiss, 1987). It was certainly more heartening than the results of the Texas study which showed only eight minutes a day devoted to science instruction because of inadequately prepared teachers (Bethel, 1982). These discrepant reports regarding the amount of time spent on science need to be examined further, preferably via observation or examination of lesson plans, since self-report by teachers may be inflated due to the desire to respond in socially acceptable ways. Another reason for the differences may be state mandated curricula.

Obviously some states have different curricular emphases; California may be exhibiting more leadership through its emphasis on a science curriculum and by pushing for statewide science achievement tests at the sixth grade level. A recent proposal in this state seeks 100 schools willing to restructure science education from the traditional program of biology, chemistry, and physics in grades 7-12. It asks for a conceptual, integrated approach which would give students more science throughout the high school years (California State Department of Education, 1989). Without this type of external influence, other states may continue to lag in quantity, and consequently quality, of science instruction.

The highly motivated group taught more science than the other two groups, had taken more college science courses, had more inservice hours, had a greater percentage of subjects with an advanced degree, and scored higher on self efficacy. Then how do we also account for the differences in teaching modalities which set this group apart from the two control groups?

Quality of Science Instruction

According to the literature, quality of science instruction is negatively influenced by a limited curriculum (Heath, 1983) and problematic methodology (Harlen, 1984). Rather than be stymied by such conditions, as a person with low efficacy would be, the "can do" person looks for solutions to problems and creates opportunities. These characteristics were noted by Bandura (1982) in his research on knowledge acquisition and response execution as a stage in the range of efficacy reactions. This general theory can be applied to teachers represented in this study.

Therefore, an explanation for the different teaching modalities demonstrated between the highly motivated group and the other two groups is that with more belief that they can teach science, and possessed of more substantive science content, the motivated group found ways to circumvent the bureaucratic school system. They devised supplements to the curriculum and methodology which made science teaching possible. Being empowered gave the teachers the ability to identify and prioritize local needs and act on those needs, by individualizing programs for their classes.

An example here should highlight the point. One of the participants in the intensive science inservice program had need of equipment for her activities, specifically a balance. Knowing that San Diego is an illegal methamphetamine center; and that balances are used in manufacturing "crystal meth;" she also surmised that police routinely confiscated such equipment. She inquired at the police station, requesting a donation of a balance and was asked to make the necessary official request. Within a month she had a balance. This

teacher was clearly empowered to act on the needs of her classroom and she and her students were all the richer for it. An example such as this is a glowing tribute to good inservice programs which contribute to a teacher's confidence and empowerment (Bowyer, 1987; Burke, 1980; Burrello & Orbaugh, 1982; Daresh & LaPlant, 1984; Diatolevi, 1987).

A specific modality in which the three groups of elementary teachers differed significantly was in the use of the lecture method, with the highly motivated group using this method to a greater extent than the two other groups (mean 11.3 minutes, SD 9.0). The reported use of lecture by the highly motivated group was 3.1 minutes more than the next mean score of the science interested group which was 8.2 minutes (SD 5.3), while the difference between the two control groups was a negligible .3 minutes. A feasible explanation for more lecture is that armed with more science knowledge, teachers were supplementing or replacing traditional textbook material with material from their inservice program which was more relevant to their immediate needs. This behavior is once again consistent with Bandura's social learning theory and the empowerment that occurs with substantive science education. A teacher with little knowledge of science will have little to say and thus not use the lecture method, but rather resort to some sort of self contained paperwork as an alternative.

The lecture method was used more by the highly motivated group than the other two groups. However, the results of this research also indicated that lecturing was used more frequently than reading by all of the groups. Yet the literature stated that the textbook

was the basis on which the science lesson was built (Mechling & Oliver, 1983). It would appear that the science classrooms in this study are teacher dominated instead of textbook driven, a contradiction to the previous literature. Nonetheless, reading (presumably a textbook) was a prominent feature in the amount of time spent on science, ranking third in priority for each of the three groups. However, the amount of time spent on reading was not significantly different among the groups (Table 8).

