A STUDY OF ATTITUDES OF ELEMENTARY TEACHERS TOWARD SCIENCE

By

JOHN BENJAMIN LEAKE

Bachelor of Arts
University of Oklahoma
Norman, Oklahoma
1944

Master of Science Education
Washington University
Saint Louis, Missouri
1958

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University in partial fulfillment of the
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TOWARD SCIENCE

Thesis Approved:

Kenneth E. Wiggins
Thesis Adviser

Roy W. Jones

Robert [illegible]

[illegible]

J. R. Boggs
Dean of the Graduate College

PREFACE AND ACKNOWLEDGMENTS

The purpose of the study was to investigate the attitudes of elementary teachers toward science and to determine whether activity-type in-service instruction in science is a factor which influences these attitudes.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROBLEM

Introduction

Many efforts are being made nationwide to improve the science program and the teaching of science in the elementary schools (1, 2). For several years certain divisions and personnel of Oklahoma State University have been interested in improving the science training of elementary teachers (3, 4, 5). One of the more recent results of this interest was the in-service course, Natural Science 314, offered by Arts and Sciences Extension. Classes were held at Claremore and Sapulpa, Oklahoma, during the academic year of 1964-65. Five graduate students supported by the National Science Foundation Academic Year Institute were used to develop the teaching outline for the course during the summer session of 1964. This group was also used to teach the course.

The classes were held once a week for 24 weeks and each session was scheduled for 2½ hours, usually in the evening. A typical meeting included investigative laboratory work, discussion of data being taken on continuing experimentation, analysis of data on concluded experiments, and discussion of the relationships of these activities to present problems.

The activities in which the teachers participated might or might not be applicable in their classrooms. It was not the intent to provide a set of demonstrations or lessons that the teacher could take back to duplicate with the children in her class. However, it was the intent that the activities be so basic to science that the teacher would gain insight into what science is and develop some tools, both physical and mental, to enable her to practice science with confidence.

This in-service program in science is being expanded in 1965-66. Eight graduate students have prepared and will teach the course in several school districts within driving distance of Stillwater, Oklahoma. A few more physical science topics are being introduced, to provide a degree of balance and some background necessary for certain topics in biological science. The course name and number is Natural Science 320 (6).

Importance of the Study

Although much has been written in an effort to improve science at the elementary level (5, 7, 8), and efforts have been made to improve the competence of elementary teachers in science (2, 9), not much work has been done in an effort to evaluate changes in attitude or behavior as a result of these efforts. There may be a good reason for this state of affairs. Relatively few organizations are working on new and different approaches to curriculum organization and it takes time to test and evaluate curricula. But there are even fewer programs which are trying unique approaches to teacher-training in science.

This study will attempt to evaluate by measurement of attitude the effectiveness of a rather unique method of presenting selected conventional science topics to elementary teachers enrolled in in-service classes of Natural Science 320. Decisions are constantly being made to ascertain whether an activity or program is producing results which are justifiable from several viewpoints. These may be financial, esthetic, personal or any number of others. To aid in making these decisions, some sort of objective evaluation, where possible, is desirable. For instance, the writers and teachers of the above described in-service program would have a feeling of accomplishment if they could be more certain that their efforts with elementary teachers had a profound effect on these teachers and was measurable in an increase in quality and quantity of science being taught in the elementary classroom. Also, the administrators of Arts and Sciences Extension might be better able to defend the economics of this program if there was some statistically valid evidence that a change in a desirable direction had been made on the part of participating elementary teachers as a result of the in-service program. In short, it is desirable to know, as objectively as possible, whether a procedure presently being employed is worthy of continued use or might be altered to become more effective.

Clarification of Terms

Attitudes may be roughly defined as feelings for or against something. As defined by Dutton (10) the term "attitude" refers to how an individual feels about elementary school science--an emotionalized feeling for or against science. A distinction needs to be made between this type of attitude and the term scientific attitude or scientifically minded person who possesses an open-mind, looks at a problem from many sides, and seeks reliable sources for his evidence.

Basic Assumptions

The major assumptions in this study relating to attitudes and the measurement of attitudes are:

1. The attitudes of elementary teachers toward science can be measured by instruments properly designed for that purpose.
2. Attitudes are normally distributed and may be statistically treated accordingly.
3. The instrument which Dutton constructed, using techniques developed by Thurston and Chave (11), does, indeed, measure attitude.
4. The expressed responses of the subject reflect their true feelings and attitudes. As Thurstone states:

    > All that we can do with an attitude scale is to measure the attitude actually expressed with the full realization that the subject may be consciously hiding his true attitude or that the social pressure of the situation has really made him believe what he expresses. This is a matter for interpretation. It is something probably worthwhile to measure as an attitude expressed by opinions. It is another problem to interpret in each case the extent to which the subjects have expressed what they really believe. All that we can do is to minimize as far as possible the conditions that prevent our subjects from telling the truth, or else to adjust our interpretations accordingly. (12)

5. Attitude toward science is a major factor in the science teaching ability and competence of the elementary teacher.

Washton (13) indicates that there is a need for elementary teachers to overcome the fear of learning science and to develop positive attitudes that will help them master the teaching of scientific knowledge, skills, and attitudes to children. Wytiaz (14) indicates that since the teacher plays a vital role in the lives of the children in her classroom it is important that she have a favorable attitude toward science.

Statement of the Problem

The purpose of the study is to investigate the attitudes of a group of Oklahoma elementary teachers toward science. The problems are to determine whether the natural science course for elementary teachers provided by extension from Oklahoma State University is a factor which influences these attitudes. The study will involve the testing of the following hypotheses stated in null form:

A. There is no significant difference between the attitudes of in-service participating teachers and non-participating teachers in the same school district or in adjacent school districts with similar environments.

B. The attitude of elementary school teachers toward science will not be significantly different after participation in the in-service course, than it was before participation.

Scope and Limitations

This study is an investigation of the attitudes of 285 elementary teachers toward science. The study sought to determine whether there is a significant difference between the attitudes of those teachers who have had certain instruction and the attitudes of those teachers who have had no such instruction. The study also sought to determine whether there is significant difference between the attitudes of teachers before certain instruction and the same teachers after instruction. The study was limited to the consideration of the attitudes of teachers who were teaching in grades 1 through 8. The data collection was limited to school systems within a 120 mile radius of Oklahoma State University.

One must assume that variations exist which cannot be measured, but which still have a certain amount of influence on the attitudes of the subjects of the study. These factors include differences in the quality of instruction received by teachers who have had training in science, differences in the prevailing educational philosophies of the schools from which the samples were drawn, and differences in the administrative policies of the schools from which the populations were selected. These variations are inherent in the findings of the study and should be given consideration when conclusions are drawn from these findings. However, the effect of such variations can be minimized when the responses are considered in groups and treated statistically. Wert, Neidt, and Ahmann maintain that acceptable measures of human characteristics may be obtained in the following:

> The inability to obtain precise measures of human characteristics is a limiting factor whenever the purpose is for counseling an individual, but is a consideration of less importance in research studies involving groups of individuals. Generalizations may be drawn concerning group reaction which would be extremely dubious if applied to any individual within the group. (15)

Summary and Preview

In recent years a number of people and organizations have worked to change the traditional pattern of the elementary school science curriculum. As a result there are now many new or modern programs in elementary school science. Some teachers, therefore, are finding themselves ill-equipped for teaching contemporary science and many are taking advantage of in-service opportunities. Since educators agree that a teacher's effectiveness is directly related to his attitude toward the program in which he is teaching, it is of importance that studies be made to determine whether these in-service experiences foster better attitudes toward science on the part of those teachers who participate in them.

The purpose of this study was to measure and compare the attitudes toward science held by 283 elementary teachers in the state of Oklahoma. Statistical procedures were employed to determine whether the Oklahoma State University extension program was a factor which has an effect upon these attitudes. In this chapter the writer has developed the background of the problem, stated the problem, shown the need for the study, and indicated the scope of the study.

Chapter II is a report on current experimental elementary school science curriculum programs and steps being taken to retrain elementary teachers in science. The impact of these efforts are just beginning to be felt by the schools of Oklahoma.

Chapter III is a discussion of the instruments used in the study and the method of their construction. This chapter will also include a description of the subjects and a discussion of the analytical methods.

The content of Chapter IV is a presentation and analysis of the data obtained. This chapter includes tables and other illustrative devices to enable the reader to grasp the significance of the responses to the instruments of the study.

In Chapter V the writer summarizes results, conclusions, and recommendations indicated by the data.

CHAPTER II

RECENT DEVELOPMENTS IN ELEMENTARY SCIENCE AND SCIENCE FOR ELEMENTARY TEACHERS

This chapter is divided into two sections. The first part discusses the history and current status of the more ambitious elementary science curriculum projects. The last part indicates the implications for change which these curriculum projects are making in the elementary school science curricula and the impact this change is having on the pre-service and in-service training of elementary teachers in our country.

I

The descriptions of the elementary curriculum projects will be discussed in the following order and are listed here as an aid for quick reference:

1. AAAS Commission on Science Education
2. Elementary School Science Project (Utah)
3. Elementary Science Study
4. Minnesota Mathematics and Science Teaching Project
5. School Science Curriculum Project (Illinois)
6. Science Curriculum Improvement Study
7. Elementary School Science Project (California)
8. Elementary School Science Project (Illinois)

AAAS Commission on Science Education

The American Association for the Advancement of Science established a Commission on Science Education in May 1962. The decision to set up the commission followed a feasibility study in which scientists and leaders in education were brought together to consider the need for improvement in science education in the elementary and junior high schools. Three of these conferences were held in 1961. The conferees agreed on the urgent need for improved materials for science instruction in primary, elementary and junior high grades. The commission decided that as a part of its activities it would sponsor the development of instructional materials starting at the primary grade level.

During the summer of 1962 the commission sponsored two eight-day conferences, one at Cornell University and one at the University of Wisconsin. Scientists, teachers, school administrators, and leaders in teacher education came together at these conferences to consider, among other things: (1) the impact of the new secondary curriculum studies on science education in general, (2) research in science education, and (3) research in learning. From these two conferences came drafts of possible science sequences for the early grades, suggestions for further studies of the purposes and objectives of science education and of research in science education, and a recommendation that in the early grades instructional materials should stress the processes of science rather than science content alone.

The commission set up a panel to pursue the conference suggestions on science education materials to be used in the early grades. This panel was to work during the year 1962-63 preparing for the summer writing conference. The panel agreed that science instruction materials for the early grades should follow a process approach. They outlined the processes to be used and identified stages of development of skills which children might expect to achieve at various ages. Several sample activities were prepared. An important feature was that an evaluation was built into each one. At the end of each exercise an appraisal activity was provided. The teacher would be expected to use this activity to determine whether the children actually had achieved the abilities which the exercise sought to induce. The materials prepared by the panel were given to the writers at Stanford University and helped to direct their attention to the process approach. (16)

From this beginning 14 booklets have resulted, parts 1 (A and B) through 7 (A and B), each part containing descriptions of about 25 science exercises. An additional booklet is COMMENTARY FOR TEACHERS. Each booklet is numbered a grade higher than it is to be taught as the kindergarten level is also included. The preliminary edition of Part 7, the booklet for the sixth grade, was completed during the summer writing conference in 1965. Each exercise is addressed to the teacher and describes the activities to be conducted with and by the children. For each exercise there is given a set of objectives, a rationale, new vocabulary to be introduced, and a list of materials needed. In addition, a section on appraisal suggests the kind of additional questioning that may be used by the teacher to satisfy herself that the desired learning has occurred.

The National Science Foundation has provided the support for the development of these materials. The writing conferences have been held during the summer months of 1963, 1964, and 1965 and have been composed of scientists and educators. At present, the materials are being tried out in 14 school systems, and additionally in 20 individual schools, in various part of the country.

