A COMPARISON OF TWO METHODS OF TEACHING

FIFTH GRADE SCIENCE

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PREFACE

The work reported in this investigation was performed in two of the elementary schools of the Stillwater City Schools and by permission of the school administration. The primary objective of this study was to compare two methods of teaching fifth grade science. Comparisons were made in the areas of study achievement, attitude, and interest in science. It is hoped that resultant recommendations will provide a basis for further investigations in these areas.

I am especially grateful for the assistance and encouragement given throughout the program of study by Dr. Kenneth E. Wiggins, Chairman of my Advisory Committee.

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CHAPTER I

INTRODUCTION

Background of the Study

Among the influences affecting schools during the second half of the twentieth century are the influx of children to be educated, the tremendous increase in knowledge, and various viewpoints as to the essential purposes of education.

A number of studies have been undertaken in an effort to improve educational materials and teaching techniques in the schools. All areas of the curriculum have been under the scrutiny of educators and organizations dedicated to the improvement of education. In the vanguard is a great amount of research and group deliberation related to the improvement of teaching in the sciences. Not the least of the reasons for the emphasis on science research was Russia's bid for technical leadership by orbiting the first satellite.

At the time the Russians launched their first space vehicle, most elementary school science programs could be characterized as being "correlated" with other subjects. Science was often considered as being an incidental part of the curriculum; to be taught if the teacher had time or had a special interest in the subject area. With the awakening of the public regarding the status of scientific knowledge and concepts in a highly technical and specialized society came financial assistance and pressure to improve public school science programs, from kindergarten through high school.

Owing to recent developments, elementary school science is now achieving full and independent status. It is no longer to be found on the periphery of other subjects in the elementary school program. As the importance of science becomes apparent to members of our society, it assumes a more definite setting in the curriculum of the elementary school.

With the movement in modern science instruction shifting to the elementary school level, educators are re-evaluating the objectives of science education. The following objectives are listed by Schlessinger (45):

1. Providing experiences through which boys and girls can arrive at some of the concepts of science.

2. Providing science experiences planned around activities of significance to boys and girls.

3. Organizing the learnings in science so that they will result in certain desirable outcomes by the time the child completes the elementary grades. For example, beginning of habits of systematic observation; of quantitative thinking and representation; some acquaintance with modes of scientific thought; beginnings of a scientific vocabulary; and a desire for a scientific explanation.

4. Helping the child, whenever possible, to apply the methods of science to other subject matter areas.

In an analysis of viewpoints of science educators responsible for recent books on elementary school science, Smith (49) found that they all agreed that the objectives for elementary school science should be stated in terms of children's behavior. They were also in agreement that acquisition of knowledge should not be the sole criterion for measuring effectiveness of the science program.

Without indicating an emphasis, Hurd (27) summarizes the objectives of elementary school science in seven categories:

1. Understanding science (knowledge, vocabulary, concepts, principles).

2. Problem-solving (variety of approaches, intuition, imagination).

3. Social aspects of science (relationships among basic research, applied research, technology).

4. Attitudes (open-mindedness, accuracy, curiosity, creativity).

5. Appreciation (of science as a discipline and as a vocational pursuit).

6. Careers (science careers in our culture).

7. Skills and abilities (reading, inferring, evaluating).

Writers in the area of science education vary in their viewpoints whether science is a body of knowledge as reflected in facts or concepts or whether science represents an approach to knowledge as reflected in heuristic procedures and attitudes. Weaver (53) makes the following comment:

> We are not dealing with some mysterious body of absolute truth but rather with that amazingly successful, interesting, intriguing, illusive, and rewarding human process by means of which, within one particular framework of reference, man approaches truth. This process moves in the direction of increasing precision and validity but it does not reach perfection.

Navarra (36) holds that science is a kind of elusive human activity that, when encouraged by teachers, must place greater emphasis on thinking, creativity, and the learner's autonomy than on the correct response or the right answer.

Other writers place the emphasis for science teaching on the fundamental structure of the discipline. Bruner (11) calls for the development of intuitive and analytical thinking in the setting of the basic structure of science:

> In essence it consists of learning initially not a skill but a general idea, which can be used as a basis for recognizing subsequent problems as special cases of the idea originally mastered. This type of transfer is at the heart of the educational process--the continuing broadening and deepening of knowledge in terms of basic and general ideas....Mastery of the fundamental ideas of a field involves not only the grasping of principals, but also the development of an attitude toward learning and inquiry, toward guessing and hunches, toward the possibility of solving problems on one's own.

In expressing this emphasis, Bruner reflects the thinking of a segment of the American scientific community. Atkin (4) criticizes current teaching as being too dependent on the transitory interests of children and the utility value of science. He feels the aims of science teaching should be related to the pervasive concepts in science and the structure of the discipline.

Authorities in the elementary school are in general agreement concerning the goals of science teaching. These goals include the teaching of some knowledge of content and basic concepts, an interest in science as a discipline, and a favorable attitude concerning the importance of science in our daily lives.

The influx of children, the tremendous increase in knowledge, and differences in viewpoints concerning the most effective methods of teaching make it imperative that educational practices be continually evaluated. As new materials are developed and new approaches to teaching are proposed, it becomes increasingly important that studies be undertaken which seek to compare the effectiveness of these materials and approaches in the classroom setting.

In accord with this need, a number of studies have dealt with grouping of children and various methods of instruction in the area of elementary school science (32, 35, 42, 44). Their common goal has been the search for a more effective method of teaching. They are in general agreement that the element that holds the key to the success of any proposed procedure is the classroom teacher.

This study involved a comparison of the effectiveness of two methods of teaching fifth grade science. Each teacher in the study was assigned classes under each of the two methods.

Statement of the Problem

The objective of this study was to compare the resultants of two methods of teaching science to fifth grade students.

One method placed emphasis on teacher lectures, use of a school-adopted textbook and unit tests, teacher directed demonstrations, and student discussion of teacher selected concepts. This method emphasized the "telling and seeing" aspect of science and for the purposes of this study was designated as the "traditional" method of teaching. Groups taught by this method were designated as control groups.

The second method included the same subject matter areas, but involved less teacher direction and more pupil participation in planning class activities. A variety of textbooks and reference materials was available, placing a greater emphasis on pupil investigation. The method stressed students' making and recording quantitative observations. The approach emphasized the "doing" aspect of science and was designated as the "pupil-investigation" method of teaching. The groups taught by this method were designated as experimental groups.

Specifically, this study attempted to answer the following questions:

1. To what extent do achievement scores differ between students taught by the traditional method and those taught by the pupil-investigation method?
2. To what extent do science attitude scores differ between students taught by the traditional method and those taught by the pupil-investigation method?
3. To what extent do science interest scores differ between students taught by the traditional method and those taught by the pupil-investigation method?

Hypotheses

The specific hypotheses tested in this study were:

1. There is no significant difference at the .05 level of confidence, in science achievement of fifth grade children who have been taught science by the traditional method and those who have been taught science by the pupil-investigation method, by the same teacher.
2. There is no significant difference at the .05 level of confidence, in attitudes toward science of fifth grade children who have been taught science by the traditional method and those who have been taught science by the pupil-investigation method, by the same teacher.
3. There is no significant difference at the .05 level of confidence, in interest toward science of fifth grade children who have been taught science by the traditional

method and those who have been taught science by the pupil-investigation method, by the same teacher.

Significance of the Study

There has been an increased emphasis on the teaching of elementary school science in recent years. Studies have stressed the need for desirable curriculum objectives, the adequacy of teaching facilities and materials, the need for adequately trained teachers, methods of teaching and pupil deployment, and various goals directed toward the improvement of teaching elementary school science. Although science educators emphasize the need for an investigatory approach, little research has been done that attempts to compare this method with the traditional method of teaching.

It is recognized that the general ability and personality of the teacher are important factors in evaluating the effectiveness of any method of presentation. In all known studies involving comparisons of methods of teaching elementary school science, different approaches were taught by different teachers. This presents a difficult problem for researchers in this area. Shoresman (46) expressed the opinion of many writers in the following statement:

> A major obstacle in educational research preventing the design of a "clean" field experiment with extant classes has been the inability of researchers to control for, or even describe, teacher variability. Under ideal experimental conditions, each teacher would be assigned to teach classes under each of the two experimental treatments.

In other words, are the hypotheses accepted or rejected because of the methods being tested, or is it because of the personnel involved in the study? Is a well-trained and experienced teacher more successful in achieving desirable teaching goals by one method than by another?

Most researchers have been unable to assign members to groups in a random manner. Few studies have been attempted which have not required equating of groups by pre- and post-test procedures.

This study is significant in that it did include both of these unusual advantages. Subjects were assigned to groups by random selection and each teacher involved taught classes under each of the prescribed methods. Any study which seeks to improve teaching methods possesses a degree of significance. If no differences are found, other avenues of investigation may be suggested. If differences are found, they may stimulate other studies to explore further these differences with the aim of suggesting additional ways of improving the teaching of elementary school science.

Limitations of the Study

The study was limited by the following:

1. Population and sample was limited to fifth grade students enrolled by September 1, 1966, at Will Rogers and Westwood elementary schools in Stillwater, Oklahoma. Students who enrolled after this date or who withdrew before March 23, 1967, were not included in the study.
2. The study was limited to one control group and one experimental group at each of the above mentioned school sites.
3. The study did not attempt to compare teaching effectiveness of the two teachers involved in this study.

Definition of Terms

Achievement in science

Achievement in science will mean a measure of the acquisition and retention of science information, as measured by a Stanford Science Achievement Test.

Attitudes toward science

Attitudes toward science refers to how an individual feels about science; an emotionalized feeling for or against science as measured by the attitude inventory, Interests and Ideas.

Interest in science

Interest in science refers to how a person reacts to science related activities; indicated by the degree of participation in a variety of these activities, as measured by Activities, an interest inventory.

Control groups

Those groups taught by a traditional approach to the teaching of elementary school science.

Experimental groups

Those groups taught by a pupil-investigation approach to the teaching of elementary school science.

Assumptions of the Study

There are several assumptions that are basic to this study. It must be assumed that:

1. The subjects of this study were representative of the population.

2. The instruments used in this study were valid in measuring science achievement, attitudes toward science, and interest toward science.

3. Factors which influence student achievement, attitude and interest were randomized.

4. The teaching personnel could differentiate between their teaching methods when teaching control and experimental groups.

5. The personnel involved in the study were unbiased concerning the most effective method of teaching fifth grade science.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Since the turn of the century there has been little doubt that science contributes a dynamic force and is a vital component of present day culture. To believe that it is important for mankind to understand something of the forces affecting his environment is to agree that he must obtain an understanding of science. Since understanding is a function of learning, it follows that man must learn something of science in order that he may begin to understand it.

Most of the learning of phenomena outside the confines of the home occurs in the school. If knowledge concerning science can be envisioned as a tool, like reading, writing, and arithmetic, it is not unreasonable to suggest the development of a functional understanding of this knowledge at an early age.

In an effort to review literature pertinent to this study, attention was given to comments by researchers and science education specialists in areas related to the improvement of instruction. Some of the more relevant areas of literature are (a) curriculum development, (b) attitude and interest scales, and (c) teaching methods and personnel.

Curriculum Development

As previously noted, educators are in general agreement that the study of science should begin in the elementary grades. A study of literature, however, indicates diversity of opinion concerning what should be taught and the sequence of the subject matter.

A variety of concepts in biological and physical science have been incorporated in teaching guides. Stollberg (50) indicated that across the country curriculum guides included (a) the life sciences including plant and animal life and human health, (b) the earth sciences including geology, weather and climate, and simple astronomy, (c) physical sciences including such areas as machines, energy, force, and chemistry. He concluded that comprehensiveness of teaching guides was more potential than actual. Dubins (22) concluded after reviewing a cross-section of 192 guides, that although there were hundreds of concepts presented to children, there was confusion as to what to teach and little attempt to define objectives in elementary school science instruction and relate content to them.

In a study conducted by Bruns and Frazier, (12) it was found that about one-half of the school systems used a "spiral" organization for the sequence of elementary school concepts, the concepts recurring with greater complexity at successive grade levels. There was a lack of consistency among schools as to what concepts were appropriate for each grade level or what grade levels should represent the stages of spiral recurrence for concepts. In a later study, Chinnis (17) found little agreement among textbook authors regarding either grade placement, content, or the depth to which given concepts should be developed at a given level. An analysis of the current status of elementary school science curriculums was reported by Mallinson (34). In a survey of curricular patterns, she emphasized the confusion in sequencing of science topics. She also found no agreement about time allocation afforded science in selected school districts.