The use of worksheets by the science motivated group was a teaching technique which also differed significantly from the other two groups. An explanation for this preference could be similar to the rationale previously stated, that worksheets may supplement or replace the textbook. Thus the teacher once again demonstrated the ability to change the curriculum to meet local needs. Several other factors may be involved. These teachers may enjoy designing worksheets for their students; they may also feel these supplements are necessary to their students' understanding of key concepts. Interestingly, the design of worksheets takes time, so either these teachers have considerably more time, or prefer to put the time into science activities rather than other curricular items. In which case, one might ask how they can justify the time spent on these activities. The issue of time will occur again in other contexts.

Until this point we have discussed ways in which the science motivated group differed from the other two groups. However, there was one area in which each of the other two groups demonstrated significant differences from the science motivated group. First, the no

science interest group made more use of seatwork; second, the science interested group reported more reliance on routine activities.

How can these results be explained? With low science proficiency, teachers may rely on activities within their comfort zone, where they are not challenged by students who ask "why" questions, and where there is no need to set up materials and supplies for hands on activity. It would appear that seatwork and classroom routines are expedients used by the inadequately prepared science teacher to satisfy curricular requirements. In other words, they may rationalize that they have met the standards by adhering to the letter rather than the spirit. Research by Riggs (1988) demonstrated that there was a positive correlation between high efficacy teachers and more effective teaching strategies. A reasonable assumption, based on the opposite point of view, is that teachers with low efficacy choose traditional, safe teaching strategies since they are not confident of their ability to carry out what they perceive as more adventurous techniques.

One way in which all three groups were the same was in the almost total absence of any reported computer use in the K-6 classroom. Despite widespread use of computers in business and industry, educators are not taking part in this aspect of the technological revolution. And this research finding is hardly surprising, since a nationwide study has shown that "far from being an educational panacea, school computing is close to being a practical failure" (Perkins & Rivers, 1989, p.1). The failure of computer use in education is due to a combination of untrained teachers and incompatible hardware and software. Once again, the issue of teacher training is at the forefront of an educational problem, demonstrating

that money, equipment, and supplies will be of little use unless there are qualified personnel to make use of these resources.

Inadequately Trained Teachers

What can be done about inadequate teacher preparation? The current situation is doleful. Teacher preparation has been called "shallow and irrelevant" (Wise, 1988, p. B1) with an emphasis on educational philosophy and pedagogy rather than subject specific content. "Future teachers are in the hands of educationists who load their programs with trivia; they cannot think quantitatively; they are not up to 'honest' physics courses; the problems of elementary school science are so large that they can be managed only through specialist teachers" (Bromley, 1972, p 1). A minimum of basic science taught by scientists is provided in teacher training programs. But in these courses, potential teachers are exposed to just the very type of science education we are currently attempting to avoid in science instruction for children -- lecture-based, with a few prearranged demonstrations, and simplified laboratory activities -- according to D. Allan Bromley, who was recently confirmed as Bush's director of the White House Office of Science and Technology Policy. Bromley's argument carries some weight, since he has been a professor of physics at Yale since 1960. He contends that we must allow future teachers the same latitude they must give their pupils: the time to "explore, measure, compute, err and recover, and draw unanticipated conclusions," (1972, p. 1) all of which are missing in current preservice science education. Given this treatment of science instruction in preservice, inservice programs must provide both substantive discipline based content and the opportunity to experiment with activities of

immediate practical use in the classroom. This will permit teachers to practice the new behaviors required if we are to make any progress in arresting the minimal science cycle now being perpetuated.

The inservice program offered at UCSD was such an attempt to change the system and involved university faculty in K-12 education on a variety of levels. Discipline based and comprehensive, the program contained components of both theory and practice. UCSD research scientist/faculty taught current developments in three scientific fields: biological sciences, earth/space sciences, and physical sciences. Exposure to top level scientists gave teachers an opportunity to become aware of the enthusiasm and dedication of exemplary people in the field. In addition, laboratory sessions in each field of specialty gave teachers opportunities to practice hands on activities which applied the theory learned. Laboratory sessions were geared to specific grade levels and the activities offered contained extensions to other areas of the curriculum. Extensions included simple practice in mathematical computation, exercises in report writing, or the history of a person or theory. This part of the inservice provided practical, relevant information for immediate classroom use to balance the theoretical concepts presented by faculty.