The uniqueness of the program is clearly pointed out by Gagné:

> The most striking characteristic of these materials is that they are intended to teach children the processes of science rather than what may be called science content. That is, they are directed toward developing fundamental skills required in scientific activities. The performances in which these skills are applied involve objects and events of the natural world; the children do, therefore, acquire information from various sciences as they proceed. The goal, however, is not an accumulation of knowledge about any particular domain, such as physics, biology, or chemistry, but competence in the use of processes that are basic to all science. (17)

The processes related to the exercises of parts 1-4 are called Observation, Classification, Communication, Number Relations, Measurement, Space/Time Relations, Prediction, and Inference. The exercises in each process grow increasingly complex, making use of what the child has learned before. Classification, for example, will begin with a one-stage system such as sets of objects which are either red or blue, or rough and smooth. Successive exercises become increasingly complex in the direction of schemes applicable to collections of plants and animals.

Formulating Hypotheses, Making Operational Definitions, Controlling and Manipulating Variables, Experimenting, Formulating Models, and Interpreting Data are the processes dealt with in parts 5, 6, and 7. The exercises in parts 5-7 cover a range of important topics from physical science, earth science, life science, and behavioral science. (17)

In assuming the process pose the AAAS Commission on Science Education in its curriculum project takes a fundamental position concerning the purposes, conduct, and expected outcomes of evaluation, which are currently assumed in the assessment of experimental curriculum materials. This is the behavior position as opposed to the content position. The question asked is: "What do we want the learner to be able to do after instruction that he was unable to do before instruction?" (18) Thus, in addressing themselves not only to the task of developing a K-9 science curriculum but also a behavioral evaluation program, the Commission has committed their program to an extensive teacher-guidance and training program. To this end the parts are addressed to the teacher and present the objectives, rationale, vocabulary, materials, and procedures for each exercise.

Elementary School Science Project

This project sponsored by the physics and education department of Utah State University and funded by the National Science Foundation was created in 1962. It is developing a series of lessons in science and mathematics for grades 1 and 2 designed to reveal some of the basic unifying ideas of science through investigation of everyday experiences of the child. Children identify differences or changes in comparison-type puzzles and are led through activities requiring the use of all the senses to observe and solve puzzles. They observe such phenomena as stretching a spring, sympathetically vibrating a tuning fork, or lighting a lamp with electricity. Attention is focused on the objects and the changes which take place in them. The child learns that interactions of objects are not isolated and unique, but are related to events which they have observed at other times. Acoustical interactions, for example, involve vibrating objects whether they are tuning forks or mother's vocal chords. A spiral type of approach is used, in that many experiments are repeated in several different units, each time emphasising a different aspect of the problem (19).

This is not a particularly unique program, but to be carried out properly materials must be handled by the children and this is considered desirable in science. To give the teachers guidance at each grade level a Teacher's Manual has been produced. At the present rate of production it will be 1974 before materials will be ready for 6 grades.

Elementary Science Study

This project was initiated by the late Francis L. Friedman, Physicist at Massachusetts Institute of Technology, and Charles Walcott, Applied Biologist of Harvard. The desire was to develop meaningful activities for children in the elementary grades. Several general objectives served as guidelines: (1) the development of blocks of scientific content which supply a flow of related ideas from the questions and observations of elementary children; (2) the development of accompanying inexpensive apparatus which may be effectively used by children themselves under the guidance of a resourceful teacher; (3) the development of a style of teaching, emphasizing the presentation of scientific content by student experimentation, thus allowing the children to gather and interpret data, draw inferences, and make predictions regarding other related phenomena; and (4) the development of closely integrated film loops, motion pictures, and other teaching aids.

It may be seen that emphasis is thus toward laboratory investigation and discovery by the student.

While some preliminary work was done during 1960 and 1961, the major beginning of this project dates from the summer of 1962 when more than 100 scientists and teachers devoted two months to the development of blocks of scientific content. A second summer study was carried on in the summer of 1963 with approximately 100 elementary teachers, scientists, and curriculum directors from various parts of the country. The major responsibility of this conference was to refine and expand the blocks of content already prepared and at the same time develop new units incorporating the philosophy and purpose of this study. The continuing financial support for the Elementary Science Study is from the National Science Foundation.

From the outset the writers and developers of material for this program have felt that the blocks should not pinpoint the development of scientific content to a concise set of specific objectives. The consensus is that such a procedure would so structure the material that observation, inquiry, original experimentation, and the rewards of scientific investigation would be lost (20).

After 2 years of testing on a rather restricted and controlled basis, the Elementary Science Study, in 1965, began distributing the first five prepared units of study materials for wide testing throughout the country. The list of titles included Growing Seeds, Small Things, Behavior of Mealworms, Gases and "Airs," and Kitchen Physics: A Look at Some Properties of Liquids. The general aim as presented in the Introduction to the commercial materials indicates the present beliefs of the authors of the program:

> Within the Elementary Science Study we have found basic agreement that a major aim of our project must be to encourage children to examine, analyze, and understand the world around them and to stimulate their desire to continue to do so. We view our task simply as the development of a variety of materials and techniques explicit enough to preclude the need for specialist teachers and diverse enough to awaken the curiosity and desire for understanding in children of many ages, interests, attitudes, skills, and backgrounds. In approaching our task we should not attempt to make all children into scientists, but to promote their scientific literacy and general intellectual curiosity. (21)

At the present time 41 units are in some stage of preparation. None of the units are limited by recommendation to a single grade level and most of them span at least 3 if not 6 grades. The completed program will generally be K-8. No evaluation is planned through objective testing because of the belief that such a procedure is limited by the validity of the evaluative instrument used (22).

Minnesota Mathematics and Science Teaching Project

The specific purpose and objectives of this project are to produce coordinated mathematics and science curriculum for grades K-9, and mathematics, science, and methods courses for pre-service and in-service education of teachers (22). The work began in June, 1961 and is the result of inspiration of Dr. Paul C. Rosenbloom, Professor of Mathematics, University of Minnesota. To date 9 units have been produced for science K-7. A recent statement made by Rosenbloom enables one to compare his program with others:

> To a large extent, this resembles superficially the plan of the AAAS Project to focus the attention in the primary grades on the processes of science. In some of the literature not associated with the AAAS Project, advocating an emphasis on the processes of science, there seems to be a distinction between process and subject matter which rests on a misconception.

> Man's scientific activity is not merely a way of looking at science, but is an essential and fundamental element in the subject matter itself.
>
> When the emphasis is not on the processes of science, considered impersonally, but on scientific activity as an aspect of man's behavior we must build up an understanding of how man forms and tests his ideas. The child must be led to act like a scientist in solving 'baby' research problems. He must learn from firsthand experience what scientists do. Only after he has worked like a scientist on concrete problems, should he look back on what he has done and form generalizations about the processes of science. I believe that most of us agree on this strategy in the actual construction of science curricula. (23)

The science units begin with an attempt to evoke wonder and curiosity, which will hopefully lead to the formulation of a problem which the children will think is important to them. The problem will be investigated experimentally in the spirit of scientific research. Problems are chosen so as to lead to the necessity for "basic" research. When the children have discovered the basic laws by their own observations, they are guided to the application both to their original problem, and to other problems which might seem unrelated. In this way it is hoped to give the pupils an appreciation of the value of fundamental knowledge.

School Science Curriculum Project

This project originated at the University of Illinois in 1963. The operating principles were to "search for and to develop the most effective teaching methods and to make selections of science content best suited to serve current and future needs." (24) The SSCP believes that a child learns best when he is given an opportunity to be involved in science himself, when he sees the rationale and structure of the problems to be solved, and when he can make his own analysis of such problems. The problem is to select from all the possibilities, those experiences of sufficient generalizing potential to make them worth developing on the child's part, as opposed to those which add to the accumulation of factual knowledge.

The program is concerned with the education of the general public for the time in which they live and the time into which they are moving. An education that encourages and contributes to scientific literacy. This is an attempt to provide students with sufficient knowledge and experience so they will have some understanding of the scientific work being carried on by others, even though they, themselves, do not become scientists.

Once an idea is selected, children representing several different cultural backgrounds and grade levels are called in to help modify the outlines that have been proposed by adults. After this initial confrontation the material is tried by a Project staff member in a classroom. On conclusion of this second level in the development of material the unit is written for teachers relating how a similar set of lessons could be conducted. A few of the 22 subjects for which materials have been produced and Photographs and Pendulums, Drosophila, Ants, Coulombs Law, and Blue Bottle (determination of composition of exhaled air) (22).

Science Curriculum Improvement Study

This study under the direction of Professor Robert Karplus originated at the University of California Berkeley in 1959 with a grant from the National Science Foundation. With three colleagues, Arthur Pardee, Nello Pace, and Lloyd Scott three science units were prepared and taught in local schools. Analysis of the trial teaching experience led Professor Karplus to raise three questions:

> First, how can one create a learning experience that achieves a secure connection between the pupils' intuitive attitudes and the concepts of the modern scientific point of view? Second, how can one determine what the children have learned? Third, how can one communicate with the teacher so that the teacher can in turn communicate with the pupils? (25)

Since that beginning and those questions Dr. Karplus has travelled over the United States and Europe familiarizing himself with elementary teaching and elementary curriculum studies. He has been associated with no less than five current curriculum studies.

His continuing efforts have resulted in the approval of a budget in excess of $1,000,000 for the two years 1965-67. Curriculum-construction efforts are to be continued on an expanded scale at the Berkeley headquarters of SCIS. At the present time, seven sequential physical science units for the primary grades have been tested and are being readied for public distribution during the current academic year. These units are entitled Material Objects, Systems, Interaction, Relativity of Position and Motion, Subsystems, Solutions, and Temperature. (26). Several of these are revised editions of units that have been released previously. The conceptual structure embodied in these units will be extended with new physical science units for the upper elementary grades. Equilibrium, energy, and various specific interaction mechanisms will be the foci of this program.

Elementary School Science Project

The University of California Elementary School Science Project was organized in the spring of 1959. The present staff includes professors from the university in physics, chemistry, mathematics, botany, zoology, physiology, genetics, and paleontology. Herbert L. Mason, Professor of Botany in speaking for the group says:

> All are concerned with improving and extending the science offering of the public schools. Some in addition, are exploring the elementary approaches to their science itself to determine if a firmer foundation might be reached in an approach directed to lower age levels. All seem concerned also with an adequate presentation of mathematics pertinent to the background in their own work. All aim at developing their conception of scientific method and scientific attitudes in the youngster. (27)

The curriculum approach begins with the scientist identifying those fundamental science concepts within his discipline which may lend themselves to treatment at the elementary school level. With an experienced elementary teacher, a technical writer, and an evaluator he begins to prepare a unit of instruction. By actual trial and experimentation in class by the teacher a series of lessons is developed. The technical writer then prepares a written unit of such form that it may be used in a trial evaluation. This preparation includes not only the suggested instructional program for children but also provides the public school teacher with a "sufficient content background to maximize teaching success (28)."

The units initiated to date are in some stage of completion. Most of them are still undergoing trial and test.

University of Illinois Elementary School Science Project

The activity of this project has centered on astronomy. It was commenced in 1960 under J. Myron Atkin, an educator, and Stanley P. Wyatt, an astronomer, with funds from the National Science Foundation.

The primary goal has been to produce astronomy materials that are sound astronomically, that reflect the structure of the subject as it is viewed by astronomers of stature, and that can be handled by teachers and children in actual classrooms. The initial guideline for curriculum construction was the structure of astronomy as it has developed during the history of man. It was thought that interest in science could be developed from a curriculum based on certain aspects of the discipline. And that a significant understanding of the usefulness of science could result from a basic understanding of the subject.

One of the first books produced was CHARTING THE UNIVERSE. It covered such topics as measurement, distances in the solar system and beyond, the size and shape of the earth, and inverse square law applied to light as a tool for determining great distances. Other books completed or in process are THE UNIVERSE IN MOTION, GRAVITATION, THE MESSAGE OF STARLIGHT, THE LIFE STORY OF A STAR, and THE GALAXIES AND THE UNIVERSE.

Each summer since 1961 has been devoted to writing or revising this series of books for children (grades 5-8) and the accompanying teachers' guides. To prepare the booklets, the professional astronomers re-examine their field asking themselves: "What is basic?" and "Which relatively few ideas will take the student farthest in comprehending the subject (29)?" During the school year following each writing conference, the new materials are field tested in over 350 classrooms throughout the country. Evaluation of project material is obtained from cooperating teachers in writing and through interviews, from project staff who visit classrooms where the books are being tested, and from written tests administered to the children. Subsequent revisions are based on this feedback.