If in some schools the organization of science curriculum is vague or inconsistent, in others the concepts are presented incidentally. Science teaching in some schools is subsidary to instruction in the social studies or language arts, which leads to science being a collection of "atomistic" packages of content without cohesion. Navarra (36) stated that such integration of science with other disciplines contributes to making science teaching trivial, defeats the understanding of science as a discipline and a process, and causes personal and utility values to override more critical objectives in science education.

These studies indicate a lack of well-defined objectives in the teaching of elementary science. This is a situation which seems to characterize the developmental period of any phase of the school curriculum. It is generally agreed that a more dynamic approach to science is needed. At the present time many groups of varied backgrounds have concerned themselves with science in the elementary school. There is, however, no single group that can at this time speak with finality and authority (37).

Authorities are in agreement that science in the elementary school should be taught as a separate subject. Instruction should not be opportunistic or casual but rather sequential and developmental.

Attitude and Interest Scales

As schools attempt to evaluate programs of study, teacher-made tests and standardized achievement tests are frequently used to assist in measuring the amount of knowledge acquired by the learners. This is an important area of evaluation but the teacher should also attempt to assess the attitudes and interests pupils are forming concerning the study of science. Elementary school pupils will later become adults living in a science-based world. The attitudes and interests developed early in life will certainly affect choices made in high school, college, and adult life.

Ragan (41) emphasized the importance of developing positive attitudes. He states that the evaluation of a child's attitudes--his feelings for or against things--assumed a fundamental role in guiding his development. He stressed that the child's attitude affects what he learns, what he remembers, and what he does in later life. Carin and Sund (16) mentioned interest as a prime factor in teaching and learning science and a natural outgrowth of the experiences of the learner.

Science educators have long recognized that scientific attitudes are among the important outcomes which should result from science teaching (6). Although much experimentation has been carried on in the field of measuring attitudes and opinions, a large portion of this literature has dealt with the measurement of attitudes on social questions.

Judging from their prevalence in the literature, three studies in the measurement of scientific attitudes have been most widely accepted by science educators. Instruments constructed by Davis (20), Noll (38), and Hoff (25) were at one time widely used to measure scientific attitudes. Because of rapid advances in this area, these tests are largely outdated in terms of pupil experience and scientific progress.

Baumel and Berger (6) recently constructed an attitude instrument designed for use in ninth year general science courses. Although this test was not designed for elementary children, it did reveal that (a) students who scored high were not necessarily those with high grades in science and (b) students who scored low were not necessarily those with low grades in science. Results tended to indicate low correlation between achievement and attitude.

From this study emerged a number of hypotheses subject to further investigation. Those appropriate for testing at the elementary school level are as follows:

1. Scientific attitudes may be acquired by students at all levels of ability.
2. The teacher needs to evaluate not only the knowledge achievement of his student but also their growth in scientific attitudes.
3. The student with scientific attitudes will more effectively cope with school and community problems.
4. Success in developing scientific attitudes depends ultimately on the teacher.

In an effort to determine children's attitudes toward science, a projective-type instrument was designed by Perrodin (40). This instrument was administered to pupils in the fourth, sixth, and eighth grades in three representative school systems. In general it appeared that fourth graders had very favorable attitudes toward science, favorable attitudes reached a peak in the sixth grade, and declined somewhat at the eighth grade level.

A survey of likes and dislikes of children in elementary school science, in response to Perrodin's sentence fragments, indicated some interesting facts. The most frequently named activity to "The part I like best about science is..." was "experiments." Some answers to "The part I like least about science is..." were "copying off the board," "just listening to something in class and not doing anything," "just studying and not working together," and "writing down study questions at the end of the chapter."

A science attitude inventory prepared by Shoresman (46) was designed to obtain an indication of pupil attitude toward instruction in science. Three major sub-scales; (a) values related to science, (b) affect related to sceince, and (c) approach or avoidance behavior associated with science and science-related activities served as the basis for this instrument. The original instrument has recently been revised and has been used with fifth and sixth grade students by the Elementary School Science Research Project at the University of Illinois.

An examination of current interest inventories and of the literature on the nature, origins, and measurements of interests supports the conclusion that current interest measurement is largely a matter of obtaining a quantitative score based on a respondent's subjective statements of likes and dislikes (19, 51).

Two recognized authorities, Cooley and Reed (18), felt that an alternative technique of measuring interests, and perhaps a more valid one, was to obtain a score based on the respondent's statements concerning his degree of actual participation in selected activities.

The Reed Science Activity Inventory is composed of 70 science activity items with a six-point frequency scale for each item. Respondents are instructed to circle the appropriate symbol for each item, indicating how often the activity has been done during the past year, because of the respondent's interest in the activity.

An instrument entitled Activities, consisting of 80 items, was developed for use by the Elementary School Science Research Project (ESSREP) of the Lexington, Massachusetts, Public Schools by Shoresman (46). The Reed Science Activity Inventory was a precursor of this instrument. It also placed emphasis upon the operational level of voluntary participation, in contrast to the verbal level of subjective statements concerning what one might be or do. An instrument that attempts to measure interest in science by assessing behavior would appear to be more effective than one relying on verbal statements.

In a comprehensive investigation reported by MacCurdy (33) and conducted in three states over a four-year period, it was revealed that specific scientific interests of elementary school children were closely related to later occupational choices. Interest leaned more than heretofore toward the physical sciences as contrasted with the biological sciences. Moreover, teachers were exerting a stronger influence on these interests than previously. It was also reported that first scientific interests were usually personal and solitary.

Although attitudes, interests, and achievement are by no means synonymous, writers recognized the relationship between them. Witty (55) made this statement in discussing the role of attitudes in children's failures and successes:

> In every subject area the efficiency of instruction will be brightened by the development of an educational program which recognizes the significance of each child's attitudes.

Bixler (9) determined that a significant relationship existed between student acquisition of science information and attitudes and the teacher's attitude toward science. The degree that teachers reflected authoritativeness and the nature of teacher's attitudes toward desirable teacher-pupil relations were important but not as significantly related to children's science information and attitudes as was the teacher's attitude toward science. It is generally agreed that if teachers are prepared to teach science and feel adequate to do so, children's achievement and attitudes toward science will be enhanced.

Science Instruction

Essentially, three proposals for providing science instruction in the elementary school have been made through the years and continue to be reiterated with certain variations. The proposals generally deal with the individual responsible for providing the instruction: (a) the general classroom teacher, (b) the general classroom teacher with auxiliary aid, or (c) the special teacher of science.

Courses of study often deal with the competencies we would have children develop from a study of science. However, the competencies of children are inextricably interwoven with the competencies of teachers.

Research in various subject matter areas has been directed toward a comparison of effectiveness of presenting pupil progress under different patterns of instruction.

A study was conducted by Russell (43) for the purpose of determining the basic methods of teaching elementary science and the relative value of each. From a review of over 500 references, he determined four basic teaching methods; (a) the incidental method, (b) definitely planned units, (c) subject-core units, and (d) science-concept units. Fifty-one science educators were asked to comment on the four methods. Tabulations of resulting comments indicated that the majority of the specialists favored the science-concept method.

Several studies focused on various types of class organization or teaching procedures. The following citations concern efforts directed toward the identification of superior methods of presenting subject matter.

Schab (44) directed a study which compared the achievement of groups of remedial reading students taught by different methods. Methods were identified as "Teacher-Planned Activities" and "Teacher-Pupil-Planned Activities." Although there was no significant difference in achievement by different groups, the "Teacher-Pupil-Planned Activities" method seemed to be more effective in developing positive attitudes on the part of pupils toward reading. This was, however, only a reflection of teacher opinion.

In an experimental evaluation of two curriculum designs for teaching first-year algebra to ninth grade students, Loman (32) compared a contemporary algebra program's effectiveness with the effectiveness of a traditional program. The contemporary program made use of materials developed by the University of Illinois Committee on School Mathematics. Although results were significantly higher among students of highest ability (upper one-third), using contemporary materials, no apparent differences in general achievement or in manipulative skills was noted between the remaining participants.

Alcorta (1) made a comparison of the effectiveness of two organizational patterns for science instruction in secondary schools. One pattern involved two teachers for two-class-period blocks with each experimental group while control groups were instructed by one teacher in single period blocks of time. A review of the relative merits of the course favored a two-teacher, two-block organization. However, differences were not significant.

A more comprehensive study by Shoresman (46) utilized different patterns of teacher-utilization and pupil deployment in teaching fifth and sixth grade science. Experimental groups utilized team-teaching procedures and control groups were instructed by regular classroom teachers. Results of the study were inconclusive regarding the comparative effectiveness of team-teaching as opposed to the self-contained classroom pattern of organization.

A number of studies and articles concerned with elementary school science stressed the need for adequately trained teachers of science. While some authorities maintain that a science specialist is essential to an effective program of science in the elementary school, others advocate better science training in the general education of all teachers as the best approach to the improvement of elementary school science programs (21, 26).

Gibb and Matala (24) reported the results of a comprehensive study conducted under the auspices of the American Association for the Advancement of Science that was designed to compare science instruction by special teachers with teaching in self-contained classrooms.

Data were drawn from four school systems wherein fifth and sixth grade children were matched on the basis of intelligence and achievement. They found that children, regardless of intellectual ability, learned science more effectively when taught by special teachers.

Becker (7) reported on an investigation of the scientific achievement of children who were separated on the basis of intellectual ability. The study involved effectiveness of special teachers as opposed to self-contained classrooms. He reported no significant differences attributable to this type of grouping.

Although many writers advocate a "discovery approach," it should not be assumed that a discovery method implies absence of teacher direction in the classroom. Butts (14) conducted a study that focused on the question of adequacy of experience alone in science concept formation. He concluded that teacher direction is needed for the discovery of relationships to take place and that the school should do more than furnish a rich opportunity for exposure to science experiences. The teacher must furnish a conceptual framework for learning.

Atkins and Karplus (2) reported findings similar to Butts'. Certain concepts of science, such as the magnetic "field," did not fit "common sense" understandings. Children did not discover them solely by self-generated and autonomous activity. The teacher had to furnish the framework within which autonomous learning occurred profitably. Ausubel (5) argued that discovery was often an unrealistic expectation, that available procedures and methods of handling data must be skillfully arranged and simplified for children "in such a way as to make ultimate discovery almost inevitable."

From a survey of studies related to the use of sensory aids in the teaching of elementary school science, it is difficult to make any generalizations with respect to the comparative value of such aids. Enders (23) compared test results that were recorded for a group of children whose science instruction included the use of television with children who were taught science without the influence of television. Robert Bickel (8) made a study of the effect of television instruction on the science achievement and attitudes of children in the upper elementary grades. Logically expected results were not consistent and the effectiveness of television as an instructional tool in the teaching of science was not demonstrated in these studies. Research, however, seems to indicate that such devices as films, radio and television broadcasts, and records are helpful in developing interest and increasing the students' factual knowledge of science (13).

The Classroom Teacher

The uniqueness of the elementary classroom teacher lies in the nature of his function. Not only must he be a specialist in various academic areas, he must also be well-trained in the field of child development and other areas of classroom management. These requirements necessitate such a broad preparation that many elementary teachers feel inadequately trained or prepared to teach elementary school science. In a study involving 106 elementary teachers, Victor (52) stated that although there was a variety of reasons why they objected to teach science, the main areas of objection were in the following categories:

1. Nearly 80 percent would rather not teach an unfamiliar subject such as science.
2. Seventy-five percent would rather not handle unfamiliar equipment.
3. More than 70 percent often found it difficult to locate suitable equipment, experiments, and supplementary reading materials.
4. More than 65 percent found it difficult to answer some of the questions asked by interested students.
5. More than 60 percent disliked being in a position of having to say, "I don't know," when asked about a phase of science with which they were unfamiliar.

With an increased emphasis on elementary school science, the development of new programs, and contemporary approaches to teaching, this feeling of inadequacy assumes added significance. However, some of the feeling of inadequacy of the elementary teacher concerning the teaching of science may be unwarranted. Ruchlis (42) reminded the teacher that it should be remembered that the young child does some of his thinking with his "body." A feeling that a concept must be accurately stated and fully developed at the elementary school level helps defeat the teacher and child at the start. Much of the paralysis of fear that affticts the elementary teacher stems from the pressure that she must be fully "accurate" in her teaching.