It is this program which the science motivated group attended. Data from the efficacy and the demographic instruments showed that the group of teachers who had the intensive science treatment did have significantly higher efficacy scores, spent more time on science, and had different teaching methods. In addition, they were obviously better prepared, since they had a higher number of college science courses and a higher amount of science inservice, both of which may

contribute to their efficacy in science instruction. Thus, the example of the UCSD inservice program demonstrated that the potential exists to ameliorate preservice deficiencies through quality inservice education. This is the beginning of a change in the cycle of science education: empowering the teacher, encouraging the students, increasing the pipeline, and contributing to scientific literacy in the community.

Table 14

Comparison of Groups by Mean Number College Science Courses,
Mean Hours Science Inservice, and Mean Efficacy Scores

Group	Science Courses	Inservice Hours	Efficacy Scores
No science interest	1.27	1.16	48.89
Science interested	1.74	2.22	50.28
Science motivated	1.83	3.35	56.66

However, several factors stand in the way of implementation of such programs on a large scale, two of which are motivation and funding. Motivation is, of course, critical. "At the elementary school level there is little to complain about. In fact, there is almost nothing at all to speak of" (Goodstein, 1988, p.2). In short, with no mandatory assessment, there's no science. In 1990, however, California faces a statewide achievement test at the sixth grade level, so the external environment in this state will drive the need for accountability in science education at the elementary level.

A further rationale for the dearth of science education in K-6 has been the lack of funding. Funding is designated for a variety of programs, some cosmetic, some political, some seemingly devoid of function or merit. Recent educational funding has gone to special education or bilingual programs to redress long-standing deficiencies in those areas. However, some argue that the grand experiment of trying to "create an educated nation has failed as far as the sciences are concerned. In the sciences, and in physics in particular, we still have a small, educated elite, and a basically illiterate public" (Goodstein, 1988, p 1). Regardless of the hue and cry concerning Japanese encroachment in technology -- or from an earlier era, the Russian technological feat of putting Sputnik into orbit -- science and technology education is not an issue of high salience with today's general public. UCSD is fortunate to have the backing of the National Science Foundation and contributions from private foundations to fund its programs being offered to teachers in the San Diego area. UCSD has funding, but more importantly, it also has a vision for the future of K-12 education. It is also fortunate to have motivated faculty who are willing to act as advocates for science education and to articulate that vision.

While research and practice have both contributed to the identification of exemplary models of science inservice programs, and federal and private funds have contributed to the implementation of these programs, they remain distant landfalls in a sea of science illiteracy. They have yet to be implemented, much less institutionalized, in our schools and districts, which was a recommendation made by the Exxon Foundation in its review of

science education in 1984. Five years later, it remains for the individual teacher to recognize his or her deficiencies and to make a personal commitment to the future of science education, a step which, as previously indicated, is not generally noticed or appreciated by individual schools or districts.

Thus the environment for exemplary science inservice programs seems less than salubrious for the immediate future, despite the political exhortations of George Bush that he intends to be the education President. The reality is that he has put no additional funds into education with the exception of the recognition of the Head Start Program. Political attention to education gains headlines and may heighten public sensitivity, but it takes money and vision to rectify the current dismal state of science education and to retrain several generations of inadequately trained teachers. Bush is notably short on "the vision thing" and the money has not been forthcoming. The Strategic Defense Initiative has requested \$5.9 billion for fiscal year 1990; the National Science Foundation has requested \$190 million, the equivalent of one third of a stealth bomber (Hake, 1989).

Sharing Science Information

Joyce and Showers (1983) have conducted research which reported the effectiveness of coaching as a means of improving staff proficiency. Coaching was defined as the process in which an experienced teacher observes and comments on the new classroom behavior of a beginning teacher. The results of this research showed that the UCSD group practiced coaching while the other two groups did not. With this method of enhancing science education, some teachers and their respective schools and districts will demonstrate

more effective behaviors since this method is proven to be more useful (Bowyer, 1987). Teachers with more self confidence are quite likely to be more apt to share their expertise and mentor others. Again, efficacy is a behavior in which a person expects certain outcomes, and mentor teachers can get immediate feedback from their peers or observe fairly rapid change in a new teacher's behavior. The efficacious teacher finds the time and the opportunity to help others and all benefit as a result.

Another way in which the highly motivated science group differed from the other two groups was in its reported incidence of presenting science information at local inservice and regional professional meetings. An impression is that presentations of this type indicate higher self efficacy and self confidence, as well as the belief that one has information worth sharing and from which others may benefit. It was significant that none of the others had presented science information at local or regional meetings.