II

The curricular projects described above are leading the elementary schools into new procedures in the presentation of elementary science. In 1962 Johnson (30) indicated that in the years ahead certain changes would be produced in elementary school science and this these would include changes from (1) much subject matter to less, (2) one problem-solving method to many relatively unstructured methods, (3) much use of one book in a series to the use of many books, (4) emphasis on accumulating knowledge to an emphasis on how to find and create knowledge, (5) facts and factual concepts to skills in inquiry as teaching goals, (6) teacher selected concepts as teaching goals to concepts as they arise in confirming and rejecting hypotheses, (7) the terms "elementary science" and "general science" to "science," (8) reliance on qualitative observation to stress on making and recording quantitative observations, (9) films that stress a body of knowledge to films that report one or a series of experiments, (10) science experiences as preparation for secondary school science to experiences for the basic education of all pupils, (11) science as something to be learned from books to something that grows out of a series of experiments, (12) a program based on topics, limited concepts, and experiment to one based on a more fundamental frame of reference, (13) great attention to uses of science including technology to more attention to science, and (14) science built on a limited understanding of mathematics to science built on mathematics.

The same year George (31) expressed similar views relative to elementary science education. More recently Plouts (32) contends that trends in elementary science are toward (1) larger units with more depth; (2) greater emphasis being placed on individual involvement and participation; (3) greater emphasis being placed on earth, space, and physical sciences in contrast to earlier domination of plants, animals, human body, and related life science topics; (4) more freedom of scope and sequence; (5) more flexible texts or references; (6) simplification of equipment; and (7) increased quantitative and manipulative skill.

These trends contain implications for the education in science of elementary teachers. A panel concerned with the education of elementary teachers at the American Association for the Advancement of Science Meeting in Montreal in 1964 emphasized the need for breaking away from traditional patterns of "cookbook" courses, and in their places substituting carefully organised laboratory work in which future teachers participate in planning and carrying out laboratory projects designed to find answers to real questions. It was emphasized that practices and techniques used in traditional courses are inadequate and do not provide the student with an understanding of what science really is (33). At the present time, most teachers, after leaving college, must take in-service courses that stress the basic principles and nature of science before they are prepared to teach modern science programs. Only by revolutionising existing courses can we give elementary teachers an adequate foundation with which to approach their science teaching.

As early as 1963 some recommendations pertaining to science preparation for elementary teachers were beginning to appear. George (31) made four general suggestions. First, he indicated that college science courses for elementary teachers should be the ones appropriate for liberal arts majors and other non-scientists. They should include basic scientific concepts and principles as opposed to facts. The students must perform experiments in these courses. Problem solving should be stressed. The student should learn to quantize as much as possible. Second, all prospective elementary teachers should be required to take a methods course in the teaching of sciences. They should do experiments that would be appropriate for the elementary school and become familiar with science equipment. They should learn proper techniques of doing a demonstration and how to encourage the children to hypothesize as to the reasons the demonstration worked as it did. The students should have experience in finding out where to obtain things. Third, all prospective elementary teachers should have an area of concentration and for some this area should be science. These teachers who had concentrated in science could then assume an advisory capacity, assisting other teachers less acquainted with science. Fourth, the teachers who are already teaching in elementary schools should have in-service training. The in-service science program should be one which the teachers attend for two hours a day, one day a week, for at least ten weeks. Universities can help by offering these courses and by making instructors available for them. The concepts of science would have to be stressed for those who did not have a basic science course.

Another group interested in the preparation of elementary teachers is the National Science Teachers Association. The Commission on the Education of Teachers of this group held a series of three conferences on college science teaching during 1964 and 1965. The group at Long

Beach considering the problems of preparing elementary teachers organized its recommendations under two basic principles of science teaching. These were reported by Eiss (34) as follows:

> BASIC PRINCIPLE: Content and process in science are inseparable. Methodology should be consistent with the nature of science.
>
> Recommendations:
>
> 1. The process approach should be used and defined in teaching content.
> 2. Laboratory work should be an integral part of the instructional program.
> 3. Laboratory experiences should be open-ended.
> 4. Group analysis of laboratory experiences is a requisite.
>
> BASIC PRINCIPLE: A sequential science program for prospective elementary teachers begins with so-called general education science courses.
>
> 1. At least twelve hours of general education science courses should be prerequisite to courses which include science methods.
> 2. Second level courses to provide additional experiences in science should be designed for those who have taken the general education courses and wish to pursue science in greater depth.
> 3. Professional courses including science methods should provide opportunities for students to work with children in classroom situations as an integral part of the course.

The National Science Foundation commenced supporting summer institutes in science for elementary teachers in 1960. The initial summer they granted institutes to thirteen institutions of higher education on a trial basis. Although NSF has continued to support these institutes they are not widespread, for it would seem an impossibility to offer institutes of this type to a large percentage of elementary teachers. However, a 1966 National Science Teachers Association listing contains information for 166 science and mathematics summer programs primarily designed for elementary teachers at 140 institutions in 41 states (35).

The interest shown by the National Science Foundation, the American Association for the Advancement of Science Commission on Science Education, and the projects producing elementary curricula in science has produced several movements to develop special courses for the training of elementary teachers.

The Minnesota Mathematics and Science Teaching Project is producing a content and a methods course for the preparation of teachers for teaching current curriculum efforts and especially MINNEMAST. A summary of the recommendations which they make for a content course is as follows:

1) The content course should require one year and probably be elective.
2) It should be a liberal arts course designed to educate citizens--not just teachers--about science.
3) Instructors should consider sophisticated concepts--but they must start each development at the origin.
4) The basic course goal should be to give students some intensive contact with science and the activities of science. This means that they will study fewer areas in greater depth.
5) Content should be selected from the entire spectrum of science.
6) The best scientist-teachers available should be urged to teach these sections. Academic and professional stature, ability to communicate, recognition of the importance of the course, and enthusiasm would be criteria for the selection of staff.
7) Materials should be drawn from current curricula.

8) This should be a laboratory course. Some opportunity should be provided to carry out some independent research. The basic aim is to develop citizens able to continue to learn independently.
9) Lectures should also incorporate the idea of experimentation--as opposed to demonstration.
10) Those atrocious "science-without-math" texts should be destroyed.
11) In addition to providing this course, scientists should encourage other departments to incorporate science into their programs. History should include study of the development of scientific as well as political ideas. Scientific activities should be identified as such, whether they occur in physics or English, biology or education.

Some of the recommendations for a methods course include:

1) The science methods course should be a semester elective.
2) The teacher should know some science, and he should know some of the new directions of science instruction. He should also be aware of the operation of an elementary school classroom.
3) In this class students should carry out themselves just as many of the activities they will later ask their students to perform as time and course organization allows.
4) Students should develop a strategy for teaching science to small children.
5) Students should become familiar with some of the apparatus, the paraphernalia of science teaching. (36)

A conference was held at the Center of Continuing Education of the University of Chicago 5-7 September, 1963, for the purpose of stimulating activity among scientists and educators toward the development of improved college physical science courses for nonscience liberal arts majors and in particular for prospective elementary school teachers. The conference was sponsored jointly by the Advisory Council on College Chemistry and the Commission on College Physics. In calling the conference, the chairmen of the two groups stated in part:

> If successful courses result from these attempts, courses with similar objectives should probably be developed by other groups, especially in the life science. In view of the inherent difficulties involved in the creation of courses covering both the physical and the biological sciences and of the recommendations of the NASDTEC-AAAS Studies, we feel that our initial efforts should be aimed at a one-year course in physical science only. (37)

As a result of this conference and several others at different locations a course was produced during the summer of 1965 at Rensselaer Polytechnic Institute from the following general description and statement of principles:

> The course is to be a one-year course in physical science for the nonscience major who is not planning to take additional physical science courses. It will introduce the student to physical phenomena through experimental activity. While it will be designed to meet the needs of the prospective elementary school teacher, it is anticipated that it will be found useful for a broad group of nonscience majors in the liberal arts colleges.
>
> General Principles:
>
> 1) To develop in the student a sympathetic attitude toward science and an understanding of the nature of physical science, methods and techniques, important in the society of today and future.
> 2) He must be given a chance to feel enjoyment.
> 3) Time must be provided for thoughtful observation.
> 4) It must be realized that conventional laboratory space will not be available in many institutions.
> 5) The treatment of every topic must take into account the fact that the intellectual habits and natural temperament of many students are verbal rather than mathematical.
> 6) Textual material for the course is to be assembled, as far as possible, from existing sources or parts thereof.

7) Throughout the course, certain "threads" or themes of importance, which are characteristic of science, should be noted and emphasized again and again. These threads are:
   a) An appreciation in science of the beauty of order and symmetry.
   b) The principles of conservation of certain physical quantities.
   c) The aspects of behavior which are associated with discontinuity of functions and quantization of properties in many areas of science.
   d) The recognition of mathematics not only as a time and space-saving system of notation, but more importantly as a way of refining, simplifying and generalizing concepts. (38)

In keeping with trends and the national emphasis on elementary science and the preparation of teachers, the College of Arts and Sciences Extension of Oklahoma State University has developed a course which is a special study in science for elementary teachers. A description of the current edition of this course is included in Appendix A. It will be noted in the descriptive material and objectives of this course that the flavor of the recommendations outlined above by other groups is retained and may even be more apparent in the Oklahoma State University Extension course. This is one university's attempt to meet the challenge of the new curricular developments in science.

A different approach is being used by the University of Oklahoma. Their College of Education has become a trial center for the Science Curriculum Improvement Study which will have a strong influence on the methods courses in science for elementary teachers and probably, to a certain extent, the content courses at that institution. (26)

The new curriculum programs discussed in this chapter are illustrative of attempts being made in this country to upgrade science instruction in the elementary school. As a result of these programs new ways are being investigated for the training and retraining of elementary teachers in science. Oklahoma State University is taking part in these efforts in its extension division science course. This study is an attempt to evaluate one aspect of this course.

CHAPTER III

EXPERIMENTAL PROCEDURES AND PERSONNEL

Instruments Used in the Study

There were two instruments used in this study. One was constructed by Dutton and Stephens (10) and the other by the writer. Both instruments were constructed using the method of Thurstone and Chave (11).

In 1929 Thurstone and Chave used a version of category scaling in order to scale the strength of the attitude expressed by each of 130 statements concerning one or another aspect of religion. The resulting scale, based on the responses of 300 subjects, represented a serious and effective effort to introduce a metric where none had existed before.

As reported by Stevens (39) a study in 1959 undertook to apply a larger battery of scaling devices to some of Thurstone's attitude statements. When Thurstone's method of sorting the statements into 11 categories was used the resulting partition scale correlated highly with the original partition scale of Thurstone and Chave. The passage of 30 years and the use of a new sample of subject apparently made little difference.

The first step in the construction of an attitude scale by this method is the accumulation of statements which are representative of the area being tested. Most statements used in the Dutton scale were obtained by asking 200 prospective elementary school teachers to write short statements of their feelings about science. This scale represents a sampling of the universe of interest pertaining to the teaching and learning of science. The criteria accepted for selecting and editing these attitude statements were prepared by Wang, Thurstone, Likert, and Edwards (40). Statements which are factual or might be interpreted as factural are eliminated. Ambiguous statements, incomplete sentences, and statements with more than one interpretation are eliminated.

The procedures for the writer's scale and the Dutton scale are identical after editing, therefore a description of the former procedures will suffice as a description of both. For convenience the instruments will be referred to as Scale I (Dutton) and Scale II (Leake).

The edited list, Appendix B, of statements dealing with elementary school science were presented to 90 subjects from the Oklahoma State University science methods classes. These students were asked to sort the statements into 11 categories (A through K) representing intervals of A (favorable toward science) to K (unfavorable toward science). While Thurstone and Chave used 300 subjects for sorting, Edwards and Kenney (41) report a correlation of .95 between the scale values for 129 statements obtained from a group of 72 judges with the scale values for the same statements based upon the judgements of 300 judges.