It has been stressed that the quality of any instructional program depends primarily on the qualifications of the teacher. This axiom applies to science teaching as well as to all other subject-matter areas. It is common knowledge also that elementary teachers are generally less adequate in their science training than in other academic areas. A summary of investigations dealing with the science backgrounds of elementary teachers makes this point clear (34):

> These studies of the lack of subject-matter knowledge in science of prospective elementary teachers reveal that most of them do not possess an adequate knowledge of science to enable them to teach effectively. While most prospective teachers have had good science backgrounds in high school, it would appear that they need some general survey courses on the college level to refresh and supplement their science knowledge.

Higher institutions of learning are aware of the necessity for improving teacher competence in this area. In their search for better ways of preparing the elementary teacher to do a more effective job, many colleges are taking a critical look at course requirements and methods of training teachers. Recent studies by Leake and Oshima (31, 39) indicated a desire to improve teacher-training methods at the college level. An ever-increasing opportunity for elementary teachers to participate in federally financed workshops and in-service training programs, and an expanded summer school curriculum attest to efforts being made to overcome inadequacies in the teaching of elementary school science.

Financially and administratively, it is not possible to turn the teaching of elementary science entirely over to specialists. Neither is it realistic to expect that a great majority of elementary teachers will return to colleges or universities to receive the type of training which they presently lack (28). Nevertheless, Mitias (35) declared that anticipations for improving elementary school science teaching seem to have been an important aspect of the educational and social fields since the first decade of the century.

Summary

The volume of research in the area of elementary school science is indicative of a growing awareness of the need to improve instruction in this area. Studies relating to elementary school science occupied a slightly larger proportion of the total research effort in science education during the period from 1960 to 1963 than during previous cycles reported (3). Educators recognize the necessity of boys and girls having an understanding of science and of the importance of its contribution to our everyday lives.

Authorities are in agreement that the study of science should begin in the lower elementary grades and that it should be taught as a separate subject. Studies indicate a lack of well-defined objectives or agreement concerning the scope and sequence of elementary school science. This is a situation that seems to characterize the developmental period of any phase of the school curriculum. As the study of elementary science assumes a more important role, greater emphasis is being placed on content and concepts appropriate to each grade level.

There is agreement that science teachers should be adequately trained. While some educators maintain that a science specialist is essential to an effective elementary school science program, others advocate better science training in the general education of all elementary teachers as the best approach to the improvement of elementary science programs. It is generally agreed that the element which holds the key to the success of any procedure is the classroom teacher.

There has been a great deal more research in the area of secondary school science than in elementary school science. However, it is often assumed that studies of how science is learned are most effectively attempted with young children; they offer a fertile ground for the testing of various teaching-learning theories (3).

A review of the literature reveals strong support for elementary school science being taught by a concept-centered or exploratory method. However, efforts to compare the effectiveness of various teaching methods have been generally inconclusive. Pupil-investigatory or discovery approaches do not indicate an absence of teacher direction. Science education specialists state that certain concepts do not fit "common sense" learning and the teacher must furnish a conceptual framework for learning.

The goals of science teaching should include the acquisition of content and science concepts, an interest in science manifested by the learner's behavior, and the acquiring of a positive attitude toward science.

There is no known investigation completed or in progress that analyzes the comparative effectiveness in achieving the goals of science instruction between the "traditional" and "pupil-investigatory" methods of teaching elementary school science, taught by the same teacher.

CHAPTER III

METHODOLOGY OF THE STUDY

Introduction

The central purpose of this study was to attempt to determine the relative effectiveness of two methods of teaching elementary school science at the fifth grade level. Following is a statement of the null form of the major hypothesis tested in this investigation:

> At the fifth grade level, there will be no significant differences at the .05 level of confidence, in the measurable acquisition of science content, attitude toward science, and interest in science, when science is taught by a traditional method and when it is taught by a pupil-investigation method, by the same teacher.

Several studies cited in the preceding chapter have focused on various techniques and materials in efforts to compare the relative effectiveness of different teaching approaches (1, 21, 32, 44). In the majority of these studies, the writers were unable to control teacher variability. It is well known that similarities in educational training and teaching experience do not automatically develop teachers of equal ability. No doubt, researchers have often wondered if their hypotheses were accepted or rejected because of differences in teacher ability.

In this study the writer has made an attempt to hold several previosuly uncontrolled variables constant. Since the same teachers taught both the experimental and the control groups, variations in teacher knowledge, teacher attitude, and teacher ability would not be considered as being obstacles to a "clean" experiment.

Population and Sample

The population of this study included all of the fifth grade children enrolled, on September 1, 1966, at two of the elementary schools of the Stillwater City School District. For identification purposes in this study, the schools will be designated as School "A" and School "B". As of the above date, 99 children were enrolled in the fifth grade at School "A" and 87 were enrolled at School "B".

The fifth grade population of each building was randomly assigned to class sections in each of the two schools. In order to guarantee the assignment of approximately one-third of the population of each sex to each of three groups, sex division was equated on the basis of stratified random assignment.

It is a policy of the Stillwater City Schools to assign students to class sections on a heterogeneous basis. It is also considered desirable to place approximately the same number of each sex in each section. The stratified assignment of students to class sections was not in opposition to school practices.

Classrooms of the elementary schools in this school system are basically self-contained; in most cases the teachers remain with the same group of children for the entire school day. It is, however, a common practice for teachers to exchange groups of children for brief periods of time. This procedure permits teachers to spend additional periods in specialized areas of instruction.

Since one teacher taught all fifth grade science at School "A" and another taught all fifth grade science at School "B", only the non-homeroom groups of these teachers were included in the sample. The sample, therefore, consisted of two sections, or approximately two-thirds, of the September 1, 1966, population in each of the buildings.

In each school, one fifth grade section was randomly selected as the experimental group to be taught by a "pupil-investigation" approach. A second was randomly selected as the control group to be taught by a "traditional" approach. The remaining group was assigned as the homeroom group of the teacher cooperating in the investigation.

During the course of a school year, it is normal to expect some change in class membership as some students withdraw from a school and others enroll. Only those students who had enrolled on or before September 1, 1966, and were still members of the same class group as of March 24, 1967, were included in this study. Of the 66 students included in the September 1, sample at School "A", 61 met the above requirement. Of the 58 students included in the original sample of School "B", 54 were still in attendance on March 24, 1967.

Teaching Procedures

In each of the two schools selected for this study, one teacher was responsible for instruction in science at the fifth grade level and, for the purposes of this study, taught one group of fifth grade pupils by a "pupil-investigation" method and one group by a "traditional" method.

The teachers were well-qualified to participate in an investigation of this nature. Each held a Master's Degree in Elementary Education, had had several years of teaching experience at the fifth grade level, and had a good understanding of principles and concepts necessary to teach fifth grade science. The teachers were also eager to compare the effectiveness of two different approaches to teaching elementary school science. They realized that their greatest problem would be that of wearing "two hats"; of teaching two groups of children by different approaches. Having received assurance that there would be no "pressure" from the investigator, they committed themselves to adhere to fairly definite guidelines regarding the different teaching methods.

Preceding and during the experimental period of this investigation, several meetings, which involved the cooperating teachers and the investigator, were arranged. During these meetings agreement was reached concerning the teaching approaches to be used with the experimental and control groups. The following guidelines were equally applicable to <u>both</u> groups:

1. In each school the groups met for a total of 90 minutes per week. Although this time allotment was normally divided into three 30-minute periods, variations in length of class periods were permitted.
2. In each school both sample groups met in the same classroom. This arrangement made reference materials and science equipment equally available to both groups involved in the study.
3. The experimental and control groups were taught during the same half of the school day.

4. The adopted textbook was used as a sequence guide (10). The same general units of science content were taught to each group of students.

5. The investigator acted as liason to facilitate the availability of printed materials, films, and other need science supplies.

6. Students and nonparticipating personnel were not informed of the reason for teaching by different approaches.

7. Post-tests which involved the measurement of student achievement, student attitudes toward science, and student interest in science, were administered by the investigator. Cooperating teachers had no prior knowledge of the content of the evaluative instruments.

Each teacher gave special attention to the following procedures as she taught the experimental group by what has been designated as a "pupil-investigatory" approach.

1. Emphasis was placed on pupil participation in planning and implementing the class program.

2. Time was taken to acquaint students with the various kinds of equipment and supplementary materials available in the classroom. Students shared in the responsibility for the care and use of these aids.

3. The use made of one item of equipment was determined by the class. This item was "100 Invitations to Investigate," a box of 100 ungraded, open-ended investigations on individual cards. These were prepared by the publishers of the adopted text, for use by fourth, fifth, and sixth grade students. It was

decided that students should be permitted to take these cards from the classroom, checking them out in the same manner as if they were library books.

4. Assignments that required the use of the adopted textbook were minimized. Emphasis was placed on the use of other texts and supplementary materials located either in the classroom or in students' homes.

5. The use of community resources was encouraged. Students shared in the planning of these activities.

6. Students were encouraged to formulate hypotheses concerning proposed experiments. The teachers maintained a positive attitude toward student hypotheses; experiments were encouraged even if failure was certain. Teachers felt it was better for the student to think and make mistakes than to discourage the thinking process.

7. Encouragement was given to individuals to pursue special interests in the areas studied.

8. Part of the class time was devoted to making and recording quantitative observations. Small groups were simultaneously involved in performing experiments in efforts to test group suggested and individual hypotheses.

9. Teachers became adept at answering student queries with questions designed to direct student thinking into different avenues. Since student inquisitiveness was encouraged, teachers did not expect to know the answers to all questions which were asked.

10. At the conlcusion of a unit of study, time was given to a discussion of "what we have learned."

11. Student evaluation for the determination of grades was infrequent and informal. Preliminary scoring and correcting of papers was done by students; each student checking his own paper. In the assignment of grades, emphasis was placed on student interest and participation.

12. Although the general sequence of the course was determined by the cooperating teachers and the textbook, the scope was largely determined by student interest in the various content areas.

13. From the student point of view, course emphasis was on the "doing" aspect of science.

Even though the "pupil-investigation" approach could be categorized as a discovery method and emphasis was placed on pupil involvement and participation, it could not be said to be pupil-directed. The teacher realized she was responsible for guiding discovery. This approach did not relieve the teacher from planning toward desirable outcomes but it did give a great deal of attention to student interest and participation in implementing these outcomes.

Each teacher gave special attention to the following patterns of behavior as she taught the control group by what has been designated as a "traditional" method of teaching.

1. Emphasis was placed on teacher direction in planning and implementing the science program. Since teachers are generally held responsible by administrators and patrons

for satisfactory class progress, it was assumed they were qualified to make decisions of this nature.

2. Most assignments were specific in nature and required the use of the school adopted text. The text was a recent edition and included on the Oklahoma science textbook adoption list.
3. Although the teacher mentioned the reference materials available in the classroom, the students were neither encouraged nor discouraged to make use of them.
4. Most textbook suggested experiments were discussed but not performed. Some experiments were discussed which had been prepared prior to the class period by the teacher or by students of the experimental group. Occasionally, teacher-selected experiments were prepared and demonstrated by members of the control group.
5. Teachers felt responsible for giving lucid explanations to pupil questions arising from material discussed in connection with class assignments.
6. Although the teacher was primarily concerned with pupil acquisition of science content, this did not preclude the use of audio-visual aids such as tape recorders, film strips, and overhead projectors. The differences in method were not those of availability of teaching materials and equipment, but in the type of presentation of science principles and concepts. The teacher did assume full responsibility for the care and operation of all science equipment.

7. Children of the control group were aware that they were responsible for written answers to questions at the conclusion of units of study. Formal tests, checked by the teacher, were also given at the conclusion of each unit.
8. The scope and sequence of the course was determined by teacher judgment and textbook arrangement. Students did not generally participate in decisions concerning the length or content of an assignment.
9. From the student point of view, course emphasis was on the "listening and seeing" aspect of science.

Various names have been used to distinguish between different approaches employed by the classroom teacher. The term "traditional" has not been used in the sense that it prohibits the use of recent teaching materials but that class procedures are highly teacher controlled. The teacher is the central figure and, as such, determines the scope of the content, the manner of presentation, the points of emphasis, and the "rewards," based on levels of student achievement.

The Instrumentation

In the attempt to compare the effectiveness of two teaching methods in fifth grade science, three evaluative instruments were employed. The first instrument described below was designed to measure pupil acquisition of science content. The second evaluative device was designed to measure student attitude toward science; an emotionalized feeling for or against science as exhibited by behavior. The third was developed for the purpose of assessing pupil interest in science; measured by the degree of participation in a variety of science-related activities.

Student knowledge of principles and concepts of science was measured by scores obtained by the administration of the Stanford Science Achievement Test (30). Form W of the Intermediate II Battery, 1964 edition, was used. The test was composed of 58 items and designed to be used for grades 5.5 to 7.0.