Other Findings

Participation in Inservice

In the conclusion and discussion, it was suggested that participation in inservice programs influenced self efficacy and gave the teacher more confidence to teach science, since the teacher had greater content knowledge of the subject. Yet many teachers do not participate in inservice programs. A 1981 survey of 450 teachers reported that 79 percent had no science inservice programs of ten

hours or longer in ten years (Shymansky & Aldridge, 1982). Why should this be the case?

To gain some insight into what would facilitate teacher participation in training programs, the demographic questionnaire which was sent to one of the control groups, the science interested teachers, contained the question: "What can UCSD do to facilitate your participation in future inservice programs?" Following the question was a list of items and respondents were asked to circle those most meaningful. There was also space for open ended responses.

Scheduling emerged as the critical issue for 51.4 percent; another 21.4 percent were involved in year round schools; and yet another 10 percent had a problem with Saturday sessions. Adding these together, those with schedule conflicts amounted to 82.8 percent of responses. What does this finding imply for the university in terms of its commitment to assist K-12 educators in becoming more capable teachers? And what implications can be generalized for other university-school partnerships? It will certainly challenge administrators and science faculty with some problematic decisions to be made.

To begin with, UCSD has its own scheduling problems. It has a quarter system in which the bulk of the students attend during the academic year and depart for the summer. With the absence of regular full time students, the university facilities are then available for programs dedicated to special populations. These consist of summer session students; educational opportunities for underrepresented groups who are invited to campus; and a host of special interest conferences, seminars, or colloquia. Teacher institutes form a portion

of these special groups, and institutes are made possible by available space and resources during the summer which are generally not available during the traditional academic year. Yet the K-12 teachers surveyed are asking for more flexibility in scheduling from an institution which does not respond quickly to change and which has a set and seemingly rigid schedule. University priorities will obviously come before K-12 educational programs.

At UCSD, research is the priority, followed by graduate and undergraduate education. Community programs are fitted in the interstices of these priorities as a means of satisfying community conscience, rounding out the university calendar and creating revenue. To ask that the university change its schedule to permit inservice programs at alternate times appears an impossibility.

Yet it could be done. Given the indication that teachers were willing to attend programs in the evenings and weekends, then that may be the compromise. Such scheduling of classes is commonplace for university extensions nationwide and these are fee based classes. A free inservice program, offered in the evening or at the weekend, could have a substantial following as well. Add a stipend to compensate teachers for the inconvenience of nights and weekends spent in preparation, then participation in this flexible schedule becomes a more viable possibility.

However, there does remain the issue of a fully committed faculty, already engaged in research, teaching, and administration, who may be unlikely to respond to the call of K-12 teachers to be available for evening and weekend teaching assignments. This is a critical concern, since the quality of the UCSD inservice program lies

with the quality of its faculty. The chancellor of the university stated that he felt the excellence of the faculty was the focal point of the university, and from that excellence there emanated funding, students, and facilities (Atkinson, 1989).

UCSD certainly has a history, via its extension programs, for flexible scheduling. What it does not have is participation of UCSD full time faculty in these extension-type classes. Consequently, professionals from the community are employed to teach such courses. Can UCSD convince its faculty to share its expertise with the K-12 population in order to continue the quality inservice programs? Or will UCSD be in the position of having to hire community professionals and thus lose a valuable component which contributes to the excellence of the inservice? While prospects for flexible scheduling appear possible, prospects for increased UCSD faculty involvement appear problematic. "Present institutional attitudes and structural conditions mitigate, however, against a serious university role in educational innovation and excellence" (Reif, 1974, p. 537). Faculty are encouraged to research and to publish. There are few incentives for the exemplary professor who puts the student first.

Other, smaller, liberal arts colleges may have an easier time adapting to the conflicting schedules of their respective K-12 teachers and so may be positioned to lead some flexible inservice scheduling. However, the very fact that the college is small limits its responsiveness to the community, because of limited resources. The responsibility for taking the lead in science then seems to rest with a large, research based institution which has the infrastructure to

accommodate external programs such as K-12 inservice. Yet these are the very institutions which have a publish or perish mentality.