The scale value for each statement was determined by techniques developed by Thurstone and Chave (11). Figure 1 shows the tabulation and the graph plotted from the accumulative proportions into which statement 19 was sorted. Where the curve crosses the 50% point on the

A	
B	1
C	2
D	7
E	8
F	26
G	24
H	10
I	11
J	1
K	

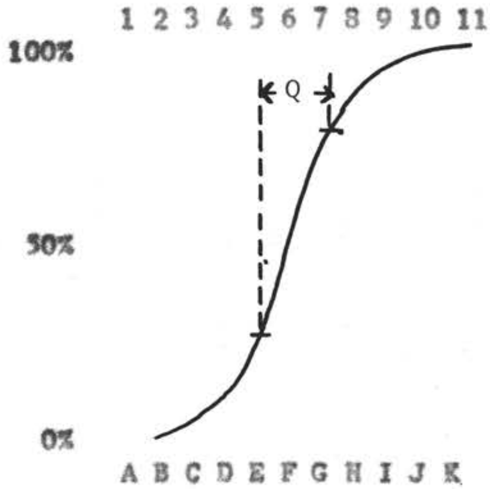

Figure 1. Tabulation and graph of statement 19

ordinate indicates the position at which 50% of the judges have made a choice concerning how favorable the statement is toward science. The scale value is then interpolated on the abscissa and for statement 19 can be read as 6.0. The scale value for the 32 edited statements is presented in tabular form in Appendix C.

The difference between the upper and lower quartile is a measure of the ambiguity of the statement and is called the Q value. The Q value for statement 19 is indicated in Figure 1. Ambiguous statements will be sorted into a wide range of categories on the scale and the Q value will be high. Concise statements which convey nearly the same meaning to the readers will be placed in about the same position on the scale, and the Q value will be small. Figure 2 is a graph of statement 32 which has a high Q value and was discarded for this reason.

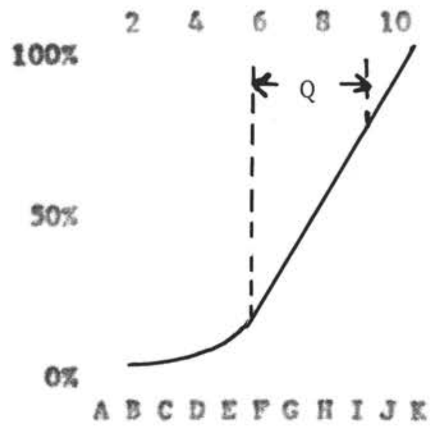

Figure 2. Graph of statement 32

Twenty statements showing feelings toward science were selected for Scale II from the 32 statements used in the sorting process. The selection was made according to: 1) items with low Q values, 2) distribution of scale values for symmetry, and 3) an equal number of favorable and unfavorable statements. Appendix D is a list of the 32 statements and both the scale value and the Q value for each statement. Applying the above criteria, statement 1, 2, 3, 4, 13, 16, 21, 25, 27, 28, 30, and 32 were eliminated.

According to Dutton and Stephens (10) the reliability of Scale I, measured by the test-and-retest procedure was 0.93. As will be shown later in this study, Scale II correlates well with Scale I. Scale I and II are presented in Appendix E.

Test Groups Included in the Study

The population in this study was taken from six Oklahoma school districts. These were coded in the following manner:

School 1 Watonga

School 2 Western Heights (primary grades)

School 3 Kingfisher

School 4 Pondcreek and surrounding districts

School 5 Western Heights (intermediate grades)

School 6 Sand Springs

The population of each school was composed of 2 parts, designated A and B. Part A were those teachers who were enrolled or participating in the in-service science course. Part B were those teachers from the school district who were not participating in the course and who were willing to fill out and return an attitude scale.

The science classes met one day per week for a period of approximately two and one half hours. The first class meetings were held the last part of August or in early September of 1963. The classes were instructed, with the exception of School 6, by a group of National Science Foundation Academic Year Fellows who had undergone a brief familiarization period with the course materials during the first part of August. School 6 was instructed by Dr. Kenneth Wiggins of the Oklahoma State University faculty with assistance by the Academic Year fellows and graduate students.

Collection of the Data

All classes were pre-tested with Scale I before any instruction had been initiated. The post-test was administered after approximately 6 months of instruction. At this time both Scale I and II were used on populations A and B. The data are presented in Appendices F through K.

Analytical Procedures

Since the study included data from a number of schools it was considered appropriate to pool these data. This would result in an overall analysis of technique and method of teaching and minimize variability in individual schools and instruction. As the data were disproportionate the "abbreviated Doolittle" procedure was selected from which to calculate an analysis of variance. As described by Goss (42) the Doolittle technique is a method of obtaining the solution to a set of n equations in n unknowns. For each school there is 1 equation with several unknown parameters, therefore this analysis would involve 6 equations with several similar unknowns.

If significance is found in any of the parameters analyzed in the pooled solution then that parameter may be studied for each school to ascertain at what point there is interaction and if it also is significant. For this latter analysis the modified block procedure is sufficient to produce an analysis of variance.

Summary

In summary, teacher populations from 6 Oklahoma school districts were studied to determine whether or not participants in teacher training classes underwent a significant change of attitude toward science. Furthermore, non-participating teachers were compared with participating teachers. Two attitude scales were used. Scale I was developed by Dutton and Stephens in California and the other, Scale II, was constructed by the writer. Scale I was used as a pre- and post-test on the participating teachers and Scale II was used in conjunction with Scale

I on participating and non-participating teachers. The resulting data were analyzed by statistical techniques to determine significance.

CHAPTER IV

RESULTS OF THE STUDY

Statistical Analysis of the Data

Three analyses of variance were constructed from the "abbreviated Doolittle" method of solution. The calculations for the "Doolittles" are presented in Appendices L and M. Appendix L is the procedure for the comparison of Groups A (participating teachers) with Groups B (non-participating teachers using Scales I and II.

The analysis of variance for the pre- and post-test presented in Table I indicates there was not significant difference at the .05 level between the attitudes of teachers toward science before participating in the course and subsequent to that participation. Similarly, using Scale I there was not significant difference at the .05 level between participating and non-participating teachers. This analysis of variance is presented in Table II. The analysis of variance shown in Table III indicates that all schools are not behaving in the same manner relative to Scale II. A series of analyses of variance calculated from a modified block procedure indicated an almost significant difference at the .05 level for schools 3 and 4. The analyses of variance for these two schools are shown in Tables IV and V, respectively. Therefore in these two school districts, Scale II indicates the attitude toward science of non-participating teachers is nearly significantly different than

TABLE I

ANALYSIS OF VARIANCE FOR POOLED SCHOOLS, GROUPS A, SCALE I

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	Calculated F Ratio
Total	133	48.519702		
Between Schools	5	5.951551	1.190310	
Pre- vs Post-	1	.454030	.454030	2
School X Test	5	1.623218	.324644	1
Teachers Within Each School	61	22.647155	.371265	
Teacher X Test X Within Each School	61	17.843748	.292520	

TABLE II

ANALYSIS OF VARIANCE FOR POOLED SCHOOLS, GROUPS A AND B, SCALE I

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	Calculated F Ratio
Total	150	65.786093		
Between Schools	5	4.345028	.869006	
A vs B	1	.002763	.002763	1
Control vs Instruction	5	.386272	.077254	1
Within each school	139	61.052030	.439223	

TABLE III

ANALYSIS OF VARIANCE FOR POOLED SCHOOLS, GROUPS A AND B, SCALE II

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	Calculated F Ratio	Tabular F Ratio
Total	150	240.633380			
Between Schools	5	5.873015	1.174604		
A vs B	1	.050805	.050805	1	
Control vs Instruction	5	108.958960	21.791792	42.1	3.51
Within Each School	139	125.750610	.904681		

TABLE IV

ANALYSIS OF VARIANCE FOR SCHOOL 3, GROUPS A AND B, SCALE II

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	Calculated F Ratio	Tabular F Ratio
Total	22	34.638261			
Control vs Instruction	1	3.030261	3.030261	2.01	4.32
Teachers X Test	21	31.608000	1.505143		

TABLE V

ANALYSIS OF VARIANCE FOR SCHOOL 4, GROUPS A AND B, SCALE II

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	Calculated F Ratio	Tabular F Ratio
Total	18	42.757895			
Control vs Instruction	1	7.270202	7.270202	3.48	4.45
Teachers X Test	17	35.487693	2.087511		

the attitude of participating teachers. The illustrations in the descriptive analysis will make this difference clearer.

Descriptive Analysis of the Data

Figures 3 through 8 illustrate the pre- and post-test scores of participating teachers using Scale I. These show graphically the change in attitude as measured by Scale I, before and after participation in the natural science course. It may be noted that 1) generally the teachers with the less favorable attitude became more favorable and the teachers with the more favorable attitude became less favorable toward science; 2) there is radical change in some individuals and very little, if any, in others; 3) there is a higher percentage of positive slopes in some schools than in other; and 4) generally teachers are favorable toward science.

Figure 9 illustrates the change in mean for Group A of each school from pre- to post-test. It can be noted that the slopes of 4 schools were either positive or zero with schools 1 and 5 having a negative slope.

Figures 10 and 11 are graphs for the means of Scales I and II, respectively, for a comparison of Groups A with B. Note that there is positive correlation between the two scales everywhere except in school district 1. Schools 3 and 4 in Figure 11 graphically illustrate why interaction was indicated in the pooled analysis of variance for Scale II. Although the slope of neither school by itself was sufficient for a test of significance to be positive, the two combined in the pooled solution were diametrically opposed since one is positive and the other negative.