The primary objectives measured by this instrument were (a) the ability to see the application of the principles of science in our environment and everyday activities, (b) knowledge of the facts and generalizations from the various branches of the natural sciences, and (c) some knowledge of the scientific method.

Concerning validity, the examiner's manual stated that the authors "sought to insure content validity by examining appropriate courses of study and textbooks as a basis for determining the skills, knowledges, understandings, etc. to be measured." (29) The split-half reliability was .88 and the standard error of measurement was 3.3 raw score points (29).

Since the test was designed for students of this grade level, was recently constructed and standardized by a reliable publisher, and included basic facts and concepts of all areas of elementary school science, it was deemed applicable to the subjects of this study.

Student attitude toward science was determined by use of the instrument, Interests and Ideas, Form AV (47). Its precursor, Interests and Ideas, Form AY, was prepared by Shoresman (46) while working with the Lexington, Massachusetts, public schools. In the author's letter granting permission to reproduce and use this instrument, he stated that the revision, Form AV, had been used extensively in the evaluation program of the Elementary-School Science Project and the School Science Curriculum Project. A copy of this letter is in Appendix A of this study.

This instrument was designed to be used with fifth and sixth grade children and developed for the purpose of obtaining an indication of their attitudes toward science. The items assess three facets of children's feelings about science; (a) values related to science, (b) affect related to science, and (c) approach or avoidance behavior associated with science and science-related activities. A copy of the instrument is in Appendix B.

This inventory was not designed to be administered within any specified period of time. The children had an opportunity to respond to all of the test items. Responses that indicated the most favorable attitude toward science were weighted as four points; those least favorable to science were weighted as zero points. Of the forty items of the inventory, ten were unrelated to science. The maximum score was 120 points.

Inventories of this nature are relatively recent in development and, as yet, there is no single independent criterion with which scores may be compared. At the present time there seems to be no clear method for calculating a single empirical validity coefficient. Split-half reliability, determined by the writer was .95. Data supporting this coefficient has been placed in Table VI of Chapter IV.

The instrument selected to assess student interest in science was <u>Activities</u>, Form IV. This inventory was prepared by Shoresman (46) for the Elementary School Science Research Project of the Lexington, Massachusetts, public schools. A copy of the author's permission to reproduce and use the instrument has been placed in Appendix A.

In the preparation of this inventory, Shoresman (46) stated he had used in modified forms items from (a) the Reed Science Activity Inventory, developed by Horace B. Reed; (b) a Reed Activities Index, developed by William W. Cooley; (c) an Activities Questionnaire, by Neil Bostick and Harry Levi; and (d) an Inventory of Science Activities, developed by Kenneth J. Jones, Jr.

The purpose of the instrument was to measure science interest by determining the frequency with which pupils had actually participated in certain voluntary activities. It was assumed that manifest interests, as demonstrated by voluntary and freely chosen out-of-school activities, will be more indicative of the true interest of children than subjective statements of their expressed interests. Cooley and Reed (18) discussed the practicability of this technique in constructing interest inventories. An instrument of this nature attempts to place emphasis on "what I did because I wanted to," instead of on "what I think I would like to do." Super (51) also questioned the advisability of depending on expressed preferences as the sole basis for assessing real interests of children.

The inventory was composed of 80 items with an accompanying four-point frequency scale for each item. Instructions stressed there was no right or wrong answers; students simply indicated the number of times, since the end of the previous school year, they had voluntarily engaged in the activities mentioned in the items of the instrument. A copy of the instrument in in Appendix C.

Although no empirical validity determination could be made from the inventory, since the development of the precursor instruments were by experienced teachers and science educators, validity would seem to be high. Split-half reliability, determined by the author of the instrument, from application of the Spearman Brown modified formula was .94.

Collection of Data

At the beginning of the 1966-67 school year, the fifth grade population of Schools "A" and "B" was randomly assigned to class sections. In order to guarantee approximately the same number of each sex in each class section of a school, sex division was equated on the basis of stratification. The number of fifth grade students was such that there were two groups included in the sample from each school. One teacher was responsible for science instruction of the sample groups of School "A"; a second cooperating teacher was responsible for the science instruction of the sample groups at School "B".

Prior to and during the period of investigation the investigator and cooperating teachers met weekly to discuss teaching methods, teaching supplies, and equipment needs. In addition, the cooperating teachers frequently contacted each other and shared teaching ideas and experiences. Descriptive information concerning teaching techniques and student reaction was related to the investigator by the classroom teachers. Additional information was secured from notes written at various times by the teachers. These recorded observations were not only valuable in this study but will also be helpful to the teachers as they continue to work with students.

Previously discussed differences in teaching methods were maintained with sample groups for a period of nearly seven months; from September 1, 1966, through March 24, 1967. During this time each teacher presented materials from the same content areas to both sample groups. Because of a difference in the amount of pupil-participation in the experimental and control groups, the scope of the content was not the same. Although the investigator spent some time observing classroom procedures, he had no direct contact with students of the sample groups.

In each school the science period of the experimental group preceded the science period of the control group. Because of this time schedule, the teacher often illustrated principles of science to the control group through the aid of experiments prepared by members of the experimental group.

At the end of the period of investigation the writer administered instruments devised to measure student achievement in science, student attitude toward science, and student interest in science. Each instrument was administered to both sample groups of the same school in consecutive periods of the same day. All pupil responses were secured during the mid-morning and mid-afternoon periods of the week of April 3-7, 1967. Although all students who were members of the experimental and control groups in each school at the time of evaluation responded to the questionnaires, only responses from those students who had been members of the groups for the entire investigatory periods were included in this study.

Experimental Design

The experimental design used in this study is a modified "Posttest-Only Control Group Design" in which there are two experimental treatments, one of which is referred to as the control group. Campbell and Stanley (56) make the following statement concerning this design:

> While the pre-test is a concept deeply embedded in the thinking of research workers in education and psychology, it is not actually essential to true experimentation designs. For psychological reasons it is difficult to give up "knowing for sure" that the experimental and control groups were "equal" before the differential experimental treatment. Nontheless, the adequate all-purpose assurance of lack of initial biases between groups is randomization. Within the limits of confidence, randomization can suffice without the pre-test.

Figure I is an illustration of this design. The assumption is that since the control and experimental groups were "equal" at the beginning of the experimental period, any differences between the groups at the end of the experimental period may be attributed to application of the controlled variable to the experimental group.

R	X_1	0_1
R	X_2	0_2

Figure 1. Posttest-Only Control Group Design Used in This Study

Because of the inability of the majority of researchers to achieve randomization of assignment to control and experimental groups, this design is infrequently used in educational research. The writer was in the position of being able to assign pupils to class groups on a random basis.

The data from the experimental and control groups of the two schools were not pooled in this study. This procedure could be considered disadvantageous from the standpoint of size of the experimental and control group samples. On the other hand, it had merit in that the study was strengthened through duplication of results. There was no desire to compare student or teaching performance in the two schools; rather a desire to ascertain if the effects of the different teaching approaches were in accord or in opposition. Consequently, the statistical design illustrated in Figure 1 was applied to each school separately; each "R" represented one sample group from the same school.

Analytical Procedures

The data derived from the application of the Stanford Science Achievement Test were interval in nature and subject to parametric techniques. It was assumed that the samples were random and that variances within the subgroups were homogeneous. In support of this assumption, a variance check was made to test for homogeneity of groups of each school.

A *t* test was made to test for significance of the difference between achievement test means of the experimental and control groups of each school. This is a powerful parametric statistic appropriate for use with interval data of two independent sample groups (48).

The data which resulted from the application of the attitudes and interest inventories were ordinal in nature and required the use of nonparametric statistics. Since the writer had little information relative to the reliability of Form AV of the Interest and Ideas attitude inventory, test reliability was established by the determination of a coefficient of correlation by the use of the Spearman rank correlation coefficient statistic, with a correction factor for tied observations (48). An estimated coefficient of reliability was obtained through the application of the Spearman-Brown modified formula (54).

The statistic used for the analysis of differences between the experimental and control groups in attitude and interest areas was the Mann-Whitney U Test. With reference to the Mann-Whitney U Test, Siegel (48) states:

> This is one of the most powerful of the nonparametric tests, and is a most useful alternative to the parametric *t* test when the researcher wishes to avoid the *t* test's assumptions, or when the measurement is weaker than interval scaling.

The Mann-Whitney U statistic was applied to the differences between the rank distributions of the attitude inventory scores and the interest inventory scores of the sample groups of each school.

CHAPTER IV

TREATMENT OF DATA

The purpose of this study was to compare the effectiveness of two methods of teaching fifth grade science. Comparisons of effectiveness were made in the areas of acquisition of science content, development of favorable attitudes toward science, and student interest in science.

Specific hypotheses tested in this study were as follows:

1. There is no significant difference at the .05 level of confidence in science achievement of fifth grade children who have been taught science by a traditional method and those who have been taught science by a pupil-investigation method, by the same teacher.
2. There is no significant difference at the .05 level of confidence in attitudes toward science of fifth grade children who have been taught science by a traditional method and those who have been taught science by a pupil-investigation method, by the same teacher.
3. There is no significant difference at the .05 level of confidence in interest toward science of fifth grade children who have been taught science by a traditional method and those who have been taught science by a pupil-investigation method, by the same teacher.

Three instruments were used to test these hypotheses. The first hypothesis was tested through analysis of data that resulted from the administration of the 1964 edition of the Stanford Intermediate II Science Achievement Test, Form W. The test contained 58 items, had a reliability coefficient of .88, and was designated for use at the 5.5 to 6.9 grade level (29).

The second hypothesis was tested by an attitude instrument, Interests and Ideas, Form AV (47). The precursor of this science attitude inventory, Form AY, was developed by Shoresman (46). It was modified and has been used extensively by the Elementary School Science Project at the University of Illinois. It was a five-point Likert-type test and was treated essentially as a summated rating scale. It had a possible score range of 0 - 120 points, which indicated the least to most desirable attitudes, respectively.

Since the writer had little information concerning the reliability of the modified form, a coefficient of reliability was determined from half-test scores of the 61 members of the sample groups of School "A". Since the scores of this instrument were ordinal in nature, the Spearman rank correlation coefficient, with a correction for tied scores, was used. Application of the r_s yielded a correlation coefficient of .90. This coefficient placed in the Spearman-Brown modified formula gave a reliability coefficient of .95. Information pertinent to the ranking of half-test scores for the determination of test reliability has been placed in Table VI.

Form IV of Activities, an instrument designed to measure student interest in science, was used to test the third hypothesis of this study. This inventory was constructed by Shoresman (46) to be used with fifth and sixth grade children. The score was based on the frequency with which children actually participated in certain voluntary activities. The instrument placed emphasis on "in what activities have you participated," rather than on "in what activities are you interested." It was composed of 80 items with a possible score range of 0 - 240 points, which indicated least to greatest interest in science, respectively.

Data relative to the composition of the testing instruments used in this study have been placed in Table I. The data from achievement test scores were interval in nature and was analyzed by parametric techniques. Data from the attitude and interest inventories were ordinal in nature and were analyzed by nonparametric techniques. All data derived from the testing instruments were based on raw scores.

The members of the sample groups were assigned on a random basis. The *t* test used in the analysis assumed homogeneity of variances. In order to support this assumption a variance check was made. Preparatory to a variance test, a summary of scores which resulted from the administration of the achievement test was prepared. This summary, which included group means and standard deviations of all sample groups, was placed in Table II. Asterisks were used in this table to denote scores of male students. The reader will note that in the experimental group of each school, scores of male students occupy more than a proportionate amount of the first and fourth quartiles of the score distributions. This tendency was not apparent in male scores of the control groups; nor was it noted for either sex on attitude and interest inventory score distributions.

TABLE I

TESTING INSTRUMENT DATA[a]

Instrument	Items	Possible Score	E[b]	C[c]	Reliab. Coeff.
1. Stanford Science Achievement Test, Form W	58	58	57	58	.88[d]
2. Science Attitude Inventory, Form AV	40	120	57	58	.95[e]
3. Science Interest Inventory, Form IV	80	240	57	58	.94[f]

[a]All data for raw scores.

[b]Experimental group total, both schools.

[c]Control group total, both schools.

[d]Supplied by publisher of test.

[e]Application of Spearman-Brown modified formula to Spearman rank correlation coefficient.