Table 15

Comparison of groups by percentage of females, percentage of MA degrees, years teaching, and efficacy

Item	No Interest	Science Interested	High Science Motivated
Years teaching	9.8	10.9	12.0
Percent female	99%	83%	88%
Percent MA degrees	30%	43%	45%
Efficacy score	48.89	50.28	56.66

Other Issues

The no science interest group showed a number of curious differences from the other two groups which raise questions, specifically regarding gender bias, amount of education, and number of years teaching. While this study did not reveal statistically significant differences in the efficacy of males or females, there was none the less a higher efficacy score among the males. The Riggs (1988) study did show statistically significant male bias in efficacy. Table 15 indicates that the no science interest group was composed almost totally of females, while the other two groups had a greater percentage of males. The virtual absence of males may have negatively affected the efficacy results of the no science interest group while the higher percentage of males positively affected these results in the other two groups.

In addition, the no science interest group had fewer people with advanced degrees, another factor which may influence confidence levels in teaching. The contention by the Carnegie Foundation is that teachers have a broadly based undergraduate education in a discipline, then go on to teacher training at the graduate level (Task Force on the Teaching Profession, 1986). These results seem to indicate that overall amount of education may possibly play a part in influencing confidence levels in teaching.

Lastly, while this study showed no statistically significant results regarding years teaching, it is nonetheless interesting to note that the no science interest group had the least years teaching. The information on this group contradicts the study by Ashton (1984) that showed efficacy to be high in the five to ten year teaching range and then to decline after ten years of teaching. In fact, science efficacy was higher for the two groups which had more than ten years teaching. All these factors contribute to raising questions about the nature of this group of teachers which will be considered in the section on future research.

Limitations

A pseudo experimental design applied to three static groups was used in this project employing a post test only. Problems with a post test only design include the causation issue, since there may be reasons other than the treatment for the data results. Threats to internal validity include history, maturation (to some extent), testing, and instrumentation. In terms of history, other educational programs

may have had an influence on the efficacy scores of the teachers in any of the three groups. Maturation is not as critical an issue, since the survey respondents were all adults. However, for a first year teacher the learning curve is quite steep and those persons in the beginning stages of a teaching career might have therefore responded differently than those in the middle or later stages of teaching.

Reactive testing may be another threat to internal validity, with teachers wishing to respond in what they perceive to be socially acceptable ways, thus inflating the self-report data on items such as the amount of time spent on science, for example. Two of the surveys were conducted in group settings; one was done by mail. The former responses may indicate more of a socially desirable response rate than the latter, which was presumably done in the privacy of the teacher's home. Lastly, the issue of instrumentation must always be considered since the very act of measurement often changes the experiment.

The three groups surveyed in the population of elementary teachers were originally deemed to be quite different in terms of science background and science motivation. The criteria established for entry into the UCSD science institute recommended a science degree and science teaching experience. However, in the recruitment of participants, it became obvious that UCSD would not meet its desired objective of 100 participants and so all who applied were accepted, regardless of science background or experience. In addition, the original cohort of 102 applicants changed between the time of acceptance and the time of testing since some teachers had to drop out and were subsequently replaced. Therefore, for the purpose of this study, the groups differed only in so far as one group followed

through on the application process and was accepted, another group expressed an interest but did not apply, and the third group did not apply either through lack of knowledge of the program or lack of interest in it.

Implications for Future Research

Riggs (1988) developed and validated an efficacy instrument (STEBI) as a means of testing what teachers believe about science education, since such beliefs influence what goes on in the classroom. In her dissertation, Riggs called for future research to replicate the study using the STEBI on other populations from geographically diverse areas. The Riggs study involved 332 teachers from the Kansas City area. The current research was done with 221 subjects from San Diego city and county. While this replication has added to our information pool on science efficacy beliefs, there are several other areas which can be addressed in future research.

1) The relationship of time to efficacy could be a topic for future research. The highly motivated group spent more time on science instruction than the other two groups. How did this group justify its use of time in what teachers' perceive to be an already overburdened curriculum? Is the time spent in more qualitative teaching or is time in fact taken away from other substantive areas? Are teachers with high efficacy also high in task centeredness and structure, features which may permit more content and less process in the classroom?

2) Can science interested teachers be identified and re-educated in science content and methodology in order to change

science instruction? In this research, two groups showed statistically significant total mean time spent on science, yet the motivated group used that time in lecture and hands on, while the interested group used the time in routine activity. Given the interest of these teachers, much could be done to improve their effectiveness with staff development programs.