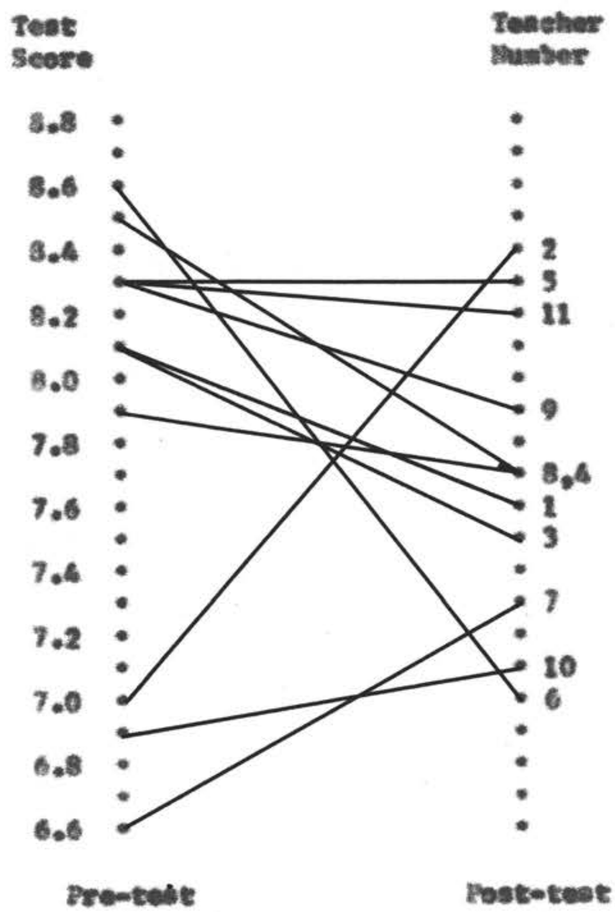

Figure 3. Individual Test Scores, School 1

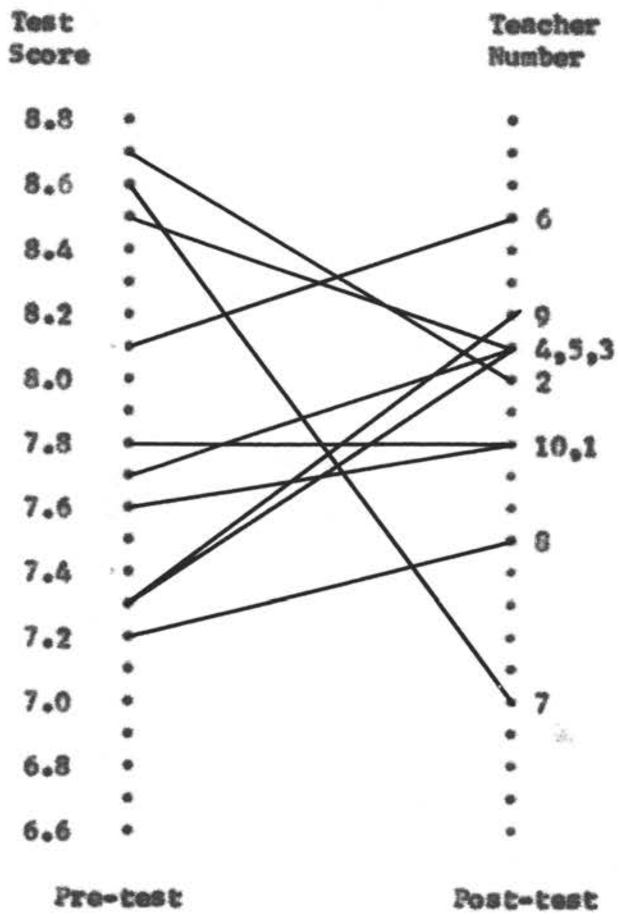

Figure 4. Individual Test Schores,
School 2

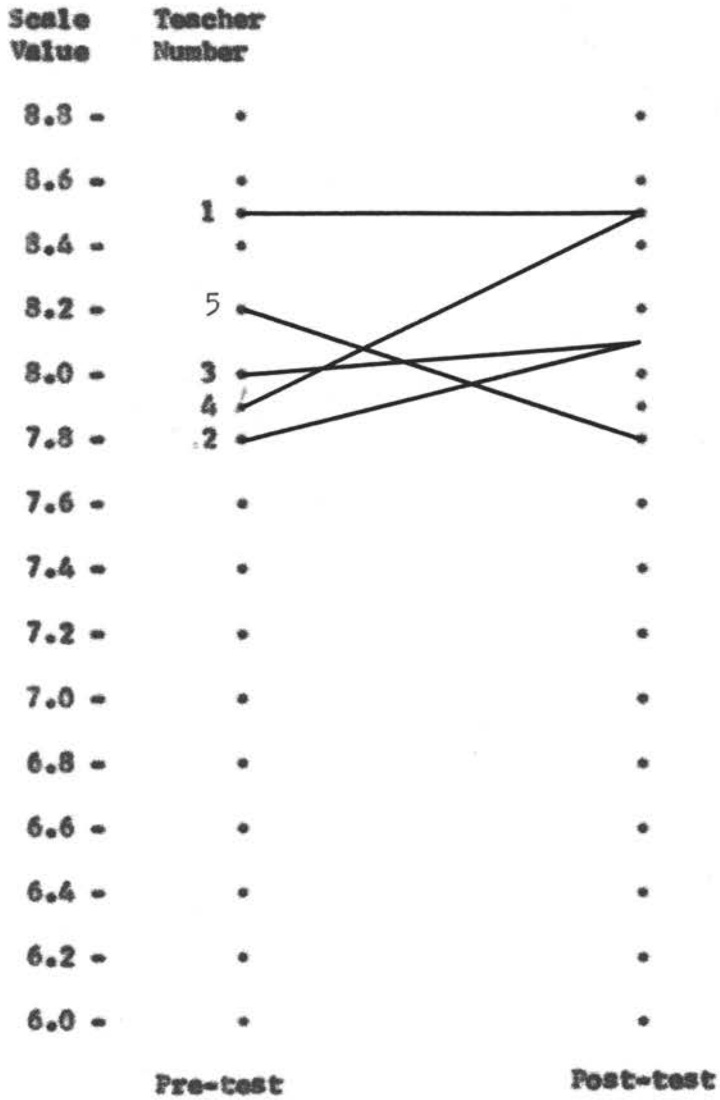

Figure 5. Individual Test Scores, School 3

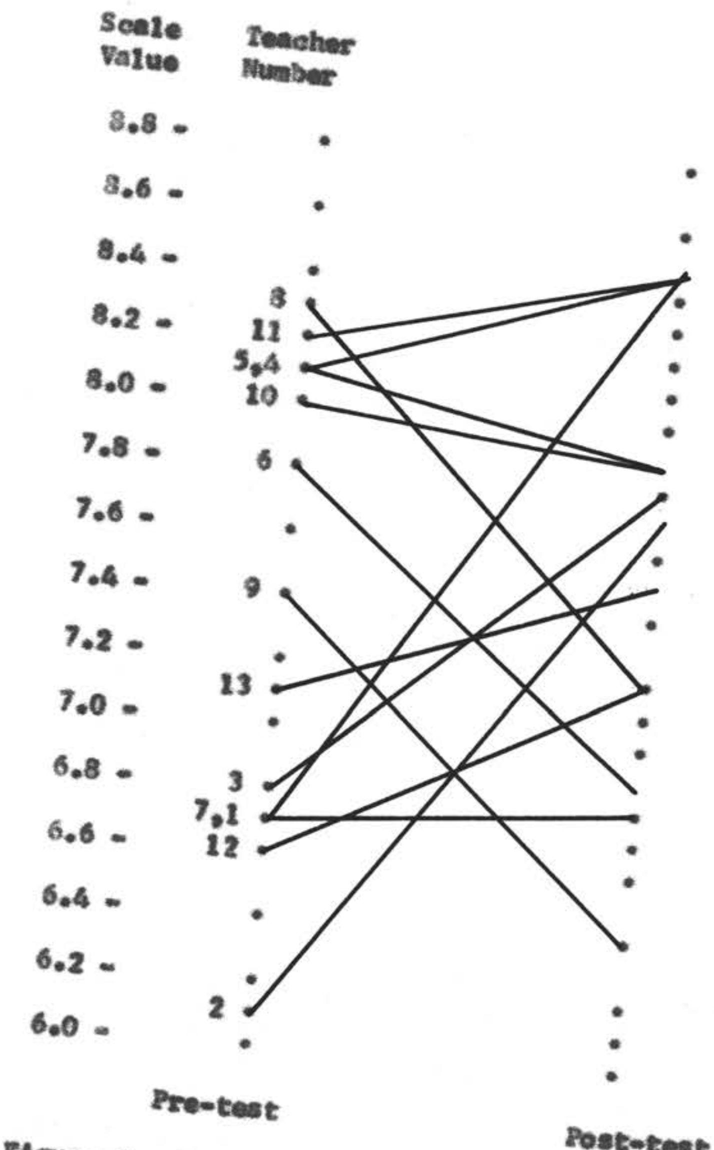

Figure 6. Individual Test Scores, School 4

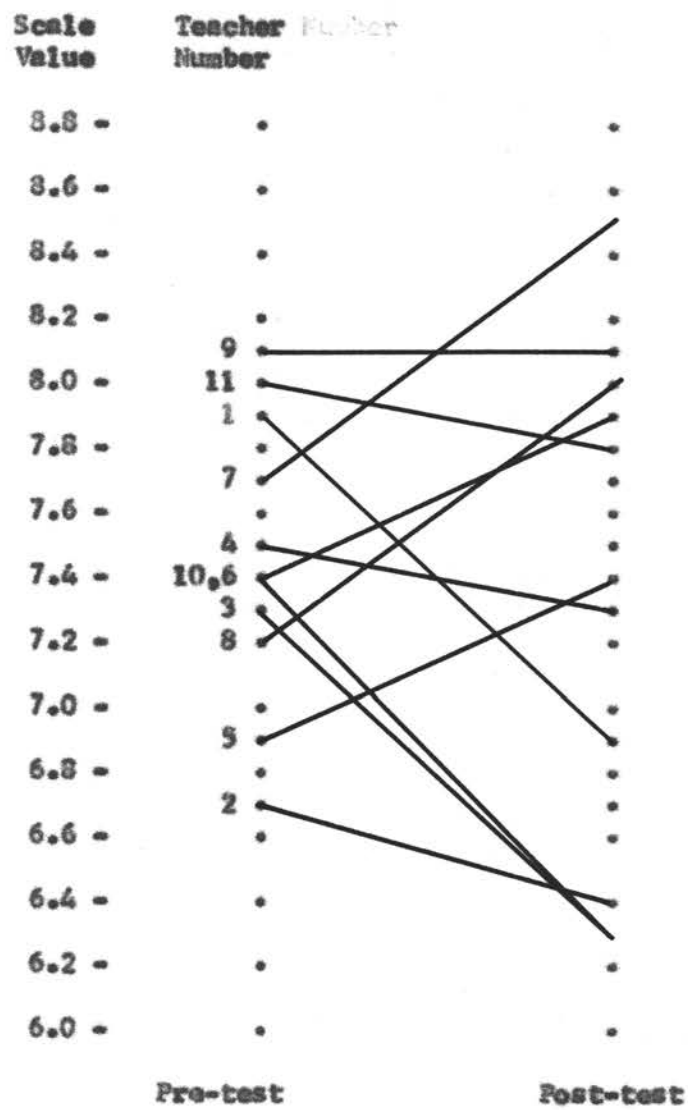

Figure 7. Individual Test Scores, School 5

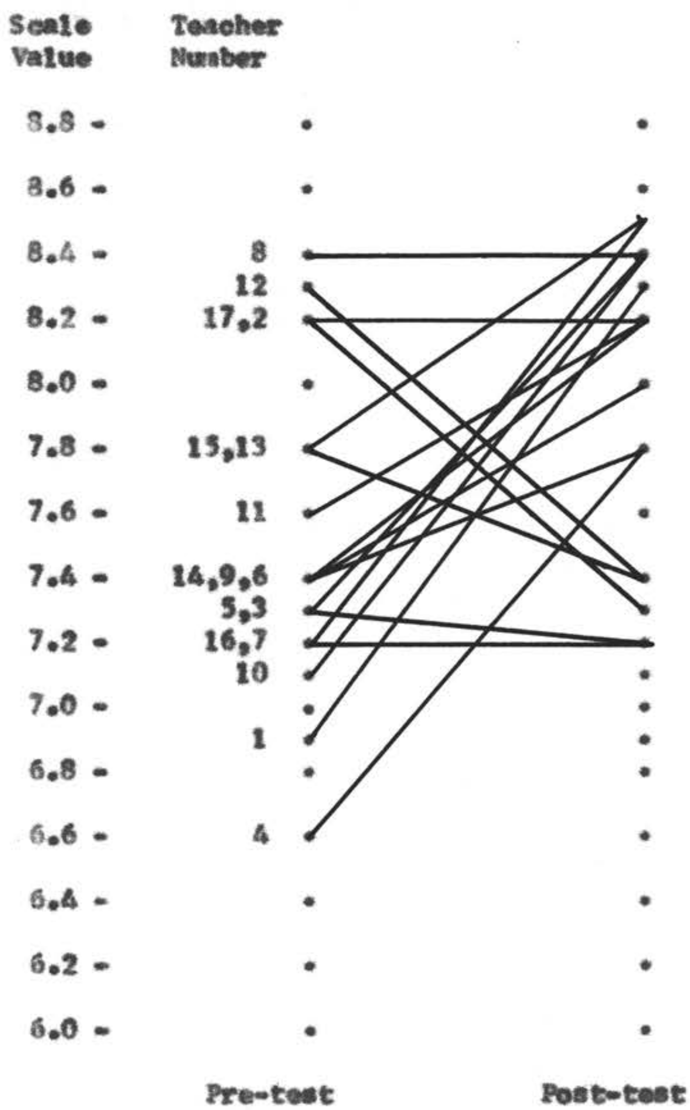

Figure 8. Individual Test Scores, School 6

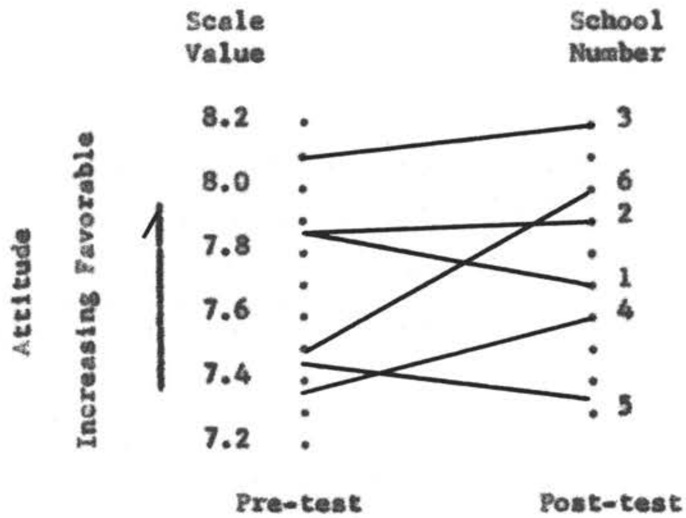

Figure 9. School Mean Scores, Group A,
Scale I

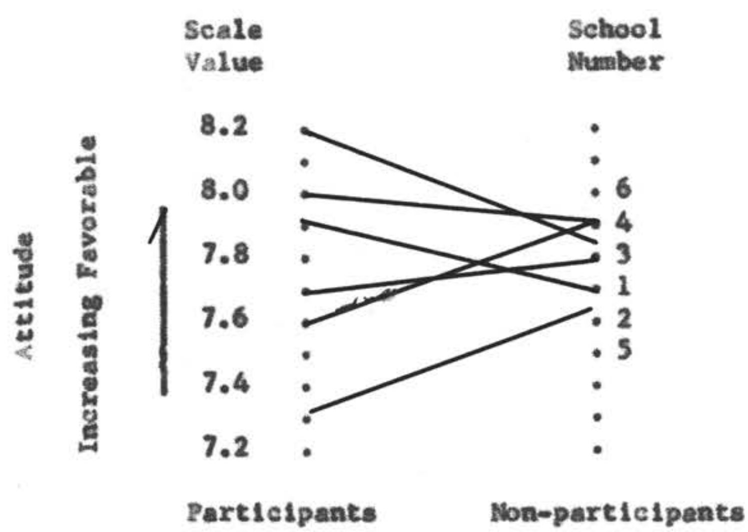

Figure 10. School Mean Scores, Groups A and B,
Scale I

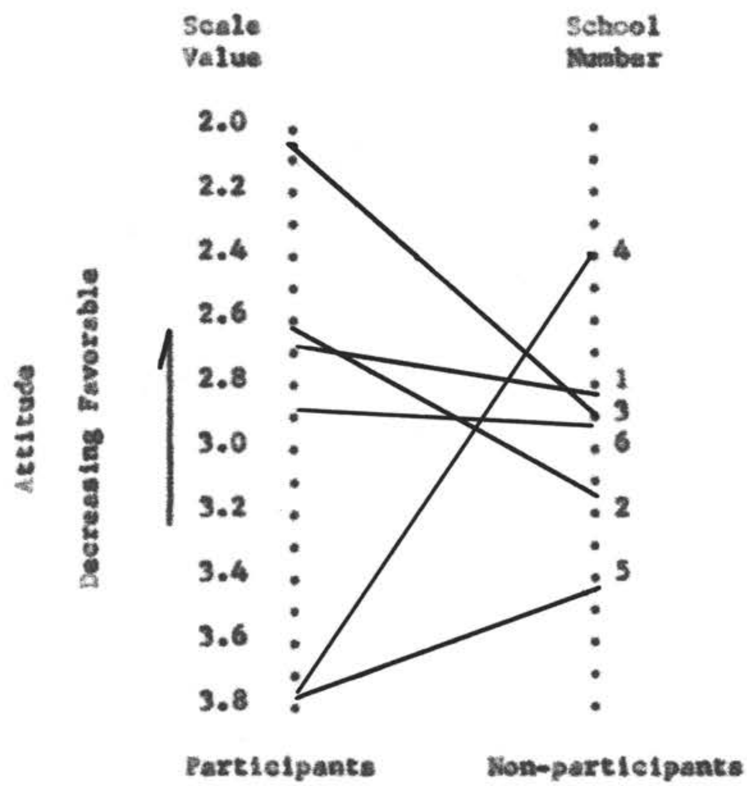

Figure 11. School Mean Scores, Groups A and B, Scale II

Summary

Statistical calculations using analysis of variance techniques indicated only one instance of significant difference in the data obtained in this study related to the hypotheses under consideration. A more detailed analysis, however, showed this difference to be caused by two opposed non-significant interactions. Graphical analysis substantiated this finding and provided some patterns for comment.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

On the basis of the experimental evidence there is no reason for rejecting the null hypotheses. There was no significant difference found between the attitudes of in-service participating teachers and non-participating teachers in the same school district or in adjacent school districts with similar environments. Similarly, the attitude of elementary school teachers toward science did not show significant difference after participation in the in-service course. However, this does not mean that the courses are failing to accomplish anything. We have just been attempting to measure one parameter of an activity with hopefully many parameters.

Close scrutiny of Figures 3 through 8 will indicate that we are possibly teaching too much to the average. We may be changing the less favorable attitudes upward at the expense of the more favorable attitudes. This set of 6 figures points out the individualism in the class participants. Some attitudes were changed drastically while others were not changed at all.

As indicated in Figures 10 and 11, Scale II may have a higher discriminatory power than Scale I. At least, using the same scale increments the slopes were more pronounced. A correlation experiment with a much greater n number is proposed to determine this.

It would seem in retrospect that attitude might be a little too abstract a quality to be measured as precisely as a study such as this requires. Achievement can be measured, but this does not assure that desirables relative to science would be the result in the classroom. Confidence might be an attribute for measurement, but it is as abstract as attitude. Some valid criteria for desirable learning behavior must be identified, then observational techniques developed so that the observer does not interact in any way with the observed. Until objective evaluation such as this has been developed we will continue to offer in-service courses related to trends in curriculum programs, which provide credit, insure salary increments, meet certification requirements, but do not necessarily insure creative science activity for school children. Until we can measure some parameter of this hoped-for behavior in science we cannot be very certain that new approaches to teacher training are any more effective than previous ones.

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APPENDICES

APPENDIX A

DESCRIPTIVE MATERIALS FOR NATURAL SCIENCE 320

College of Arts and Sciences Extension
Oklahoma State University
Stillwater

August 9, 1965

ANNOUNCEMENT

Natural Science 320 -- SPECIAL STUDY IN SCIENCE FOR ELEMENTARY TEACHERS

This course is designed especially for elementary teachers. Topics have been selected which are related to most elementary curricula. The course includes subject matter from both the physical and biological sciences. It will be offered at selected locations as a four-semester hour in-service course during the 1965-66 school year. Classes will meet for two and one-half hours each week for twenty-four weeks.

Each participant will be required to purchase laboratory materials costing $5. These will aid the teachers in carrying on independent laboratory investigations, and they will be retained by the teacher at the conclusion of the course. There is no required textbook. A bibliography and other selected materials will be provided for the various topics.

We are attempting to provide a science course which is both practical for the teacher's need and demonstrative of scientific endeavor. The following pages should give an idea of the kind of course which will be offered, and should be helpful in describing the activities in which teachers will participate.

Introduction

New course materials in science being developed for the elementary schools fall into two choices of activities. One type is chosen to develop basic ideas underlying all science, and the other uses specific areas adapted to individual activity on the part of the student; or at least the developers of them think they do. This course will combine both features of these curriculum movements. Science is finding out what one does not know through some reliable procedure of investigation and problem solving, and it is the development of skills in doing this.

We will work with (1) various physical science topics, (2) some living organisms, and (3) several special problems. This should enable us to gain better insight into how to work in a scientific manner, how to evaluate what we read or do in science, and how to make choices in solving problems of all sorts.