[f]Determined by Shoresman (46)

TABLE II

EXPERIMENTAL AND CONTROL GROUP ACHIEVEMENT TEST SCORES

Student Number	School A Experimental	School A Control	School B Experimental	School B Control
1	53	51	53*	51
2	52*	48	49*	51*
3	52*	47	48*	49
4	52*	46*	48*	47*
5	51	45	47*	44
6	46*	44	47	44
7	45*	44	47	43*
8	44*	44*	43	43*
9	44	44*	41	43*
10	44	43*	41	40*
11	43	42	41	40
12	43	41	40	39
13	42	41	39	38
14	42	41*	37*	38
15	42	38*	35	37
16	41	37*	34	36*
17	41	37*	33	36*
18	38*	37*	33*	33*
19	37*	36*	32*	32
20	35	36	32	31*
21	34*	35	31*	30*
22	34*	35	30*	29
23	33*	33	30	29
24	30*	33	24*	28
25	29	30*	23*	26*
26	29	28*	18	21*
27	25	28*	14*	11
28	25*	26		
29	24*	25*		
30	18*	20*		
31		18		
Mean	38.9	37.2	36.7	36.6
Std. Dev.	9.5	8.2	9.8	9.3

*Scores of male students

TABLE III

SIGNIFICANCE OF DIFFERENCES BETWEEN ACHIEVEMENT SCORE VARIANCES OF SAMPLE GROUPS

School	Group	N	Mean	Variance	F	F .05 level
A	E	30	38.9	91.06	1.35	1.85
A	C	31	37.2	67.63		
B	E	27	36.7	96.92	1.12	1.93
B	C	27	36.6	86.63		

TABLE IV

SIGNIFICANCE OF DIFFERENCES BETWEEN ACHIEVEMENT SCORE VARIANCES OF GROUPS BY SEX

School	Group	Sex	N	Mean	Variance	F	F .05 level
A	E	M	15	37.6	115.8	1.91	2.48
A	C	M	15	35.6	60.5		
B	E	M	13	36.1	145.9	1.96	2.69
B	C	M	13	36.9	74.4		
A	E	F	15	40.2	62.0	1.20	2.46
A	C	F	16	38.7	74.2		
B	E	F	14	37.2	58.5	1.78	2.57
B	C	F	14	36.4	104.4		

A summary of the significance of group variances was placed in Table III. The variance between groups of School "A" and School "B" was found to be 1.35 and 1.12, respectively. In each school the variance of the experimental group was slightly greater than that of the control group. The value of F at the .05 level of confidence was 1.85 for School "A" and 1.93 for School "B". Since the ratio of the variance between groups of each school was less than the F-value at the .05 level of significance, the assumption that the variance within sub-groups of each school was homogeneous was validated.

Because the achievement scores of experimental group males, which has been noted in Table II, expressed a tendency to be more extreme than the scores of control group males, a comparison was made, by sex, between variances of experimental and control groups of both schools. Data relevant to this variance check were placed in Table IV. Variances of the males in the experimental groups were noticeably greater than variances of control group males. However, variances of females in the experimental groups were slightly less than female variances of the control groups. None of the variances among groups reached the .05 level of significance. The mean score for girls was greater than the mean score for boys in three of the four groups; the exception being in the control group of School "B". Whereas, the pupil-investigatory method seemed to produce a greater diversity in male performance, as measured by the acquisition of science information, the range of performance of the girls was greater under the traditional approach.

Group Differences in Science Achievement

As a starting point toward testing the first hypothesis, the means of the experimental and control group achievement test scores of each school were noted. A *t* test was employed to test the significance of the difference between these group means. This is a parametric statistic designed for use with interval data and is powerful in the rejection of the null hypothesis when it should be rejected (48). Application of the *t* test required information relative to the sample group size, the group mean, and the sum of the squared deviations of the scores away from the mean for each group. The data necessary for the determination of *t*-values between the experimental and control groups of each school were obtained from the information in Table II. It has been summarized in Table V (54).

The value of *t* for School "A" was 0.742. The table value of *t* at the .05 level of significance for 29 degrees of freedom, was 2.045. Data for School "B" yielded a *t*-value of 0.015. The table value of *t* at the .05 level of significance for 26 degrees of freedom, was 2.056.

Since the computed value of *t* was less than that demanded for significance at the .05 level, the first major hypothesis could not be rejected for either School "A" or School "B".

Group Differences in Attitude Toward Science

The data available from attitude and interest inventory scores were ordinal in nature. The Mann-Whitney U Test was used to test for significance of difference between groups. Its application required that scores of compared groups be placed in rank order. This statistic is one of the most powerful of the nonparametric tests and is a useful alternative to the parametric $\underline{t}$ test when the measurement in the research is less than interval scaling (48). For these reasons, it was used to test both the second and third hypotheses of this study.

In preparation to testing the second hypothesis, the attitude inventory scores of both sample groups of School "A", arranged from highest to lowest, and their corresponding ranks were placed in Table VII. Similarly, the attitude inventory scores and ranks of the sample groups of School "B" were placed in Table VIII.

There was a total of 61 scores and ranks in the sample groups of Table VII, with a sum of ranks of 793 for the experimental group and 1098 for the control group. The 54 attitude inventory scores and ranks of School "B" in Table VIII had a sum of ranks of 683.5 for the experimental group and 801.5 for the control group.

In each table of this study in which either attitude inventory or interest inventory scores were ranked, tied scores were given the average of the ranks they would have had if no tied scored had occurred. When this correction was used, it tended to increase the size of the resultant statistic, making it more significant (57).

Data derived from attitude inventory scores and ranks of School "A" and School "B" were placed in the first section of Table XI. A comparison of the sum of ranks of attitude inventory scores of School "A" resulted in an observed value of U of 602.0. When the larger sample group is greater than 20, the probability associated with an observed value of U is determined by computing a value for z and comparing this value with its required level of significance table value. The probability of the level of significance of the observed value of U was

TABLE V

SIGNIFICANCE OF DIFFERENCES BETWEEN ACHIEVEMTNT TEST MEANS FOR EACH SCHOOL

School	Group	N	ΣX	$\overline{X}$	ΣX^2	$\sum x^2$	s^2	t	t .05 level
A	E	30	1167	38.9	47,937	2640.7	91.06	0.742	2.045
A	C	31	1153	37.2	44,919	2034.9	67.73		
B	E	27	990	36.7	38,820	2520.0	96.92	0.015	2.056
B	C	27	989	36.6	39,479	2252.3	86.63		

Symbols:

N - Number of cases in sample.

X - Raw scores.

$\overline{X}$ - Group mean score.

x - Deviation of score from group mean.

s^2- Group variance estimate.

t - Test of significance (t test).

TABLE VI

COEFFICIENT OF RELIABILITY OF SCIENCE ATTITUDE INVENTORY

Student	a^x	b^y	$Rank_a$	$Rank_b$	d_i	d_i^2
1	53	56	1	1	0.	0.
2	50	53	2	2	0.	0.
3	49	48	3	6	- 3.	9.
4	47	49	5.5	3.5	2.	4.
5	47	48	5.5	6	- .5	.25
6	45	40	8	16	- 8.	64.
7	48	46	4	8.5	- 4.5	20.25
8	42	48	12	6	6.	36.
9	42	46	12	8.5	3.5	12.25
10	41	44	15	10.5	4.5	20.25
11	36	49	24	3.5	21.5	462.25
12	46	38	7	23.5	-16.5	272.25
13	41	42	15	12.5	2.5	6.25
14	42	40	12	16	- 4.	16.
15	43	38	10	23.5	-13.5	182.25
16	39	42	19.5	12.5	7.	49.
17	40	41	17	14	3.	9.
18	41	39	15	20	- 5.	25.
19	39	39	19.5	20	- .5	.25
20	44	33	9	32	-23.	529.
21	36	39	24	20	4.	16.
22	36	39	24	20	4.	16.
23	39	35	19.5	28.5	- 9.	81.
24	34	44	28	10.5	18.5	342.25
25	36	37	24	25.5	- 1.5	2.25
26	34	39	28	20	8.	64.
27	39	34	19.5	31	-11.5	132.25
28	36	35	24	28.5	- 4.5	20.25
29	28	40	40	16	24.	576.
30	33	35	31	28.5	2.5	6.25
31	30	37	34.5	25.5	9.	81.
32	34	30	28	35.5	- 7.5	56.25
33	29	35	37	28.5	8.5	72.25
34	33	29	31	39	- 8.	64.
35	33	29	31	39	- 8.	64.
36	30	31	34.5	33.5	1.	1.
37	28	31	40	33.5	6.5	42.25
38	29	29	37	39	- 2.	4.
39	27	29	42.5	39	3.5	12.25
40	27	29	42.5	39	3.5	12.25
41	31	24	33	44	-11.	121.
42	29	24	37	44	- 7.	49.

TABLE VI (Continued)

Student	a^x	b^y	$Rank_a$	$Rank_b$	d_i	d_i^2
43	22	30	46	35.5	10.5	110.25
44	28	23	40	47	- 7.	49.
45	25	25	44.5	42	2.5	6.25
46	25	24	44.5	44	.5	.25
47	21	23	47	47	0.	0.
48	19	23	49.5	47	2.5	6.25
49	20	15	48	50.5	- 2.5	6.25
50	19	15	49.5	50.5	- 1.	1.
51	13	19	56	49	7.	49.
52	18	13	51	55	- 4.	16.
53	16	13	52	55	- 3.	9.
54	15	14	53	52.5	.5	.25
55	14	13	54.5	55	- .5	.25
56	12	14	57.5	52.5	5.	25.
57	12	11	57.5	58	- .5	.25
58	11	12	59.5	57	2.5	6.25
59	14	5	54.5	61	- 6.5	42.25
60	11	8	59.5	59.5	0.	0.
61	10	8	61	59.5	1.5	2.25
					$\sum d_i^2 =$	3882.50

a^x - Student score on first-half of test.

b^y - Student score on second-half of test.

r_s - .90

expressed by a value of z of 1.97. The .05 level of significance table value of z, indicated in the right column of Table XI, was 1.65.

Since the computed value of z was greater than the table value of z at the .05 level of significance, the second hypothesis was rejected for School "A". Available evidence indicated the superiority of the pupil-investigation approach over the traditional approach in the

TABLE VII

SCIENCE ATTITUDE INVENTORY SCORES AND RANKS, SCHOOL "A"

Experimental Group			Control Group		
Student	Score	Rank	Student	Score	Rank
1	109	1	1	95	5.5
2	103	2	2	94	7
3	97	3	3	90	8
4	96	4	4	85	10.5
5	95	5.5	5	81	16
6	88	9	6	81	16
7	85	10.5	7	77	20
8	84	12	8	73	26
9	83	13	9	71	28
10	82	14	10	68	29.5
11	81	16	11	67	31
12	80	18	12	64	32.5
13	78	19	13	64	32.5
14	75	21.5	14	62	34.5
15	75	21.5	15	62	34.5
16	74	23.5	16	61	36
17	74	23.5	17	58	38
18	73	26	18	56	39.5
19	73	26	19	56	39.5
20	68	29.5	20	53	42
21	59	37	21	52	43
22	55	41	22	50	45
23	51	44	23	44	47
24	49	46	24	35	49
25	42	48	25	34	50
26	31	52	26	32	51
27	29	53.5	27	29	53.5
28	26	56	28	27	55
29	23	57.5	29	23	57.5
30	19	59.5	30	19	59.5
			31	18	61
Group Median	74			61	
Sum of Ranks		793			1098

TABLE VIII

SCIENCE ATTITUDE INVENTORY SCORES AND RANKS, SCHOOL "B"

Experimental Group			Control Group		
Student	Score	Rank	Student	Score	Rank
1	97	4	1	106	1
2	97	4	2	102	2
3	95	6	3	97	4
4	94	7.5	4	94	7.5
5	91	19	5	93	9
6	90	11	6	87	13
7	88	12	7	83	14
8	82	15	8	79	20
9	81	17	9	79	20
10	81	17	10	76	24
11	81	17	11	73	26.5
12	79	20	12	72	29
13	78	22	13	70	31
14	76	24	14	67	32.5
15	76	24	15	64	35.5
16	73	26.5	16	62	37
17	72	29	17	61	38
18	72	29	18	60	39
19	67	32.5	19	58	40.5
20	65	34	20	58	40.5
21	64	35.5	21	57	42.5
22	57	42.5	22	48	45
23	53	44	23	46	46
24	45	47	24	44	48
25	41	49.5	25	41	49.5
26	36	51	26	35	52.5
27	35	52.5	27	33	54
Group Median	76			67	
Sum of Ranks		683.5			801.5

development of student attitudes toward science. For School "A", it could be stated that, at the fifth grade level, the pupil-investigation approach developed more positive attitudes toward science at the .05 level of significance, than did the traditional approach.