3) Given that the highly motivated group also differed in its teaching methods, there may be other variables which influenced methods, such as school culture, physical environment, teacher preference or student body composition. These conditions may also contribute to building confidence.

4) While the gender based results were not statistically significant in this study, the Riggs study (1988) did demonstrate a male bias toward higher efficacy. The mean score for males in that research was 58.9 which was significant at the .05 level compared to the mean for females at 55.48. Future research on gender issues would be useful to clarify factors regarding the reported female science anxiety.

5) This research did not ask for respondents' ethnic makeup, an area of concern regarding role models in the classroom who are needed to influence the pool of potential science students travelling the academic pipeline. There is concern that women and people of color are opting for less science due to biases in the socialization process rather than lack of aptitude or interest.

6) Bandura's (1982) concept of situation specific efficacy has implications for future research in another area of academic concern, that is, in the area of mathematics. While science is given minimal

consideration at the elementary level, there is considerable attention paid to mathematics, yet the corresponding national and international scores do not reflect substantial mathematics achievement (National Research Council, 1988). In addition, there are correspondingly fewer students, male and female, of various ethnic backgrounds, entering advanced mathematics classes and degree programs. Thus an instrument which would test elementary teachers' mathematics efficacy might be a step toward the identification of teaching problems in that academic discipline.

7) There has been a great deal of research on the effectiveness of inservice programs. Teachers have spoken clearly on what they like and dislike about programs. Yet there is the impression that the same old programs are being aired, like television situation comedies, with their predictable plots and the unimaginative storylines. Future research might investigate the program development procedures of administrators, principals, or resource teachers who continue to operate within the comfort zone of standard inservice programs which may not be relevant to teacher needs.

8) While this research has dealt with inservice teachers, future research can look into the confidence level of preservice compared to first year teachers, since there has been some indication that preservice teachers have greater efficacy due to the collegial nature of school life. Once teachers get into the classroom, however, the sense of isolation begins to erode that efficacy. At the University of California Los Angeles, a program called "Save Our Science" (SOS) was funded with the express purpose of nurturing beginning teachers through the

first year, a telling indication of the shock that awaits the preservice teacher once he or she enters the classroom.

9) While self-report is a convenient measurement technique, there is always the risk of inflated scores because of the need to respond in socially acceptable ways. It is suggested that future research corroborate the quality and quantity of science instruction by other means. Direct observation in the classroom would be useful, as well as indirect observation via video; however, it is recognized that both are labor intensive and hence more time consuming and expensive means of data collection. Other, less intrusive measures, could be analysis of lesson plans, investigation of the amount of supplies used, and triangulation of reports from students, parents, and other teachers. Starting in 1990, data collection can also include scores from the California achievement tests.

Final Remarks

Are we a nation at risk? If the research of Weiss (1978, 1987) is all we have to describe the condition of science education, then the answer is yes, for that data showed no positive change in science instruction over a ten year period. Likewise follow up reports on the Nation at Risk ten years later showed little progress in education at large. Yet aggregate data, unlike aggregate rocks, sometimes hides the gemstones. Just as the students of Garfield High School can confound a nation accustomed to low performance of students at inner city schools, so can an exemplary inservice program confound the researchers accustomed to little change in science instruction. There

is more science being taught in San Diego city and county schools; one could go on to say that it is better science, since the teachers involved are those who believe they can teach science and that students can learn. Science education can and is contributing to future generations of scientifically literate citizens who can address the three critical issues cited at the beginning of this paper: economic development, national security, and the survival of a democratic way of life.

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APPENDIX

LA JOLLA, CALIFORNIA 92093

April 3, 1989

Dear Colleague:

UCSD is conducting a study regarding inservice programs to compare those who participated in the 1988-89 Teacher Institute with those who did not participate. We are concerned why your inquiry about the training program did not result in an application for admission. Through your response we hope to determine what we at UCSD can do to tailor future programs to be more responsive to the needs of elementary teachers.

The enclosed survey and science instrument will take just a few minutes of your time and the information would be of great help to UCSD and many teachers. Your responses will be anonymous and results compiled in the aggregate. In appreciation of your cooperation, we're enclosing a UCSD pencil and a stamped return envelope. We would appreciate a return by April 21, 1989.

