 69-21,989

SCHMIDT, Frederick Benjamin, 1921-
THE INFLUENCE OF A SUMMER INSTITUTE
IN INQUIRY-CENTERED SCIENCE EDUCATION
UPON THE TEACHING STRATEGIES OF
ELEMENTARY TEACHERS IN TWO DISCIPLINES.

The University of Oklahoma, Ph.D., 1969
Education, teacher training

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE INFLUENCE OF A SUMMER INSTITUTE IN INQUIRY-CENTERED SCIENCE EDUCATION UPON THE TEACHING STRATEGIES OF ELEMENTARY TEACHERS IN TWO DISCIPLINES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

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Norman, Oklahoma

1969

THE INFLUENCE OF A SUMMER INSTITUTE IN INQUIRY-CENTERED SCIENCE EDUCATION UPON THE TEACHING STRATEGIES OF ELEMENTARY TEACHERS IN TWO DISCIPLINES

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ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to the many persons who have assisted in making this research possible. Particular gratitude is extended to his major advisor, Dr. John W. Renner for his untiring assistance and friendly guidance throughout.

Appreciation is expressed to Dr. Donald Reynolds for his assistance with the statistical design. The author also wishes to thank the Advisory Committee members, Dr. Arthur Doerr, Dr. William Fulton, and Dr. Clifford Merritt for their assistance in planning an appropriate program of advanced graduate study.

Gratitude is also expressed to Mr. Lester Reed, superintendent of the Norman Public School System and to the many teachers who were most cooperative and helpful.

Finally, the author wishes to express deepest appreciation to his wife Alma, for her faith, encouragement and sacrifices during the years of graduate study. Realization of the doctoral degree would have been impossible without her understanding and constant optimism.

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CHAPTER I

BACKGROUND OF THE PROBLEM

From colonial days in America to the present time, educational objectives have been formulated by various individuals and groups. One of the objectives from these early times was the preparation of young students for reading the Bible. In more recent times, specifically in 1918, the Commission on the Reorganization of Secondary Education proposed a set of seven cardinal objectives, and in 1938 the Educational Policies Commission[1] suggested four categories of desirable objectives. Included in the lists compiled by the two last named bodies were such goals as the "command of fundamental processes," and "self realization." Although worthy of attainment by the individual and society there existed little common agreement as to how these goals might be implemented, and if the common experiences of students in

[1]Education Policies Commission, The Central Purpose of American Education (Washington, D.C.: NEA, 1961), p. 5.

school did indeed succeed in bringing about these outcomes they probably resulted from the operation of indirect factors rather than through a direct causal relationship. In 1961, The Educational Policies Commission[2] delineated the Central Purpose of American Education, namely, the cultivation of the rational powers within each individual. These are defined as including the processes of recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, deducing and inferring. These rational powers are not intended to be an inclusive or exclusive summary of mental activities, but do represent the essence of the ability to think. Certain disciplines seem to represent more "natural" vehicles than others in presenting opportunities for developing the rational powers. Renner states, "The structure of science, . . . if taught as a form of inquiry or investigation, is a natural vehicle to use when leading the learner to develop his ability to think."[3]

Elementary education, especially science education, has been dramatically modified within the past decade. The changes are most apparent in the operational procedures employed by teachers using the inquiry-discovery approach, but inasmuch as classroom strategies usually reflect the

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[2] Ibid.

[3] John W. Renner and William B. Ragan, Teaching Science in the Elementary School (New York: Harper & Row, Publishers, Inc., 1968), p. 53.

underlying philosophical concepts that inspire them, a reorientation of objectives has apparently occurred. Wilson[4] details and documents most of the characteristics of "new science," and although duplicating his efforts here would be redundant, a concise summary of those criteria to create a background of understanding for this study seems appropriate. Traditional science teaching has emphasized the content phase to the almost complete exclusion if its more dynamic counterpart--the process. Objectives of traditional courses consisted of the memorizing of facts, concepts, and principles with the fountainhead of authority residing in the textbook or the teacher. Seldom were students permitted "open-ended" investigations, and science "laboratory activities" were really a verification of an already known outcome and not investigation. The natural curiosity of children, much relied upon in the inquiry-discovery approach is permitted to atrophy in the traditional science class. In inquiry-discovery classes, by contrast, the young student doing science with his own equipment and materials and fired by his natural curiosity has the opportunity to build a viable intellectual relationship with science based upon his personal experimentation, manipulation of equipment, and observation. Thus the distant, impersonal, vicarious