A comparison of the sum of ranks of the attitude inventory scores of the sample groups of School "B" resulted in an observed value of U of 423.5. The probability of the level of significance of this value of U was expressed by a value of z of 1.02. Since this computed value of z was less than 1.65, the table value of z at the .05 level of confidence, the second major hypothesis failed to be rejected for School "B".

Group Differences in Interest Toward Science

As previously stated, the Mann-Whitney U statistic was also used to test the third hypothesis of this study. Interest inventory scores of the sample groups of School "A", arranged from highest to lowest, and their corresponding ranks were placed in Table IX. In the same manner, interest inventory scores and ranks of the experimental and control groups of School "B" were placed in Table X. The 61 scores of School "A" in Table IX produced a sum of ranks of 829 for the experimental group and 1062 for the control group. The 54 interest inventory scores of School "B" in Table X had a sum of ranks of 704 for the experimental group and a sum of ranks of 781 for the control group.

The data derived from interest inventory scores and ranks of Table IX and Table X were placed in the lower portion of Table XI. Since the same statistic was used to test the significance of differences in ranks of scores of both the attitude and interest

TABLE IX

SCIENCE INTEREST INVENTORY SCORES AND RANKS, SCHOOL "A"

Experimental Group			Control Group		
Student	Score	Rank	Student	Score	Rank
1	142	1	1	138	2
2	136	3	2	132	4
3	127	6	3	128	5
4	114	10	4	124	7
5	110	11	5	123	8
6	109	12	6	120	9
7	107	13	7	104	15
8	105	14	8	103	16
9	96	19	9	102	17
10	94	20	10	99	18
11	92	22.5	11	93	21
12	92	22.5	12	89	27
13	91	24	13	88	28
14	90	25.5	14	82	31
15	90	25.5	15	79	36
16	84	29	16	75	37
17	82	31	17	71	41
18	82	31	18	68	42.5
19	81	33.5	19	67	44.5
20	81	33.5	20	58	48
21	80	35	21	57	49.5
22	74	38	22	57	49.5
23	73	39.5	23	56	51
24	73	39.5	24	55	53
25	68	42.5	25	48	54
26	67	44.5	26	47	55
27	66	46	27	46	56
28	61	47	28	45	57
29	56	52	29	40	59
30	41	58	30	39	60
			31	20	61
Group Median	87			75	
Sum of Ranks		829			1062

TABLE X

SCIENCE INTEREST INVENTORY SCORES AND RANKS, SCHOOL "B"

Experimental Group			Control Group		
Student	Score	Rank	Student	Score	Rank
1	138	1	1	132	3
2	135	2	2	127	5
3	130	4	3	126	6
4	118	8	4	123	7
5	114	9	5	107	12
6	109	10	6	105	13
7	108	11	7	99	14
8	91	17	8	98	15
9	90	18	9	93	16
10	88	20	10	89	19
11	85	21	11	84	22.5
12	84	22.5	12	83	24.5
13	83	24.5	13	80	27
14	81	26	14	79	28
15	75	29	15	71	32
16	73	30.5	16	66	34
17	73	30.5	17	60	36
18	68	33	18	57	37
19	65	35	19	54	38.5
20	54	38.5	20	48	44
21	52	40	21	47	45.5
22	51	41	22	45	47.5
23	50	42.5	23	45	47.5
24	50	42.5	24	41	50
25	47	45.5	25	40	51
26	43	49	26	38	52
27	31	53	27	30	54
Group Median	81			79	
Sum of Ranks		704			781

TABLE XI

SIGNIFICANCES OF DIFFERENCES BETWEEN RANKS OF EXPERIMENTAL AND CONTROL GROUPS OF BOTH SCHOOLS ON ATTITUDE AND INTEREST INVENTORIES

Instrument	School	Group	N	Sum of Ranks	U^a	T^b	z^c	z-value .05 level
Attitude Inventory	A	E	30	793.0	602.0	9.5	1.97*	1.65
	A	C	31	1098.0				
	B	E	27	683.5	423.5	14.0	1.02	1.65
	B	C	27	801.5				
Interest Inventory	A	E	30	829.0	566.0	5.5	1.45	1.65
	A	C	31	1062.0				
	B	E	27	704.0	403.0	3.5	0.67	1.65
	B	C	27	781.0				

[a]Mann-Whitney U statistic.

[b]Sum of tied scores.

[c]Determinant of significance

*Significant at .05 level

inventory instruments, the use of one summary table was considered appropriate.

A comparison of the sum of ranks of the interest inventory scores of School "A" resulted in an observed value of U of 566.0. The probability of the level of significance associated with this value was determined by the computation of a value of z or 1.45. Since the computed value of z was less than 1.65, the table value of z at the .05 level of significance, the third hypothesis failed to be rejected for School "A".

A comparison of the sum of ranks of interest inventory scores of School "B" resulted in an observed value of U of 403.0. The computed value of z associated with this value was 0.67. Since the computed value of z was less than the table value of z at the .05 level of significance, the third hypothesis also failed to be rejected for School "B".

Summary

Three specific hypotheses were tested in this study. Each hypothesis was related to the comparative effectiveness of two methods of teaching fifth grade science. Comparisons of effectiveness were made in areas of (a) study achievement in science, (b) student attitudes toward science, and (c) student interest in science.

There were students from two different school populations involved in the research; one experimental and one control group taught by the same teacher, from each school. The subjects were assigned to the sample groups by random selection. A variance check supported the assumption that variances within subgroups of the populations were homogeneous.

A t test was used to test the null hypothesis of no difference between means of the achievement scores of the experimental and control groups. The Mann-Whitney U statistic was used to test the null hypotheses of no significant difference between ranks of attitude and interest inventory scores of the sample groups.

A summary of the comparative results of the study appear in Table XII.

TABLE XII

SUMMARY OF RESULTS FOR TOTAL GROUPS

Area of Comparison	Comparisons Favoring	
	Experimental	Control
Achievement in Science	2	0
Attitude Toward Science	2*	0
Interest in Science	2	0

*Significant at the .05 level of confidence for School "A"

Although comparisons in the areas of achievement in science, attitudes toward science, and interest in science were favorable to the experimental groups, only one hypothesis was rejected for one school. In School "A", available evidence indicated superiority of the pupil-investigatory approach over the traditional approach in the development of positive attitudes of fifth grade children toward science.

CHAPTER V

CONCLUSIONS, OBSERVATIONS, AND RECOMMENDATIONS

Overview

The intent of this study was to compare the effectiveness of two methods of teaching fifth grade science, when taught by the same teacher. The effectiveness of the methods was assessed through comparisons of experimental and control groups on the basis of student achievement in science, student attitude toward science, and student interest in science. The teaching approaches were designated as "traditional" and "pupil-investigation." These approaches were selected because of the prevalent use of a traditional-type approach by classroom teachers and the unity of science educators in the avocation of a "pupil-investigation" or discovery-type approach (2, 16, 26, 36). The two methods are far apart on a continuum relative to student involvement in the planning of classroom activities. Criteria related to likenesses and differences between the methods were enumerated in Chapter III. The traditional approach would place emphasis on teacher direction and on student "seeing and hearing" as the most effective method of insuring student learning. The pupil-investigatory method would stress the importance of pupil "planning and doing" in fostering student learning.

The fifth grade students involved in this study were from two different schools and assigned to groups by random selection. Sex division of students was equated on the basis of stratification. The number of fifth grade students was such that there were three sections at each school. One fifth grade section of each school was randomly selected as a control group and a second section of each school was randomly selected as an experimental group.

In this study several variables, which the researcher is generally unable to control, were kept constant. Variables related to the time and place of the study of science, subject matter content, availability of teaching aids and science equipment, and the many factors related to teacher personality, attitude, and training were not problems which affected this study.

The cooperating teachers involved in this study voluntarily agreed to participate in the experiment. On the basis of training, experience, and ability, both were well-qualified to teach elementary school science.

No effort was made to compare teacher performance. The basic question around which this study was constructed was, "Which of two teaching methods can a classroom teacher use most effectively?" In seeking an answer to this question, the only comparisons made involved data of the two sample groups taught by the same teacher. The teachers felt that they could teach the groups without bias and agreed to adhere to teaching procedures prescribed for each sample group.

The different teaching approaches were maintained for a period of approximately seven months; beginning on September 1, 1966, and ending on March 24, 1967. At the end of the experimental period the writer administered three instruments, designed to measure student achievement in science, student attitudes toward science, and student interest in science (30, 47, 46). Cooperating teachers had no prior knowledge of the content of the testing instrument.

The writer was faced with the alternatives of pooling data of the experimental and control groups of the two schools, with comparisons being made between one experimental and one control group, or, of keeping data separate by sample groups, with comparisons being made between two experimental and two control groups. The first alternative would provide larger experimental and control group samples as a basis for the analysis of data. Selection of the second alternative would permit a duplication of comparative measurements between the experimental and control groups of each school. In order to compare data between the experimental and control groups of each school, from the standpoint of its being supportive or in opposition, the second alternative was selected.

Conclusions

The data analyzed in this study tended to indicate that, in each school, the pupil-investigation approach compared favorably with the traditional approach to teaching fifth grade science.

Preparatory to an analysis of data, a variance check was made. This check confirmed the assumption of homogeneity of variances within subgroups of each school population. A t test was then employed to determine the significance of the differences between the mean achievement scores of the sample groups of each school.

In each school, the mean achievement scores of the experimental group exceeded the mean achievement score of the control group. While these differences were not at the required level of significance, they supported the belief of many educators that teacher stress on content in this subject matter area does not necessarily result in greater mastery of science content.

The goals of our schools are, to some extent, based on community expectations. Even though much of the science content presented in the elementary schools may be quite outdated by the time students become productive members of society, parents often measure the quality of a school by how well their children master textbook material. This is not to imply that student acquisition of content is unimportant; rather, that stress on content does not automatically result in a higher level of student achievement.

The only noticeable difference in performance by sex was in the area of achievement. In each school the variance of the experimental group boys was noticeably greater, however, not significantly, than the variance of the control group boys. In experimental groups the scores of boys were also more divergent than scores of the girls. On the other hand, the variance of experimental group girls was less than the variance of control group girls. In control groups, the greater variation was between scores of the girls.

These differences in performance by sex were duplicated in the sample groups of each school. They have been mentioned because they suggest to the writer that the cooperating teachers did teach the experimental and control groups by different methods. They also suggest that the level of achievement of boys may be more closely related to the method of teaching than the level of achievement for girls.

The nonparametric Mann-Whitney U statistic, with a correction for tied ranks, was used to determine the significance of the difference between experimental and control group score ranks in each school.

Analysis of the data relevant to student attitude toward science lent support to the conclusion that the pupil-investigatory approach was superior to the traditional approach. In School "A", the difference in student attitude toward science was significant, in favor of the experimental group, at the .05 level of confidence. Although differences in this area were not significant in School "B", results indicated that the pupil-investigation method was at least as effective in the development of positive attitudes toward science as was the traditional method.

The Mann-Whitney U was also used to test the significance of the difference between experimental and control group score ranks in the area of interest in science.

There were no significant differences between experimental and control group scores relative to student interest in science in either school. Results of each school, however, indicated that the pupil-investigation approach compared favorably with the traditional approach as an educational experience.

With regard to the specific hypotheses of this study, the following conclusions seem to be warranted:

1. The hypothesis that there is no significant difference at the .05 level of confidence in science achievement of fifth

grade children who have been taught science by a pupil-investigation method by the same teacher, is tenable.

2. The hypothesis that there is no significant difference at the .05 level of confidence in attitudes toward science of fifth grade children who have been taught science by a traditional method and those who have been taught science by a pupil-investigation method by the same teacher, is partially untenable--the confidence scores were significantly higher in one school but below the required level of significance at the other school.

3. The hypothesis that there is no significant difference at the .05 level of confidence in interest toward science of fifth grade children who have been taught science by a traditional method and those who have been taught science by a pupil-investigation method, by the same teacher, is tenable.

Observations

Through observations of sample groups, teacher notes, and conferences with cooperating teachers, the writer noted several differences between student behavior in the control and experimental groups. Some of the more pertinent are briefly mentioned.

The mode of conduct and general student reaction was different in the sample groups. In the control groups, student attention was centered upon the teacher. The students were courteous, reasonably attentive, and presented no serious discipline problems. Most questions were asked by, or directed to, the teacher. Student questions were generally related to the textbook topic under discussion. The importance of mastery of content had been discussed and the teacher was diligent in her efforts to answer questions that would help children reach this goal.