The usual procedure will be to introduce materials with a preliminary demonstration or suggestion. Then, some first procedures or problems will be proposed. Subsequent to these introductory activities, the individuals in the class will continue investigation of the material "on their own."

Teachers are asked not to share the delights of these activities with their classes until the whole idea of the activity has had a chance to develop. In some cases a particular activity will not be appropriate for certain grade levels.

Point of View

This science course is based on the philosophy that we "learn by doing" and that we "teach as we were taught." It will be a series of activities developed around (1) a physical system or objects and (2) a population or organisms or a type of organism. Physical systems or objects will be used to demonstrate ideas basic to all science. All organisms and groups of organisms studied will be used to develop understandings basic to life science. The most important outcome of the teaching procedures will be to provide teachers with techniques and tools for attacking problems in science and science related areas. In all activities we propose to use individual materials and unstructured investigation to as great an extent as is practical. This is in the hope that as we "learn by doing" we may then be better able to justify "teaching as we were taught."

Course Summary

During the period of this course, several living and non-living systems will be studied. A sequential organisation will not be rigidly followed because materials for certain activities will be shared among several other instructors who will also be teaching sections of this course.

Sooner or later in all scientific endeavor, quantitative properties or characteristics described in quantitative terms are necessary for adequate communication of ideas. Therefore, several activities will be conducted to emphasize the importance of measurement of space, mass, and time. The pendulum will be studied as an exercise in measurement and control of variables. The balance will be studied for experience in linear and mass measurements. During both of these exercises, problems will have to be defined and solved by the members of the class and data will be taken and recorded. In all quantitative work, the metric system will be required; and the measurement activities will develop quantitative tools to study living materials.

Throughout the entire course, emphasis will be on taking data, analysing that data, and searching for some of the patterns found in nature. In every discussion, arguments will have to be supported with experimental data or other types of research. All the activities have these things in common: (1) Materials are inexpensive so that classroom quantities may be obtained, (2) choice of the living material is such that it can be used in nearly any classroom, and (3) a minimum of effort will be required of the teacher to set up laboratory situations.

Concurrent with the measurement studies, organisms will be provided for detailed investigations. As a rule, all living materials will be investigated in a similar manner. That is, specimens will be provided for all individuals in the class so that each may work with them to study growth problems and reproduction. This will include a study of characteristics in an attempt to fit the organism into some systematic scheme. The living organisms to be investigated will include seeds, hamsters, mealworms, algae, snails, and daphnia.

Several problems will be posed to attempt to locate a population of organisms in time and space. Also, a development of the sorting process will be used to familiarize teachers with methods of identifying living things by their characteristics. Areas in physical science to be used for investigation will include electricity, magnetism, matter, chemical change, heat and temperature. Both qualitative and quantitative exercises in these topics are included.

Since most elementary curriculum developments use investigation to a greater or lesser extent, this course should provide a teacher with a good background to evaluate any new curriculum effort in science.

The class will be growing things and will study many ways to solve container and environmental problems. Obviously, therefore, aquaria and terraria will be used. The "know how" of developing these projects will be emphasized.

During this course a teacher will have accumulated a depth of understanding of the living and non-living materials with which he/she has been working. One of the greatest benefits a teacher can receive from taking this course will be a feeling of confidence in approaching new problems.

Natural Science 320
Writing Program
June, 1965

General Objectives for Natural Science 320

The in-service course should foster:

1. Curiosity.

2. An increasing capacity to ask simple questions about nature that may be experimentally explored.

3. The ability to organize thoughts and data concerning natural events in order that new insights will result.

4. Enthusiasm for discovery of new knowledge.

5. Awareness of the temporary nature of information.

6. Interest in observing natural events in a critical manner.

7. Improved manipulative skills.

8. A feeling of confidence in approaching unfamiliar areas in nature.

9. Respect for opinions and techniques of others.

SCIENCE UNDERSTANDINGS

Understandings Basic to Life Science

1. Living things come from living things.

2. Life seems to be continuous although organisms seem to have an average life span.

3. There exists in nature a dynamic equilibrium which shows little apparent change over a period of time.

4. Most ideas about living things must allow for exceptions.

5. The matter of which living things are composed is eternal.

6. In all organisms, the greatest struggle for existence is the struggle for useable energy.

7. The study of living things may occupy days, weeks, months, years, centuries, and thousands of centuries, depending upon the perspective selected.