[4]John H. Wilson, "Differences Between the Inquiry-Discovery and the Traditional Approaches to Teaching Science in Elementary Schools" (unpublished Ed.D. dissertation, The University of Oklahoma, 1967), pp. 19-29.

concept is replaced by a direct, personal, and immediate experience. Such experiences are usually taken from the environment of the child and for this reason achieve a greater degree of relevance. Intrinsic motivation, the constant desire of educators, seems to accompany inquiry-discovery teaching to a high degree, and there is evidence suggesting greater retention of those facts and relationships which are self-obtained by the student when operating under this semi-autonomous scheme called inquiry-discovery teaching.[5]

The widely held view that elementary teachers lack an adequate science background and are therefore reluctant to teach it has been researched by many including Victor. He says: "The most common reason offered for this reluctance to teach science is the inadequate background of the elementary teachers."[6]

Statement of the Problem

This study will investigate two questions:

1. Can teacher behavior patterns in science classes be modified in accordance with the philosophy and objectives of inquiry-centered science through educational experiences received in a summer institute in "new science"?

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[5]Renner and Ragan, op. cit., p. 96.

[6]Edward Victor, "Why Are Elementary Teachers Reluctant to Teach Science?" The Science Teacher, XXVIII, No. 7, (November, 1961), 17-19.

2. Can teacher behavior patterns in social studies be modified in a parallel manner by this same educational experience in science?

The Educational Experience Provided to Subjects

The population for this study is a selected group of elementary teachers from the Norman and Oklahoma City area who had been participants in the Cooperative College-School Science Program summer institute in "new science" during the summer of 1967. The primary educational emphasis of the institute was not transmission of factual information, rather, it could be described as first, to acquaint teachers with the philosophy, procedures, and materials of "new" or inquiry-centered science teaching, and secondly, to make it possible for teachers to assimilate and internalize the philosophical and operational changes necessary to begin this kind of teaching in the fall of 1967. This latter accomplishment was obtained by using classroom observations of children being taught and the microteaching technique with the same children.

The institute format was deliberately designed to combine the philosophical background with practical procedures that could become immediately operational in any elementary science classroom. The guiding rationale for most of the activities of the institute was simply that the teachers would learn most about the new curricula by actually participating in the same types of activities their children would engage in later in class. Accordingly, all teachers were required to:

1. perform experiments, gather data, test hypotheses, and make predictive inferences. This "doing" of science characterizes the new curricular efforts.
2. make a presentation to the entire class of teachers one unit of study for the particular grade level that teacher taught. This was preceded by an extensive review of all available curriculum materials for one particular grade level and involvement of the entire class by the teacher making the presentation was urged where possible.
3. design a sequence of study for one grade level for one year. (These were later combined into the scope and sequence subsequently used by the Norman, Oklahoma, Public School System.)
4. engage in observation and microteaching. Each teacher made extensive classroom observations and worked several times with 3-4 pupils for a period of about 45 minutes.

Design of Research Instrument and Assumptions Regarding its Use

The first fundamental assumption underlying this study is that the development of the rational powers is a desired educational outcome. As a corollary, the assumption was also made that questioning, discussing, and other verbal and non-verbal experiences tending to promote increased frequency of use of the rational powers are likewise desired educational outcomes. It is also assumed that the rational powers can be arranged in order of increasing cognitive complexity, with "recall" representing the lowest level and "infer" representing the highest level. The first category of quantitative investigation concerns use of rational powers by teachers both before and after the summer institute.

Before considering the second assumption, the nature of science as might be encountered in an elementary classroom must be considered. Renner identifies the quality of such science in this way, "When the decision is made to use the curriculum vehicle of science to achieve educational purposes, the learning activities and the content selected must result in classroom experiences which can be recognized as science by a scientist."[7] Renner calls these classroom experiences the Essential Learning Experiences and classifies them as: observing, experimenting, measuring, data

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[7]Renner and Ragan, op. cit., p. 113.

interpretation, and prediction.[8] The second assumption then, is that participation in the essential learning experiences is desirable and, inferentially, situations that tend to increase the frequency of student involvement in them is also a desirable outcome. Accordingly, the second category for quantitative investigation is the employment of the essential learning experiences[9] by teachers, before and after the summer institute.

The third assumption concerns divergent questions. Karplus notes that divergent questions have the following characteristics, "Many questions can be grouped as divergent in that they lead to further questions, cause children to carry out or plan experiences with equipment and materials, or foster the kind of inquiry that causes children to research information in the library."[10] Since divergent questions foster inquiry, the assumption is that the use and increased frequency of divergent questions is a desired outcome. Use of divergent questions by teachers before and after the summer institute is the third category for quantitative investigation.