The classroom atmosphere of the experimental groups was more permissive. Although the teacher directed the discussion relevant to the introduction of areas of content, many class periods were characterized by student interaction. The problems connected with student control were more numerous during the early part of the experimental period but became much less in number as time progressed. Children of the experimental groups seemed to develop more self-control and confidence. During the latter part of the study, these students would often proceed with a minimum of teacher direction.

In the experimental groups, student questions often ranged beyond the scope of the textbook. Such questions as, "Why does this happen?" and, "Would it work with another material?" were not uncommon. Cooperating teachers did not consider it as necessary to answer these questions as to challenge children to find their own answers. The classroom environment was such that teachers did not mind telling students that they did not know the answers. Victor (52) stated that one of the chief reasons teachers object to teaching science was that they disliked being in a position of having to say, "I don't know."

Seating arrangement of the control group was not traditional in the sense that desks were precisely aligned. Although desks were grouped, there was little interaction among students. Desks did remain in the same general arrangement for the greater part of the experimental period.

During the early part of the study, students of the experimental groups worked in small groups of five or six. When it was noted that some children seemed to dominate their groups, teachers encouraged students to work in smaller groups of two or three. Children were free to rearrange their desks according to the interests of the groups.

The amount of required writing was greater in the control groups. Written responses to questions at the ends of subunits of the text were required. Formal tests, prepared by the publisher of the class text, were administered at intervals throughout the year. Demonstrations by the teachers were well-planned and produced the desired results. Student notebooks were kept in which descriptions and conclusions of demonstrations were recorded. All tests and notebooks were carefully checked and returned by the teachers.

Members of the experimental groups were expected to write summaries of procedures and conclusions of their science investigations. These were discussed with the teacher from the standpoint of content, structure and punctuation. Informal tests, checked and corrected by the student, were also given.

The level of achievement of the control group was quite satisfactory. Evaluation of the science achievement test given at the conclusion of the study revealed a group mean raw score of 36.9. This was equivalent to a grade score of 6.7, or a percentile rank of 76. Because of a favorable home environment of the majority of these students, a high level of achievement was expected.

The achievement level of members of the experimental group was a matter of concern to the writer. Parents and teachers often place emphasis on knowledge of content and it was possible that absence of stress in this area would be disadvantageous to these students. The mean achievement score of the experimental groups revealed that this concern was groundless. The group mean raw score of 37.8 yielded a mean achievement percentile of 78. Even though there seemed to be no emphasis on the acquisition of science content, results in this area were very satisfactory.

There was greater involvement on the part of parents of the experimental group. This was not unexpected. Kitchens were searched by students for materials helpful in the performance of home and school experiments. Children asked their fathers to take them on field trips to locate and classify items of various categories.

As the study progressed, members of the control groups requested that they be allowed to "do some of the things" their peers were doing. This "halo effect" was not foreseen. Although teachers did not change their basic teaching approaches, control group students did begin to perform science experiments in their homes.

Finally, although the basic textbook used in this course was a recent edition and compared favorably with other fifth grade adoptions, the writer and cooperating teachers felt it was more appropriate for a traditional approach than for a pupil-investigatory approach. Perhaps textbooks adopt a traditional approach because most teachers present material in a traditional manner; perhaps the reverse is true.

Recommendations

As the result of this study, the following recommendations have been made:

1. Attitude and interest inventories of the type used in this study are of relatively recent development at the elementary school level. The writer knows of no single independent criterion with which scores of these instruments may be compared. Additional research, directed toward the establishment of attitude and interest research instruments of known validity at the elementary school level is recommended.
2. The populations of the schools of this study were composed primarily of children of middle and upper-middle class families. Comparisons between other sample groups may or may not be supportive. Additional investigation which would replicate this study with sample groups from other socio-economic levels is recommended.
3. Both the experimental and the control groups of this investigation had access to the same basic materials. Studies incorporating single concept materials as pertinent variables would be of value.
4. In this study the reaction of male students of the experimental group was more diverse than control group males in the area of achievement. The efficacy of various methods for particular personality types would seem to merit investigation. Results of these studies could prove helpful in the development of more effective teaching patterns.

5. The writer would recommend that related studies be conducted that compare divergent approaches to teaching which involve dependent variables based on the use of information rather than on the recall of information. Comparisons in such areas as the ability to classify information, problem-solving approaches, and the ability to apply the methods of science to other subject matter areas would seem to be appropriate.

6. It is known that the quality of the instructional program depends largely on the qualifications of the teacher. It has also been established that many elementary teachers feel insecure in the area of science. Although not a recommendation for further research, the investigator would urge greater effort on the part of local, state, and national organizations toward providing more in-service opportunities in the area of elementary school science. These programs should involve children in classroom situations and should place emphasis on teaching science by a contemporary method.

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APPENDIX A

PERMISSION FOR USE OF TESTING INSTRUMENTS

ELEMENTARY-SCHOOL SCIENCE PROJECT
Co-Directors: J. MYRON ATKIN College of Education · STANLEY P. WYATT JR. Department of Astronomy

UNIVERSITY OF ILLINOIS
805 WEST PENNSYLVANIA AVENUE, URBANA 61801
AREA CODE: 217 TELEPHONE: 333-1846

31 October 1966

Mr. Keith Benson, Principal
Will Rogers Elementary School
1211 North Washington
Stillwater, Oklahoma 74074

Dear Mr. Benson:

You may certainly have my permission to use the testing instruments indicated in your letter of 17 October. However, since the completion of my dissertation, a new form of the attitude scale, INTERESTS AND IDEAS, has been developed. This form has been used extensively in the evaluation programs of the Elementary-School Science Project and the School Science Curriculum Project. It would be much more appropriate for you to use this form than the one included in my dissertation. I have enclosed a copy of the new form of this instrument along with supporting administration materials.

I have also enclosed a copy of TOUS: Test On Understanding Science. This instrument was designed to assess children's perceptions of the nature of science. You may wish to use this instrument also.

I offer the following information about the three instruments enclosed:

1. INTERESTS AND IDEAS: This instrument is not designed to be administered within any specified period of time. Children should have an opportunity to answer all items. The scoring is somewhat complicated. Responses indicating the most favorable attitudes toward science are weighted as 4 points; the responses least favorable to science are weighted as 0 points. I have included an answer key which indicates the weighting scheme for each of the 30 science items. The 10 items not indicated are not used in determining the final score. Maximum score = 4 x 30 = 120 points.

2. ACTIVITIES: This instrument is also not designed to be administered within a given period of time. Children should have the opportunity to complete all items. Responses are also weighted on this instrument: 0 = 0, A = 1, B = 2, and C = 3. Maximum score = 3 x 80 = 240 points.

3. TOUS: This instrument is to be administered within a 30 minute period of time. Correct answers are awarded 1 point. Maximum score = 36 points. I have included a list of themes and some statistics for the form of TOUS used in my dissertation. A new form, Form Ew, is now available.

The only stipulation for use of these instruments is that they be reproduced exactly as they now appear. They should also be administered using the instructions provided. I would also like to receive one copy each of the materials which are reproduced and used in your study.

I will be happy to supply you with further information on the use and/or scoring of any of these instruments.

Sincerely,

Peter B. Shoresman

Peter B. Shoresman
Associate Professor and
Director of Research

PBS:lp

Enclosures

APPENDIX B

INTERESTS AND IDEAS

Attitude Instrument

INTERESTS AND IDEAS

Form AV

GENERAL DIRECTIONS

1. The questions in this booklet will ask you how you feel about a number of different things. There are no right or wrong answers. Just answer each question as honestly as you can. The answers you give will not be used to make up your grade for this or any other class.

2. All of your answers are to be made on the separate answer sheet you have been given. Do not make any marks in this booklet.

3. Indicate your answers on the answer sheet by completely BLACKENING the box which has the same capital letter as the answer you have chosen. You may use a regular pencil to make your marks. However, do not use a fountain pen, ball point pen, or colored pencil.

4. You are to mark one, and only one, answer for each question. If you change your mind about an answer, erase it completely and cleanly. Be sure to make your new mark heavy and dark. Please answer EVERY question in this booklet.

5. WORK AS QUICKLY AS POSSIBLE without checking your work and without talking to anyone else.

6. If you have a question about any directions in this booklet, raise your hand. Your teacher will try to help you.

7. When you have finished, immediately close your booklet and raise your hand. Your teacher will then collect your booklet and answer sheet.

Please do not turn this page and begin until you are asked to do so.

-1-

Part I

Directions: Listed below are some questions. We would like to know how you feel about each one of them. Read each question carefully and then decide which one of the five answers below the question is MOST like the way you feel. On your separate answer sheet, find the number of the question you are reading and BLACKEN the box which has the same capital letter as the answer you have chosen. Choose ONLY ONE answer for each question. Remember, there are no right or wrong answers to these questions.

1. This is the way I feel about physical education (gym class) this year:

   A. It's my favorite subject.
   B. I like it very much.
   C. It's all right.
   D. I don't like it very much.
   E. I don't like it at all.

2. This is the way I feel about science this year:

   A. It's my favorite subject.
   B. I like it very much.
   C. It's all right.
   D. I don't like it very much.
   E. I don't like it at all.

3. I would like to study art or music

   A. no more.
   B. 1 or 2 more years.
   C. 3 or 4 more years.
   D. 5 or 6 more years.
   E. 7 more years or more.

4. I would like to study science

   A. no more.
   B. 1 or 2 more years.
   C. 3 or 4 more years.
   D. 5 or 6 more years.
   E. 7 more years or more.

GO ON TO THE NEXT PAGE

Part II

Directions: Each sentence below has a blank space in the middle. Following each sentence are five ways you can fill the blank. After you read the sentence carefully, choose the one answer which is MOST like the way you really FEEL. Choose ONLY ONE answer for each sentence. Remember, there are no right or wrong answers to any of these sentences. When you have decided which answer is most like the way you feel, find the number of the question on your answer sheet and BLACKEN the box which has the same capital letter as the answer you have chosen.

Here is an example:	O. I like summer _______ winter.	ANSWER SHEET
	A. a lot more than	
	B. a little more than	O [A] [B] [C] [■] [E]
	C. just as much as	
	D. a little less than	
	E. a lot less than	

Imagine that the right half of the above example is a small piece of your separate answer sheet. Look at row "O" on this "midget" answer sheet. In the example, answer box D has been blackened. This means that the person likes summer a little less than winter. If he liked summer a lot more than winter, he would have blackened answer box A; if he liked summer a little more than winter, he would have blackened answer box B; if he liked summer just as much as winter, he would have blackened answer box C; and if he liked summer a lot less than winter, he would have blackened answer box E. If you understand these directions, go right ahead. If you have any questions about these directions, just raise your hand; your teacher will come to help you.

5. I would like to teach art or music _______ I would like to teach science.
   - A. a lot more than
   - B. a little more than
   - C. just as much as
   - D. a little less than
   - E. a lot less than

6. I like talking about problems in science _______ talking about problems in social studies.
   - A. a lot more than
   - B. a little more than
   - C. just as much as
   - D. a little less than
   - E. a lot less than

7. I like writing answers to social studies questions _______ writing answers to science questions.
   - A. a lot more than
   - B. a little more than
   - C. just as much as
   - D. a little less than
   - E. a lot less than

8. I would like helping to care for my school's science equipment _______ helping to care for the books in the school library.
   - A. a lot more than
   - B. a little more than
   - C. just as much as
   - D. a little less than
   - E. a lot less than

GO ON TO THE NEXT PAGE

Part III

Directions: Listed below are some statements. We would like to know how you FEEL about them. Read each statement carefully and then decide how you feel about it--that is, whether you (A) agree with it a lot, (B) agree with it a little bit, (C) don't know how you feel about it, (D) disagree with it a little bit, or (E) disagree with it a lot. On your separate answer sheet, find the number of the question you are reading and BLACKEN the answer box which has the same capital letter as the answer which is most like the way you feel. Remember, there are no right or wrong answers to these questions. We just want to know how you feel about them.

	ANSWER SHEET
OO. Boys and girls should get free popcorn and candy at the movies Here is an example: A. I agree a lot. B. I agree a little bit. C. I don't know. D. I disagree a little bit. E. I disagree a lot.	OO [■] [B] [C] [D] [E]

Once again imagine that the right half of the above example is a small piece of your separate answer sheet. Look at row "OO" on this "midget" answer sheet. In the example, answer box A has been blackened. This means that the person thinks that boys and girls should very certainly get free popcorn and candy at the movies. If he did not think that boys and girls should get free popcorn and candy at the movies, he would have blackened either answer box D or answer box E--depending on how much he disagreed with this statement. If you do not understand these directions, raise your hand and your teacher will come to help you. If you do understand, go right ahead.