8. Experimentation in life science is difficult because of the number of variables which require control.

9. All living things respond to their environment.

10. Present living forms are the result of adaptation to environment and genetic changes which are continuous.

Physical Science Understandings

1. We understand our physical surroundings only as well as they can be measured.

2. Descriptions of objects and events depend upon the point of view.

3. Our interpretation of interactions seems to be basic to the physical sciences.

4. Some ideas that seem fundamental to the present concept of the physical world are:

    1. The particle nature of matter.
    2. The electrical nature of matter.
    3. The conservation concepts.
    4. The concept of force as related to change.
    5. The matter-energy relationships.

APPENDIX B

EDITED LIST OF ATTITUDE STATEMENTS FOR SCALE II AND INSTRUCTIONS TO JUDGES

INSTRUCTIONS

1. These two pages contain statements concerning science and elementary science teaching.
2. A scale is at the top of each page marked by capital letters from A to K. These letters represent a range of statements from those favorable to science (A) to those unfavorable to science (K).
3. On the line to the left of each statement place the letter which you think most nearly fits the position that that statement should occupy on the scale.
4. You will find it easier to place them if you read all the statements before you begin.

A	B	C	D	E	F	G	H	I	J	K

FAVORABLE TOWARD SCIENCE	NEUTRAL TOWARD SCIENCE	UNFAVORABLE TOWARD SCIENCE

_____ 1. I believe that students at the elementary level are capable of learning more science than they are presently being taught.

_____ 2. I really enjoy teaching science.

_____ 3. Teaching in the area of science represents a challenge for me.

_____ 4. Science has little practical application.

_____ 5. Concepts and materials in science are too difficult for students.

_____ 6. I see no practical purpose in emphasizing science.

_____ 7. Many concepts presented in science are too abstract for the students at the level for which they were intended.

_____ 8. Science is one of the most useful subjects I know.

_____ 9. I am enthusiastic about teaching science.

_____10. Science serves the needs of a large number of boys and girls.

_____11. I didn't like science in school and I still don't.

_____12. I like to teach science in school and I think it's important.

_____13. Science is challenging and intriguing.

_____14. I feel that I make science interesting to most of my pupils.

_____15. Sometimes I give extra assignments in science as punishment.

_____16. I wish I did not have to teach science.

_____17. I think most students would be enthusiastic about a science program.

_____18. The increased emphasis on science has developed too rapidly.

_____19. I like to teach science but I prefer to teach other subjects.

_____20. Science is a subject I like least of all to teach.

_____21. I think the emphasis on science may result in such concern on subject matter that the child as a learner will be overlooked.

A B C D E F G H I J K

FAVORABLE TOWARD SCIENCE	NEUTRAL TOWARD SCIENCE	UNFAVORABLE TOWARD SCIENCE

_____22. A child will learn better if he is provided with a learning situation in which he discovers the meanings and concepts in science.

_____23. I see little need for my school to offer a science program.

_____24. Science programs cause too many class discipline problems.

_____25. Elementary teachers should have formal training in the use of science laboratory materials.

_____26. I think it is exciting to teach a unit of science.

_____27. I have a feeling that my students hate science.

_____28. Science introduces too many concepts and processes at too low a grade level.

_____29. I get frustrated when I study science.

_____30. Science is very practical.

_____31. Science programs over-stress terminology.

_____32. I can teach science well without reading science magazines and methods books.

APPENDIX C

SCALE VALUES, Q SCORES, AND DISTRIBUTION OF PRELIMINARY STATEMENTS USED IN SCALE II

Statement	Scale Value	Q Score	Favorable A	B	C	D	Neutral E	F	G	Unfavorable H	I	J	K
1	2.3	2.9	12	27	20	10	10	9	2				
2	1.4	1.7	35	27	15	6	4	3					
3	1.9	1.7	21	25	23	12	4	5					
4	9.8	1.3							4	9	12	31	34
5	8.5	1.7				2	1	6	5	17	25	20	14
6	9.8	1.3						2	3	4	13	27	41
7	8.1	1.8			1		1	8	13	19	30	14	4
8	1.9	1.4	20	29	23	8	7	2	1				
9	.5	1.0	64	15	7	2	2						
10	2.3	2.0	9	23	31	9	10	8					
11	10.1	1.1			1	1		3	2	5	5	25	48
12	1.5	1.3	24	36	22	3	3	2					
13	1.1	1.2	41	28	12	6	3						
14	2.2	1.3	13	31	27	10	2	7					
15	10.4	.8							1	3	3	18	65
16	9.5	2.1	1		1			1	4	14	14	26	31
17	2.5	2.0	9	25	21	20	9	6					
18	6.5	2.0			5	1	1	27	21	14	11	6	4
19	6.0	1.5		1	2	7	8	26	24	10	11	1	
20	9.5	1.7			1	1		4	3	9	15	27	30
21	8.2	3.0		1	1	1	2	10	15	14	12	23	11
22	1.0	1.5	42	25	11	6	3	3					
23	10.0	.9								4	6	26	54
24	8.8	1.9						3	8	16	25	23	15
25	2.7	2.8	12	18	21	12	10	10	1	1	2	3	
26	1.1	1.0	37	32	10	7	3	1					
27	9.4	2.3							7	17	12	25	29
28	8.1	2.3				1	1	6	17	17	24	15	9
29	8.7	2.1					1	4	11	13	23	24	14
30	2.6	2.1	16	13	28	17	5	11					
31	7.1	1.6		1	1	3	4	8	27	21	15	9	1
32	7.4	3.2		1	1	1	3	18	14	16	10	10	16

APPENDIX D

SCALE AND Q VALUES FOR THE PRELIMINARY

STATEMENTS OF SCALE II

Scale Value	Q Value		Statement
2.3	2.9	1.	I believe that students at the elementary level are capable of learning more science than they are presently being taught.
1.4	1.7	2.	I really enjoy teaching science.
1.9	1.7	3.	Teaching in the area of science represents a challenge for me.
9.8	1.3	4.	Science has little practical application.
8.5	1.7	5.	Concepts and materials in science are too difficult for students.
9.8	1.3	6.	I see no practical purpose in emphasizing science.
8.1	1.8	7.	Many concepts presented in science are too abstract for the students at the level for which they were intended.
1.9	1.4	8.	Science is one of the most useful subjects I know.
.5	1.0	9.	I am enthusiastic about teaching science.
2.3	2.0	10.	Science serves the needs of a large number of boys and girls.
10.1	1.1	11.	I didn't like science in school and I still don't.
1.5	1.3	12.	I like to teach science in school and I think it's important.
1.1	1.2	13.	Science is challenging and intriguing.
2.2	1.3	14.	I feel that I make science interesting to most of my pupils.

Scale Value	Q Value		
10.4	.8	15.	Sometimes I give extra assignments in science as punishment.
9.5	2.1	16.	I wish I did not have to teach science.
2.5	2.0	17.	I think most students would be enthusiastic about a science program.
6.5	2.0	18.	The increased emphasis on science has developed too rapidly.
6.0	1.5	19.	I like to teach science but I prefer to teach other subjects.
9.5	1.7	20.	Science is a subject I like least of all to teach.
8.2	3.0	21.	I think the emphasis on science may result in such concern on subject matter that the child as a learner will be overlooked.
1.0	1.5	22.	A child will learn better if he is provided with a learning situation in which he discovers the meanings and concepts in science.
10.0	.9	23.	I see little need for my school to offer a science program.
8.8	1.9	24.	Science programs cause too many class discipline problems.
2.7	2.8	25.	Elementary teachers should have formal training in the use of science laboratory materials.
1.1	1.0	26.	I think it is exciting to teach a unit of science.
9.4	2.3	27.	I have a feeling that my students hate science.
8.1	2.3	28.	Science introduces too many concepts and processes at too low a grade level.
8.7	2.1	29.	I get frustrated when I study science.
2.6	2.1	30.	Science is very practical.
7.1	1.6	31.	Science programs over-stress terminology.
7.4	3.2	32.	I can teach science well without reading science magazines and methods books.

APPENDIX E

ATTITUDE SCALES I AND II

SCALE I

In the following statements, please check the appropriate blanks or fill in the general information as it applies to you.

1. Number of years teaching experience (including this year).

Elementary_____ Secondary_____

2. Grade you are now teaching: 1.___ 2.___ 3.___ 4.___ 5.___ 6.___

3. Check the range in which your age falls: 60 or above__________
50 to 59 __________
40 to 49 __________
30 to 39 __________
20 to 29 __________
below 20 __________

4. Sex: Male______ Female______

5. Please give the approximate hours that you have completed in each area and indicate the time credit was received.

Biology____________ during last 3 years__; prior to last 3 years__
Chemistry__________ during last 3 years__; prior to last 3 years__
Physics____________ during last 3 years__; prior to last 3 years__
Physical Science____ during last 3 years__; prior to last 3 years__
Meteorology________ during last 3 years__; prior to last 3 years__
Astronomy__________ during last 3 years__; prior to last 3 years__
Geology____________ during last 3 years__; prior to last 3 years__

Rate the following statements by circling the number which indicates the degree with which you agree or disagree with each statement.

EXAMPLE: Democrats are interesting people.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

(Note that 5 is circled, indicating neither strong disagreement nor strong agreement.)

COMPLETE THE FOLLOWING STATEMENTS IN A SIMILAR MANNER:

1. Field trips to such places as botanical gardens or observatories make science an interesting subject.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

2. Science is unrelated to life experiences.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

3. I could have been given more science instruction in elementary school.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

4. I have difficulty seeing anything through a microscope.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

5. It is helpful to know the basic facts about animal life.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

6. Science seems to be "over my head."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

7. Possibilities for student participation make science an interesting subject.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

8. The study of science doesn't bore me, but I would never pursue it independently.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

9. It is fascinating to study live specimens in the classroom.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

10. I am interested in learning more about science.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

11. I find it objectionable to work with mice, worms, bugs, and any other small crawling thing.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

12. Science education is a "must" at this time.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

13. Scientists are people who invent something to improve everyday living.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

14. Science learning are often the basis of a good hobby.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

15. Science is important in this scientific age in which we live.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

16. A lizard is an interesting and attractive classroom pet.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

17. Science is interesting, but not as important as other subjects.

AGREE---1----2----3----4----5----6----7----8----9----DISAGREE

18. Science is boring.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

19. I like to do science experiments.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

20. Elementary school science should be taught to groups of children with approximately the same I.Q.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

What aspect of elementary school science do you <u>like</u> most?____________

____

What aspect of elementary school science do you dislike most?_________

____

SCALES I AND II

RATE THE FOLLOWING STATEMENTS BY CIRCLING THE NUMBER WHICH INDICATES THE DEGREE WITH WHICH YOU AGREE OR DISAGREE WITH EACH STATEMENT.

EXAMPLE: Democrats are interesting people.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

(Note that 5 is circled, indicating neither strong disagreement nor strong agreement.)

COMPLETE THE FOLLOWING STATEMENTS IN A SIMILAR MANNER.

1. Sometimes I give extra assignments in science as punishment.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

2. Field trips to such places as botanical gardens or observatories make science aninteresting subject.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

3. I am enthusiastic about teaching science.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

4. Science is unrelated to life experiences.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

5. I didn't like science in school and I still don't.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

6. I could have been given more science instruction in elementary school.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

7. A child will learn better if he is provided with a learning situation in which he discovers the meanings and concepts in science.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

8. I have difficulty seeing anything through a microscope.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

9. I see little need for my school to offer a science program.

   AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

10. It is helpful to know the basic facts about animal life.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

11. I think it is exciting to teach a unit of science.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

12. Science seems to be "over my head."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

13. Science has little practical application.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

14. Possibilities for student participation make science an interesting subject.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

15. I really enjoy teaching science.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

16. The study of science doesn't bore me, but I would never pursue it independently.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

17. I see no practical purpose in emphasizing science.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

18. It is fascinating to study live specimens in the classroom.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

19. I like to teach science in school and I think it's important.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

20. I am interested in learning more about science.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

21. Science is a subject I like least of all to teach.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

22. I find it objectionable to work with mice, worms, bugs, and any other small crawling thing.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

23. Science is one of the most useful subjects I know.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

24. Science education is a "must" at this time.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

25. Science programs cause too many class discipline problems.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

26. Scientists are people who invent something to improve everyday living.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

27. I feel that I make science interesting to most of my pupils.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

28. Science learnings are often the basis of a good hobby.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

29. Concepts and materials in science are too difficult for students.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

30. Science is important in this scientific age in which we live.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

31. I think most students would be enthusiastic about a science program.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

32. A lizard is an interesting and attractive classroom pet.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

33. Many concepts presented in science are too abstract for the students at the level for which they were intended.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

34. Science is interesting, but not as important as other subjects.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

35. Science programs over-stress terminology.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

36. Science is boring.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

37. The increased emphasis on science has developed too rapidly.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

38. I like to do science experiments.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

39. I like to teach science but I prefer to teach other subjects.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

40. Elementary school science should be taught to groups of children with approximately the same I.Q.

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

IN THE FOLLOWING STATEMENTS, PLEASE CHECK THE APPROPRIATE BLANKS OR FILL IN THE GENERAL INFORMATION AS IT APPLIES TO YOU.