The fourth assumption is that use of convergent questions, those answerable by students supplying a specific

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[8]*Ibid*., pp. 112-158.

[9]*Ibid*.

[10]Robert Karplus and Herbert D. Thier, *A New Look at Elementary School Science* (Chicago: Rand McNally & Co., 1967), p. 86.

fact, and use of recall questions, those answerable by the student remembering previously learned information are not desired outcomes. However, decreases in the use of these kinds of questions by teachers after the institute as compared to the frequency of use before the institute would constitute a desirable modification of teaching patterns and thus a favorable outcome. Therefore, the use of these questions before and after the summer institute become the fourth category for quantitative investigation.

The fifth assumption is that the concept of degree of involvement of learners in a lesson as developed by Karplus and Thier[11] represents a potentially profitable frame of reference from which to interpret classroom activity. These authors cite four discrete degrees of student involvement, and describe them as follows: In degree one, the students read about science or listen to the teacher talk about science. In degree two, the students discuss science with their peers or with the teacher. Demonstrations performed by the teacher represent degree three, and at the fourth degree students personally perform experiments. Degrees one and two characterize typical traditional classroom practices, and increases in either or both of these would not be meaningful in terms of desired educational objectives. The fourth degree of involvement, that of direct participation by the student in experimentation could have

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[11] Ibid., pp. 65-68.

been considered quantitatively, but was not for the reason that this particular kind of classroom activity is already quantified under the general category of essential learning experiences. The third level of involvement, however, the use of teacher demonstrations, is of considerable interest, and incidences of use by teachers were tabulated in both science and social studies classes before and after the institute.

Basis In Related Research

Kondo[12] researched the possible relationship between teacher questioning behavior and the different types of lessons which were part of the Science Curriculum Improvement Study (SCIS).[13] He analysed teacher questions in terms of (1) the complexity of their questioning behavior using question-response-comment units called incidents, (2) the question types (Routine, Cognitive-Memory, Convergent, Evaluative, and Divergent), (3) teacher reaction to responses or to his own questions, and (4) the transition probabilities of one question type followed by the same or other types.

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[12] Allan Kiichi Kondo, "A Study of the Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching the Unit on Material Objects" (unpublished Ed.D. dissertation, Columbia University, 1968).

[13] Science Curriculum Improvement Study (SCIS), University of California, Berkeley, California.

Kondo's analyses of the questioning behavior of the teachers in the SCIS revealed the following results:[14]

1. Overall, there was a fairly consistent pattern of questioning by the teachers across the lessons. The most complex lesson was Lesson 20 (Invention of the Comparison of Objects Using Signs).

2. Differences in the complexity of questioning patterns were more striking when individual teachers were compared. Certain teachers had a more complex pattern than others.

3. On the average, the percentages of Routine and Cognitive-Memory questions across lessons seemed to be influenced by the lesson being taught, but not by whether the lesson was an Invention or a Discovery lesson *per se*. The way the lesson was approached--i.e., teacher demonstration, children handling materials, etc., seemed to have a greater influence. When the lesson was largely handled through a demonstration, the percentages of Routine questions were relatively low and the percentages of Cognitive-Memory questions were relatively high.

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[14] *Dissertation Abstracts: The Humanities and Social Sciences*, XXIX, No. 7, (January, 1969), (Ann Arbor, Michigan: University Microfilms, Xerox Company, 1969), 2040-A. (Allan Kiichi Kondo, Abstract of Ed.D. dissertation, "A Study of the Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching the Unit on Material Objects.")

4. There was a fairly uniform percentage of Convergent questions across all lessons, about one-half of all questions asked being Convergent.

5. The relative frequencies of Evaluative questions were low in all lessons.

6. While there were low percentages of Divergent questions overall across the lessons, the Invention lessons (Lessons 20 and 21a) produced the highest percentages.

7. In general, it is suggested from the data that the way the lesson is approached has a greater influence on the types of questions asked than the type of lesson per se.

8. In most cases, the differences of question types among individual teachers were more striking than the averages across lessons. This points out the importance of the individual teacher's style in the types of questions she asks.