Sincerely,

P.A. Moore
Coordinator, Teacher Institutes

Enc: Survey (ms/102)
Science Instrument
UCSD pencil
Stamped return envelope
UCSD Science Institute brochure

SCIENCE TEACHING EFFICACY BELIEF 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 do not teach science as well as I do most subjects.	SA A UN D SD
4. When the science grades of students improve, it is 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 elementary science.	SA A UN D SD
13. Increased effort in science teaching produces little change in some students' 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 skills 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 do not 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 to learn science.	SA A UN D SD

SCIENCE SURVEY FOR ELEMENTARY TEACHERS

1. How many years have you been teaching? _____
(Include substitute teaching but not student teaching).
2. What grade(s) are you now teaching _____
3. What is your gender?   Male   Female
4. What is the highest academic degree you hold?
BA   BS   MA   MS   MED   PHD   EDD
5. Please circle the approximate number of college/university level science courses you've completed.   0-4   5-7   8 or more

Please answer questions 6-8 specific to your most recent science lesson for a grade that you teach.

6. What is the grade level for the science lesson you are describing? _____
7. How many minutes were allocated for that science lesson? _____
Of these, how many minutes were spent on the following:
  - a. Daily routines, interruptions, and non-instructional activity _____
  - b. Lecture _____
  - c. Working with hands-on, manipulatives, or laboratory material _____
(teacher demonstration and/or student participation)
  - d. Reading about science _____
  - e. Test or quiz _____
  - f. Other science instructional activities _____
8. Indicate the activities that took place during that science lesson. Circle the letter(s) for all that apply.
  - a. Lecture
  - b. Discussion
  - c. Teacher demonstration
  - d. Student use of hands-on or laboratory materials
  - e. Student use of computers
  - f. Students working in small groups
  - g. Students doing seatwork assigned from textbook
  - h. Students completing supplemental worksheets
  - i. Assigning homework

The following questions concern inservice programs.

9. During the current academic year (1988-89), what is the total amount of time you have spent on in-service education in science or the teaching of science? (Include attendance at professional meetings, workshops, and conferences, but do not include formal courses for which you received college credit or extension credit). Circle one.
  - a. none
  - b. less than 6 hours
  - c. 6-15 hours
  - d. 16-35 hours
  - e. more than 35 hours

10. Circle the letter(s) that describe(s) the type of inservice.

- a. lecture presentation of science content
- b. demonstration of science activities
- c. practice of hands-on activities
- d. other _____

11. What did you like best about the inservice?

_____

12. What did you like least?

_____

13. How have you shared **science** information with your colleagues this current academic year (1988-89)? Please circle the letter(s) for all that apply.

- a. informal conversation
- b. coaching (training followed by classroom observation)
- c. mentor teacher
- d. presentation at a district or local inservice program
- e. presentation at a regional or national conference
- f. does not apply
- g. other _____

14. You inquired about UCSD's 1988-89 Science Institute for Elementary Teachers but did not apply for admission. Please circle the letter(s) that best explain the reason(s) why you did not apply. Please feel free to make any additional comments in the space provided.

- a. three year commitment
- b. schedule conflict with five week summer session
- c. stipend not sufficient
- d. got a better paying job/offer
- e. child care costs
- f. attended another training program
- g. schedule conflict with Saturday academic year meetings
- h. assignment to a year round school
- i. principal would not endorse application
- j. concern about lack of science background
- k. other

comments _____

15. What would you suggest to UCSD to facilitate your participation in a future institute?

_____

THANK YOU FOR YOUR COOPERATION. PLEASE RETURN THIS SURVEY AND THE SCIENCE INSTRUMENT IN THE ENCLOSED STAMPED ENVELOPE BY APRIL 21, 1989.

(ms/102) code # _____

SURVEY
1988-89 UCSD SCIENCE TEACHER INSTITUTE
FOR ELEMENTARY TEACHERS

1. How many years have you been teaching? _____
 (Include substitute teaching but not student teaching).
2. What grade(s) are you now teaching _____
3. What is your gender?   Male   Female
4. What is the highest academic degree you hold?
 BA   BS   MA   MS   MED   PHD   EDD
5. Please circle the approximate number of college/university level science courses you've completed.   0-4   5-7   8 or more

Please answer questions 6-8 specific to your most recent science lesson for a grade that you teach.