9. When my teacher says that she is going to call upon some boys and girls in the class to answer science questions, I hope that she will call on me.
   - A. I agree a lot.
   - B. I agree a little bit.
   - C. I don't know.
   - D. I disagree a little bit.
   - E. I disagree a lot.

10. Social studies is less fun than any other school subject.
   - A. I agree a lot.
   - B. I agree a little bit.
   - C. I don't know.
   - D. I disagree a little bit.
   - E. I disagree a lot.

11. I would not like to marry a man (or a woman) who is a scientist.
   - A. I agree a lot.
   - B. I agree a little bit.
   - C. I don't know.
   - D. I disagree a little bit.
   - E. I disagree a lot.

GO ON TO THE NEXT PAGE

12. I do not worry at all while I am taking a science test.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

13. There is too much homework in science.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

14. The subject I like most is language arts.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

15. Science is easier for me than my other subjects.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

16. People who are good in science are sort of queer or odd.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

17. I like studying science more than I like studying any other subject.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

18. I would like to teach science when I grow up.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

GO ON TO THE NEXT PAGE

19. **Science is boring.**
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

20. **Social studies is fun.**
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

21. Studying science makes life more interesting.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

22. I do <u>not</u> like reading about science as much as I like reading about other subjects.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

23. Science is fun.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

24. It is easier to get good grades in social studies than to get good grades in science.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

25. I'm surprised that some students think social studies is fun.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

GO ON TO THE NEXT PAGE

26. After I have taken a science test, I worry about how well I did on the test.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

27. I would like meeting the scientist Henry Green more than meeting Governor Clifford Jones.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

28. I enjoy doing science experiments.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

29. Science is less fun than any other school subject.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

30. Studying social studies makes life more interesting.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

31. I'm surprised that some students think science is fun.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

32. Social studies is boring.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

GO ON TO THE NEXT PAGE

33. The subject I like most is science.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

34. There is so much hard work in science that it takes the fun out of it.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

35. The subject I can remember best is science.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

36. I do not like reading about social studies as much as I like reading about other subjects.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

37. I worry when my teacher says that she is going to ask me questions to find out how much I know about science.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

38. I enjoy doing arithmetic problems.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

39. When I am taking a hard science test, I forget some things that I knew very well before I started taking the test.
    A. I agree a lot.
    B. I agree a little bit.
    C. I don't know.
    D. I disagree a little bit.
    E. I disagree a lot.

GO ON TO THE NEXT PAGE

40. I would like to become a scientist when I grow up.
    - A. I agree a lot.
    - B. I agree a little bit.
    - C. I don't know.
    - D. I disagree a little bit.
    - E. I disagree a lot.

There are no more questions to be answer in this booklet. RAISE YOUR HAND NOW and your teacher will collect your booklet and answer sheet.

APPENDIX C

ACTIVITIES

Interest Instrument

ACTIVITIES

Form IV

Please fill in the following blanks. PRINT CAREFULLY.

Name: ______________________________ . Date: ______________
Last First Middle

School: __________________ . Teacher: __________________ . Grade: __________

DIRECTIONS

1. This is NOT a test. There are no right or wrong answers. This will not count on your report card. Just answer the questions as well as you can.

2. This booklet deals with things you might have done since the end of school last June (1966).

3. We would like to find out which of these things you have done just because you yourself were interested in them or wanted to do them. You are NOT to count any things which were done only because they were a part of your school homework or assigned classwork.

4. Some things you have not done at all, some only a few times, and some many times. Show the number of times you remember doing each of these activities by CIRCLING the proper letter to the right of the activity. Circle "O" if you have never done a certain activity, circle "A" if you have done the activity 1 or 2 times, circle "B" if you have done the activity 3 or 4 times, and circle "C" if you have done the activity 5 or more times.

5. Choose ONLY ONE answer for each question.

6. Do NOT count what you would like to do, but only show what you actually did since school ended last spring.

7. Here is an example:

Things I Have Done Since Last June Because I Like Them	I Have Done This Thing: Never	1 or 2 times	3 or 4 times	5 or more times
O. Helped repair the family car.	O	(A)	B	C

In this example, answer A was circled. This means that the person "helped repair the family car" 1 or 2 times. If he had never helped repair the family car, he would have circled answer O; if he had helped repair the family car 3 or 4 times, he would have circled answer B; and if he had helped repair the family car 5 or more times, he would have circled answer C.

8. If you finish before time is called, go back and spend more time on those questions about which you were most doubtful.

9. DO NOT TURN this page until you are told to do so.

-1-

Things I Have Done Since Last June Because I Like Them.	Never	1 or 2 times	3 or 4 times	5 or more times
	I Have Done This Thing			
1. Worked on a collection of pictures of plants or animals.	O	A	B	C
2. Watched science programs on T.V..	O	A	B	C
3. Read about the lives of great scientists.	O	A	B	C
4. Used a home chemistry set or experimented with chemicals.	O	A	B	C
5. Worked out science problems or science puzzles on my own.	O	A	B	C
6. Worked with a friend on a science project.	O	A	B	C
7. Read about the moon, sun, planets, or stars.	O	A	B	C
8. Worked on a collection of pictures of airplanes, boats, rocket ships, or cars.	O	A	B	C
9. Went to a meeting of a science club.	O	A	B	C
10. Used field glasses or a magnifying glass to study nature.	O	A	B	C
11. Made models of animals or plants out of plastic, paper, clay, or wood.	O	A	B	C
12. Listened to scientific talks on the radio.	O	A	B	C
13. Watched birds build a nest or feed their young.	O	A	B	C

Things I Have Done Since Last June Because I Like Them	I Have Done This Thing			
	Never	1 or 2 times	3 or 4 times	5 or more times
14. Thought about such questions as "What is time?" "What is gravity?" "What is space?" "What is energy?" and "What is infinity?"	O	A	B	C
15. Spent time making, collecting, or studying maps.	O	A	B	C
16. Raised tropical fish.	O	A	B	C
17. Watched the moon, stars, or sky for more than five minutes.	O	A	B	C
18. Collected parts of plants, such as leaves, flowers, bark, or seeds.	O	A	B	C
19. Made a "visible man," "visible woman," or some other "visible" animal.	O	A	B	C
20. Brought scientific things to school to show my class.	O	A	B	C
21. Made models of airplanes, cars, boats, or rockets.	O	A	B	C
22. Cared for a dog, cat, rat, horse, or some other pet.	O	A	B	C
23. Watched a stream move sand and pebbles or cut away earth.	O	A	B	C
24. Tried to make some invention or gadget.	O	A	B	C
25. Tried to find out how important scientific discoveries were made.	O	A	B	C
26. Went to a zoo.	O	A	B	C

Things I Have Done Since Last June Because I Like Them	I Have Done This Thing			
	Never	1 or 2 times	3 or 4 times	5 or more times
27. Thought about how the earth, the sun, the stars, or life came to be.	O	A	B	C
28. Experimented at home with things dealing with heat or light.	O	A	B	C
29. Studied ocean life (such as snails, starfish, or seaweed) at the seashore.	O	A	B	C
30. Made models of atoms or molecules.	O	A	B	C
31. Went to the movies just to see science pictures of wild-life, such as Walt Disney makes.	O	A	B	C
32. Tried to predict the weather from clouds, temperature, and other signs.	O	A	B	C
33. Did an experiment with plants or animals (such as dissecting an animal or growing bacteria).	O	A	B	C
34. Watched for an earth satellite or tried to identify different constellations of stars.	O	A	B	C
35. Visited the pet section of a store to watch birds, fish, and other animals.	O	A	B	C
36. Tried to find out about scientific jobs, such as flying, engineering, farming, and medicine.	O	A	B	C
37. Worked on my rock collection and tried to figure out reasons for local land formations.	O	A	B	C

-4-

Things I Have Done Since Last June Because I Like Them	I Have Done This Thing			
	Never	1 or 2 times	3 or 4 times	5 or more times
38. Experimented with a gyroscope or a top.	O	A	B	C
39. Talked with my friends about scientific things.	O	A	B	C
40. Read magazine or newspaper stories about nature or science.	O	A	B	C
41. Looked at things under a microscope.	O	A	B	C
42. Memorized extra facts about science because I am interested in the subject.	O	A	B	C
43. Talked with an adult about scientific things.	O	A	B	C
44. Planted and cared for lawns, shrubs, or trees because I am interested in them.	O	A	B	C
45. Went to a lecture to hear someone talk about science.	O	A	B	C
46. Made drawings of mechanical inventions.	O	A	B	C
47. Kept a wild animal (such as a squirrel, rabbit, or robin) as a pet.	O	A	B	C
48. Experimented at home with things dealing with sound, electricity, or magnetism.	O	A	B	C
49. Worked on a collection of pictures of the moon, sun, planets, or stars.	O	A	B	C

Things I Have Done Since Last June because I Like Them	Never	I Have Done This Thing 1 or 2 times	3 or 4 times	5 or more times
50. Went for a hike in the woods or on a nature exploring trip.	O	A	B	C
51. Visited a nature museum.	O	A	B	C
52. Used a telescope to look at the moon, planets, or stars.	O	A	B	C
53. Planted some seeds to see how they would grow.	O	A	B	C
54. Played with an erector set or some other building set.	O	A	B	C
55. Collected rocks of different kinds.	O	A	B	C
56. Visited a scientific laboratory.	O	A	B	C
57. Read a science fiction story.	O	A	B	C
58. Grew vegetables or flowers.	O	A	B	C
59. Went to a meeting of the Cub Scouts, Brownies, Campfire Girls, 4H Club, Boy Scouts, or Girl Scouts.	O	A	B	C
60. Read about energy or heat.	O	A	B	C
61. Did extra science homework.	O	A	B	C
62. Worked on a collection of insects, sea shells, or other animals or animal parts.	O	A	B	C
63. Caught and studied insects (such as butterflies and grasshoppers).	O	A	B	C

Things I Have Done Since Last June Because I Like Them	Never	I Have Done This Thing: 1 or 2 times	3 or 4 times	5 or more times
64. Visited a science museum.	O	A	B	C
65. Spent my own money for scientific things (such as science kits).	O	A	B	C
66. Made a compass, telescope, electric motor, steam engine, or some other piece of scientific equipment.	O	A	B	C
67. Asked my teacher a question about science.	O	A	B	C
68. Volunteered to answer questions in class about science (not because my teacher asked me but because I wanted to).	O	A	B	C
69. Talked with a scientist about his work.	O	A	B	C
70. Went to the library to find out more about scientific things.	O	A	B	C
71. Spent time preparing a special written or oral science report for my class.	O	A	B	C
72. Worked on a collection of fossils.	O	A	B	C
73. Built a birdhouse or a dog-house or a home for another kind of animal.	O	A	B	C
74. Caught and studied salamanders, toads, frogs, tadpoles, turtles, or snakes.	O	A	B	C
75. Read, outside of school, about how the human body works.	O	A	B	C

Things I Have Done Since Last June Because I Like Them.	Never	1 or 2 times	3 or 4 times	5 or more times
		I Have Done This Thing		
76. Asked my father or mother a question about science.	O	A	B	C
77. Tried to find out how science is used in cooking.	O	A	B	C
78. Worked on a collection of science books or on a collection of science fiction books and magazines.	O	A	B	C
79. Took care of a terrarium.	O	A	B	C
80. Visited flower gardens, greenhouses, or flower shows.	O	A	B	C

There are no more questions to be answered in this booklet. If you finish before time is called, go back and spend more time on those questions about which you were most doubtful.

VITA

Keith Sheran Benson

Candidate for the Degree of

Doctor of Education

Thesis: A COMPARISON OF TWO METHODS OF TEACHING FIFTH GRADE SCIENCE

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Biographical:

Personal Data: Born near Barnsdall, Oklahoma, March 27, 1916, the son of Barney S. and Eva Benson.

Education: Graduated from high school at New Lima, Oklahoma in 1932; received the Bachelor of Science degree from East Central State College, with majors in Biological Science and Mathematics, in May, 1938; received the Master of Science degree from Oklahoma State University, with a major in School Administration, in August, 1946; completed requirements for the Doctor of Education degree in May, 1968.

Professional Experience: High school mathematics teacher at Fox, Oklahoma, 1938-1946; mathematics teacher at Fairview, Oklahoma, 1946-48; Head of Mathematics Department at Okmulgee, Oklahoma, 1948-1952; Dean of Boys at Okmulgee, Oklahoma, 1952-54; elementary principal at Okmulgee, Oklahoma, 1954-1963; elementary principal at Stillwater, Oklahoma, 1963-67.

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