9. In terms of the teacher reactions to children's responses and to her own questions, the most pronounced differences across lessons were found in Lessons 20 (Invention) and 22 (Discovery) on the one hand, and Lessons 21a (Invention) and 21b (Discovery) on the other. The percentages in categories of Repetition of responses and Question following question were higher in the first pair mentioned than in the second. Again, vast differences were found between individual teachers. This revealed the characteristic ways

in which different teachers react to children's responses and to her own questions.

10. One type of question tends to be followed by questions of the same type to a greater extent than would be indicated by the overall distribution.

Kondo's efforts and the research of this investigator are directly related to the extent that both attach significance to the use of convergent and divergent questions. A summary of his work and findings is included in the Appendix.

Porterfield[15] investigated the possibility of a relationship existing between the types of questions asked while teaching reading by teachers educated in the Science Curriculum Improvement Study (SCIS) inquiry-discovery method of science instruction and teachers of reading not so educated. The questions were subsequently classified into one of nine categories of an adapted form of the Teacher Question Inventory of Harris and McIntyre.[16] For each group of teachers, composite tabulations for each question category were determined and converted into the appropriate form for

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[15]Denzil Ray Porterfield, "Influence of Preparation in Science Curriculum Improvement Study on Questioning Behavior of Selected Second and Fourth Grade Reading Teachers" (unpublished Ed.D. dissertation, The University of Oklahoma, 1969).

[16]Ben M. Harris and Kenneth E. McIntyre, Teacher Question Inventory (Austin: University of Texas, Press, 1964).

statistical analysis. The findings and conclusions of Porterfield's[17] study follow.

Recognition and recall questions were used significantly more by both second and fourth grade non-SCIS educated reading teachers. Translation, interpretation, analysis, synthesis, and attitude or value questions were used significantly more by both second and fourth grade SCIS-educated reading teachers. Opinion questions were used significantly more by second grade reading teachers. For questions categorized demonstration-of-skills, the results indicated no significant difference between the SCIS and non-SCIS-educated teachers. Recall questions were used more than any other type of question in all teacher groups. Recall questions accounted for thirty-four per cent of the questions asked by the SCIS-educated teachers and forty-four per cent of the questions asked by the non-SCIS educated teachers.

The null hypothesis of no significant difference between the questioning behavior of SCIS-educated and non-SCIS educated reading teachers was rejected as untenable, since twenty-three of the twenty-seven comparisons revealed differences significant to the 0.05 level of confidence. SCIS-educated second and fourth grade teachers asked greater proportions of questions which called for higher levels of thought than teachers in the study not so instructed. Both

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[17]Porterfield, op. cit., pp. 100-103.

groups of teachers in Porterfield's study used the same types of reading materials. The success of the SCIS-educated teachers with questions then may, in part at least, be attributable to the methodology used in the inquiry-discovery science instruction. The teachers evidently transferred the theoretical and practical use of questions and questioning learned in the science course into the area of reading instruction.

The research of Porterfield is directly related to the problem of this investigator since both have attempted to determine if teachers educated in the philosophy and objectives of "new science" are utilizing the theoretical and functional methodology in non-science subject areas. A summary of Porterfield's work and findings is included in the Appendix.

In his dissertation, Wilson[18] makes several suggestions for further research. One of these is a before and after study to determine if teachers who had been instructed in the inquiry-discovery approach show significant changes in their approach to science teaching. Wilson also proposes that questions used by teachers in other subjects (social studies, for example) be examined to determine if after experience in an inquiry-centered science education effort, those questions tend to be of a higher cognitive complexity than mere recall.

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[18] Wilson, op. cit., pp. 72-75.

As background information, Wilson contrasts the objectives and operational differences between traditional science teaching and the inquiry approach. His stated research problem was to determine whether teachers who had been instructed in a typical "new" science program, (Science Curriculum Improvement Study,[19]) were encouraging their pupils to indulge in a significantly larger number of "essential science experiences" (observing, measuring, experimenting, interpretation of data, prediction).[20]

Specifically, Wilson tested the following hypotheses:[21]

1. There is no significant difference in the number of times pupils are provided the five "essential science experiences" in those classes taught by teachers who have been educated to use traditional, textbook-centered science instruction procedures and those classes taught by teachers who have been educated in the SCIS, inquiry-discovery approach to science instruction.
2. There is no significant difference in the number of times pupils are presented with questions which demand use of higher cognitive powers to respond in those classes taught by teachers who have been educated to use traditional text-book centered science instruction procedures and those classes taught by teachers who have been educated in the SCIS, inquiry approach to science instruction.

In Wilson's study fifteen teachers who had been educated to teach by the SCIS, inquiry approach were selected to represent all grade levels from one to six.