6. Write the grade level for the science lesson you are describing. _____
7. How many minutes were allocated for that science lesson? _____
 Of these, how many minutes were spent on the following:
  - a. Daily routines, interruptions, and non-instructional activity _____
  - b. Lecture _____
  - c. Working with hands-on, manipulatives, or lab materials _____
 (teacher demonstration and/or student participation)
  - d. Reading about science _____
  - e. Test or quiz _____
  - f. Other science instructional activities _____
8. Indicate the activities that took place during that science lesson. Circle the letter(s) for all that apply.
  - a. Lecture
  - b. Discussion
  - c. Teacher demonstration
  - d. Student use of hands-on or laboratory materials
  - e. Student use of computers
  - f. Students working in small groups
  - g. Students doing seatwork assigned from textbook
  - h. Students completing supplemental worksheets
  - i. Assigning homework

The following questions concern inservice programs.

9. During the current academic year (1988-89), what is the total amount of time you have spent on inservice education in science or the teaching of science? (Include attendance at professional meetings, workshops, and conference, but do **not** include the UCSD Summer Institute or Academic Year program, or any other course for which you received college or extension credit). Circle one.

- a. none
- b. less than 6 hours
- c. 6-15 hours
- d. 16-35 hours
- e. more than 35 hours

10. Circle the letter(s) that describe(s) the type of inservice.

- a. lecture presentation of science content
- b. demonstration of science activities
- c. practice of hands-on activities
- d. other _____

11. How have you shared **science** information with your colleagues during the past academic year (1988-89)? Circle the letters for all that apply.

- a. informal conversation
- b. coaching (training followed by classroom observation)
- c. mentor teacher
- d. presentation at a district or local inservice program
- e. presentation at a regional or national conference
- f. does not apply
- g. other _____

12. What do you like best about the UCSD Science Institute?

_____

11. What do you like least?

_____

THANK YOU FOR YOUR COOPERATION

ucsds/103 code # _____

SCIENCE SURVEY FOR ELEMENTARY TEACHERS

1. How many years have you been teaching? _____
(Include substitute teaching but not student teaching).
2. What grade(s) are you now teaching _____
3. What is your gender?   Male   Female
4. What is the highest academic degree you hold?
BA   BS   MA   MS   MED   PHD   EDD
5. Please circle the approximate number of college/university level science courses you've completed.   0-4   5-7   8 or more

Please answer questions 6-8 specific to your most recent science lesson for a grade that you teach.

6. Write the grade level for the science lesson being described.   _____
7. Write the total minutes allocated for that science lesson.   _____
8. Of these, how many minutes were spent on the following:
  - a. Daily routines, interruptions, and non-instructional activity   _____
  - b. Lecture   _____
  - c. Working with hands-on, manipulatives, or laboratory material   _____
(teacher demonstration and/or student participation)
  - d. Reading about science   _____
  - e. Test or quiz   _____
  - f. Other science instructional activities   _____
8. Indicate the activities that took place during that science lesson.
Circle the letter(s) for all that apply.
  - a. Lecture
  - b. Discussion
  - c. Teacher demonstration
  - d. Student use of hands-on or laboratory materials
  - e. Student use of computers
  - f. Students working in small groups
  - g. Students doing seatwork assigned from textbook
  - h. Students completing supplemental worksheets
  - i. Assigning homework

The following questions are about inservice programs.

9. During the current academic year (1988-89), what is the total amount of time you have spent on in-service education in science or the teaching of science? (Include attendance at professional meetings, workshops, and conferences, but do not include formal courses for which you received college credit or extension credit.) Circle one.

- a. none
- b. less than 6 hours
- c. 6-15 hours
- d. 16-35 hours
- e. more than 35 hours

10. Circle the letter(s) that describe(s) the type of inservice.

- a. lecture presentation of science content
- b. demonstration of science activities
- c. practice of hands-on activities
- d. other _____

11. What did you like best about the inservice?

_____

12. What did you like least?

_____

13. How have you shared **science** information with your colleagues this academic year (1988-89)? Please circle the letter(s) for all that apply.

- a. informal conversation
- b. coaching (training followed by classroom observation)
- c. mentor teacher
- d. presentation at a district or local inservice program
- e. presentation at a regional or national conference
- f. does not apply
- g. other _____

THANK YOU FOR YOUR COOPERATION

fbs/101 code # _____