Number of years teaching experience (including this year).

Elementary_____ Secondary_____

Grade you are now teaching: 1.___ 2.___ 3.___ 4.___ 5.___ 6.___

Check the range in which your age falls:

60 or above	___________
50 to 59	___________
40 to 49	___________
30 to 39	___________
20 to 29	___________
below 20	___________

Indicate your graduate and undergraduate grade average based on a 4.0 system.

Graduate _________ Undergraduate _________

(If you indicate it based on another scale, please indicate the scale.)

APPENDIX F

RAW DATA FOR SCHOOL 1

Group A				Group B		
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	8.1	7.6	1.5	1	8.0	5.4
2	7.0	8.4	2.5	2	6.5	3.5
3	8.1	7.5	1.7	3	8.5	2.3
4	7.9	7.7	2.0	4	8.0	2.2
5	8.3	8.3	2.9	5	7.9	2.9
6	8.6	7.0	2.7	6	7.4	3.9
7	6.6	7.3	4.3	7	7.8	1.1
8	8.5	7.7	3.4	8	8.5	2.0
9	8.3	7.9	2.4	9	7.6	6.2
10	6.9	7.1	3.6	10	6.9	4.0
11	8.3	8.2	2.6	11	8.1	1.5
				12	7.2	3.0
				13	7.6	2.9
				14	9.0	1.1
				15	8.2	2.0
				16	6.2	3.4
				17	8.2	1.4
				18	8.5	3.0
				19	7.8	2.5
				20	7.7	2.5
				21	8.2	2.6
Total	86.60	84.70	29.6		163.80	59.4
Mean	7.87	7.70	2.69		7.80	2.83
Y^2	686.68	654.39	86.62		1286.88	201.46

APPENDIX G

RAW DATA FOR SCHOOL 2

Group A				Group B		
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	7.6	7.8	1.5	1	8.1	3.9
2	8.7	8.0	1.5	2	9.2	2.2
3	7.3	8.1	1.5	3	8.0	3.5
4	8.5	8.1	1.5	4	8.8	1.7
5	7.7	8.1	2.3	5	7.8	2.0
6	8.1	8.5	4.1	6	7.6	2.6
7	8.6	7.0	4.7	7	7.5	3.5
8	7.2	7.5	2.9	8	4.9	6.2
9	7.3	8.2	4.7	9	7.7	6.6
10	7.8	7.8	1.5	10	8.0	1.3
				11	8.2	2.2
				12	7.0	2.8
				13	7.3	3.0
Total	78.8	79.1	26.2		100.1	41.5
Mean	7.88	7.91	2.62		7.70	3.19
Y^2	623.82	627.25	85.94		783.37	163.57

APPENDIX H

RAW DATA FOR SCHOOL 3

Group A				Group B		
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	8.5	8.5	1.4	1	8.2	2.6
2	7.8	8.1	2.5	2	7.9	2.0
3	8.0	8.1	1.7	3	8.5	2.5
4	7.9	8.5	3.0	4	8.2	3.0
5	8.2	7.8	1.5	5	8.5	3.6
				6	5.5	6.7
				7	8.6	3.6
				8	8.5	1.3
				9	7.5	4.1
				10	6.5	4.5
				11	7.4	1.6
				12	7.8	3.2
				13	7.8	2.4
				14	8.0	1.5
				15	8.5	2.0
				16	7.0	3.5
				17	8.0	2.0
				18	8.6	2.1
Total	40.4	41.0	10.1		141.0	52.2
Mean	8.1	8.2	2.05		7.83	2.90
Y^2	326.74	336.56	22.35		1116.0	181.04

APPENDIX I

RAW DATA FOR SCHOOL 4

Group A				Group B		
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	6.7	6.8	3.3	1	8.4	3.3
2	6.1	7.7	3.1	2	6.9	3.8
3	6.8	7.8	2.8	3	7.9	1.5
4	8.1	7.9	2.1	4	8.3	1.5
5	8.1	8.5	3.0	5	8.5	2.0
6	7.8	6.9	5.5	6	7.5	2.3
7	6.7	8.5	2.6			
8	8.3	7.2	7.8			
9	7.4	6.4	4.7			
10	8.0	7.9	2.6			
11	8.2	8.5	3.0			
12	6.6	7.2	5.1			
13	7.1	7.5	2.9			
Total	95.9	98.9	48.5		47.5	14.4
Mean	7.38	7.60	3.73		7.91	2.4
Y^2	714.15	756.44	211.87		377.97	39.12

APPENDIX J

RAW DATA FOR SCHOOL 5

	Group A				Group B	
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	7.9	6.9	5.5	1	8.3	2.8
2	6.7	6.4	3.0	2	7.2	4.2
3	7.3	6.3	5.8	3	8.6	2.3
4	7.5	7.3	2.5	4	7.7	3.3
5	6.9	7.4	3.1	5	6.6	6.1
6	7.4	7.9	3.5	6	7.0	3.3
7	7.7	8.5	4.1	7	8.1	2.0
8	7.2	8.0	2.8			
9	8.1	8.1	2.2			
10	7.4	6.3	5.7			
11	8.0	7.8	3.2			
Total	82.1	80.9	41.4		53.5	24.0
Mean	7.46	7.35	3.76		7.64	3.43
Y^2	614.71	601.11	173.22		412.15	93.76

APPENDIX K

RAW DATA FOR SCHOOL 6

Group A				Group B		
Student Number	Scale I Score Pre-test	Scale I Score Post-test	Scale II Score	Student Number	Scale I Score	Scale II Score
1	6.9	8.3	2.5	1	8.2	3.3
2	8.2	7.3	4.7	2	7.8	3.5
3	7.3	8.4	3.0	3	8.0	1.3
4	6.6	7.8	2.0	4	7.78	3.9
5	7.3	7.2	4.1	5	7.3	2.6
6	7.4	8.2	2.3	6	7.5	2.7
7	7.2	7.2	4.1	7	7.7	4.4
8	8.4	8.4	1.5	8	7.1	4.6
9	7.4	8.0	3.6	9	7.8	3.8
10	7.1	8.4	2.6	10	7.6	4.3
11	7.6	8.2	1.5	11	7.8	2.9
12	8.3	7.4	2.6	12	8.2	2.3
13	7.8	8.5	2.9	13	7.8	2.9
14	7.4	7.8	2.1	14	8.3	2.1
15	7.8	7.4	2.8	15	8.5	2.0
16	7.2	8.5	4.2	16	8.5	1.6
17	8.2	8.2	2.4	17	8.1	2.3
				18	7.8	2.3
				19	8.6	2.0
Total	128.1	135.2	48.9		150.3	55.6
Mean	7.5	8.0	2.88		7.91	2.93
Y^2	969.49	1078.96	155.29		1191.93	179.4

APPENDIX L

ABBREVIATED DOOLITTLE, GROUP A, PRE- AND POST-TEST, SCALE I

	Total	S-1	S-2	S-3	S-4	S-5	S-6	N/2	N/2	Y Scale I
	134	22	20	10	26	22	34	67	67	1031.6
		22	0	0	0	0	0	11	11	171.3
			20	0	0	0	0	10	10	157.9
				10	0	0	0	5	5	81.4
					26	0	0	13	13	194.7
						22	0	11	11	163.0
							34	17	17	263.3
								67	0	511.9
									67	519.7
S-1		22	0	0	0	0	0	11	11	171.3
		1	0	0	0	0	0	.500000	.500000	7.786364
S-2			20	0	0	0	0	10	10	157.9
			1	0	0	0	0	.500000	.500000	7.895000
S-3				10	0	0	0	5	5	81.4
				1	0	0	0	.500000	.500000	8.140000
S-4					26	0	0	13	13	194.7
					1	0	0	.500000	.500000	7.488461
S-5						22	0	11	11	163.0
						1	0	.500000	.500000	7.409091
S-6							34	17	17	263.3
							1	.500000	.500000	7.744117
								33.5	-33.5	-3.9
								1.0	- 1.0	-0.116418
									0.0	0.0

APPENDIX M

ABBREVIATED DOOLITTLE, GROUPS A AND B, SCALES I AND II

	Total	S-1	S-2	S-3	S-4	S-5	S-6	Group A	Group B	Y Scale I	Y Scale II
	151	32	23	23	19	18	36	67	84	1175.90	452.0
		32	0	0	0	0	0	11	21	248.50	89.0
			23	0	0	0	0	10	13	179.20	67.7
				23	0	0	0	5	18	182.0	62.3
					19	0	0	13	6	146.38	62.9
						18	0	11	7	134.4	65.4
							36	17	19	285.5	104.7
								67	0	519.7	204.7
									84	656.2	247.3
S-1		32	0	0	0	0	0	11	21	248.500000	89.000000
		1	0	0	0	0	0	.343750	.656250	7.765625	2.781250
S-2			23	0	0	0	0	10	13	179.200000	67.7
			1	0	0	0	0	.4347822	.565217	7.791304	2.943478
S-3				23	0	0	0	5	18	182.000000	62.3
				1	0	0	0	.217390	.782608	7.913043	2.595833
S-4					19	0	0	13	6	146.380000	62.9
					1	0	0	.684210	.315789	7.704210	3.310526
S-5						18	0	11	7	134.400000	65.4
						1	0	.611111	.388888	7.466666	3.633333
S-6							36	17	19	285.500000	104.7
							1	.472222	.527777	7.930555	2.908333
								34.139255	-34.139191	-0.307148	-1.317000
								1	- 0.99998	-0.008997	-0.038577
									0.0	0.0	0.0

VITA

JOHN BENJAMIN LEAKE

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF ATTITUDES OF ELEMENTARY TEACHERS TOWARD SCIENCE

Major Field: Higher Education

Biographical:

Personal Data: Born in Stone County, Missouri, February 10, 1923, the son of Harold H. and Dorothy Leake.

Education: Attended grade school at Monett, Missouri, and Durant, Oklahoma; graduated from Norman High School, Norman, Oklahoma in 1940; received the Bachelor of Arts degree from the University of Oklahoma, with a major in Botany in May, 1944; did undergraduate work in Education and Science at Drury College, Springfield, Missouri; did undergraduate work in Science and Education at Southwest Missouri State College, Springfield, Missouri; did undergraduate work at Southeastern State Teachers College, Durant, Oklahoma; did undergraduate and graduate work in Science at the University of Arkansas, Fayetteville, Arkansas; received the Master of Arts degree from Washington University, Saint Louis, Missouri, with a major in Science Education, in June, 1958; completed requirements for the Doctor of Education degree in July, 1966.

Professional Experience: Served in the United States Navy Submarine Service during World War II; employed as high school Science Teacher and Principal of Lawrence County, Missouri, Reorganized School District Number IV from 1949 to 1957; employed as a Science Teacher by the School District of the City of Ladue, Missouri, from 1958 to 1959; employed as a Science Consultant in the State Department of Education, Jefferson City, Missouri, from 1959 to 1964; presently employed as an Instructor in Science and Mathematics Education at the University of Wisconsin--Platteville.

Professional Organizations: American Association for the Advancement of Science, Phi Delta Kappa, Phi Sigma, National Science Teachers Association, National Science Supervisors Association

National Science Supervisors Association, Council for Elementary Science International, and Association for the Education for Teachers of Science.