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[19] Science Curriculum Improvement Study (SCIS), op. cit.

[20] Renner and Ragan, loc. cit.

[21] Wilson, op. cit., pp. 9-10.

These teachers were chosen by the director of the SCIS program from all of the SCIS-educated teachers in the Norman, Oklahoma, school system. A second group of fifteen teachers was selected by the director of elementary education for Norman's schools by choosing teachers who were teaching at the same grade level, with similar experience, and within the same building as those chosen for the SCIS group. This first group was called the SCIS group and the latter is called the traditional group. Two observations of a science lesson were scheduled exactly one week apart, at the time science was normally scheduled by each teacher. The teachers were requested to have as nearly normal a science lesson as possible.

Two instruments were used for the collection and recording of data taken from the observations. One of the instruments was designed for categorization of different science experiences encouraged by the teacher. The second instrument was designed for categorization of different types of questions posed by the teacher.

The composite of the tallies made under each category on the observation instruments was used in the statistical analysis of data. The composite figure compiled for each category of the SCIS-educated teachers groups was compared with the composite figure of its counterpart of the traditional science teachers group.

The Z-score for comparison of observed data was the statistical instrument used for analysis of data and the level of confidence for Z was set at 0.05.

In attempting to answer both of the hypotheses, Wilson used the Teacher Question Inventory of Harris and McIntyre.[22] The six types of questions used were:

1. Questions calling for recognition of correct option.
2. Questions recalling previous known facts.
3. Questions requiring demonstration of a skill.
4. Comprehension questions--those demonstrating understanding.
5. Questions requiring analysis.
6. Synthesis questions--those requiring reorganization of data.

The number of occurrences for each essential science experience was recorded; these were in turn converted to proportions of total. The same general procedure was applied to the teacher inventory questions. The proportions were then used to obtain Z-scores for the control and experimental groups which were then compared to the value of the 0.05 level of significance (Z = -.96). Wilson summarized his findings as follows:

1. For every category of the essential science-experiences inventory, a much larger number of

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[22]Harris and McIntyre, op. cit.

frequencies was recorded in favor of the SCIS-educated teachers. Respectively, the differences were: observation - 1.99 times; measurement - 7.45 times; experimentation - 1.88 times; interpretation of data - 2.12 times; and prediction - 5.80 times.

2. The total number of the essential science experiences provided for children by the SCIS-educated teachers was 1,474, or 2.15 times as many as the 685 frequencies for the traditional science teachers.

3. The questions considered lower level by Harris and McIntyre,[23] recognition and recall, were recorded a significantly larger proportion of times for the traditional science teachers group than for the SCIS-educated teachers.

4. The questions considered higher level by Harris and McIntyre,[24] analysis and synthesis, were recorded a significantly larger proportion of times for the SCIS-educated teachers group than for the traditional teachers group.

5. The demonstration-of-skill type of question was recorded a significantly higher proportion of times in favor of the SCIS-educated teachers.

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[23] Ibid.

[24] Ibid.

6. The comprehension type of question was recorded a significantly higher proportion of times in favor of the traditional teachers group.
7. The total number of questions asked by teachers educated in SCIS methods and materials was 1,416, or 1.49 times as many questions as the 955 asked by the traditional teachers group.

No other completed research was found which had a direct relationship to the proposed study. Several research studies having a tangential bearing on this research problem were reviewed and those reviews appear in the Appendix.

<u>Selection of Teachers for the Study</u>

Some members of the summer institute had already received varying amounts of exposure to "new science." This might have occurred through a previous institute, by attending in-service programs or by taking the elementary school science education courses offered at the University of Oklahoma. No teacher having any such familiarizing background was included in the study group. This group consisted of 21 teachers at the beginning of the study. During the course of the research 5 teachers were excluded for reasons such as leaving the system or not teaching both science and social studies. Complete data were available and collected upon 16 teachers.

Limitations of Study

Certain limitations were inherent to this study.

1. Number of teachers observed. Since the observations were performed in two stages, before and after the institute, the original number of teachers diminished before the second series of observations could be completed. An initial group of 21 teachers was observed prior to receiving the summer workshop training. Of this number, 16 comprised the terminal group.
2. Number of observations. Each teacher was observed once in science and once in social studies before participating in the summer institute, and with the same frequency and in the same subjects after the institute. Thus, this study is based upon four observations per teacher.
3. Recording classroom information. Perhaps due to previous unpleasant experiences with observers or possibly due to an unintentional lack of communication regarding the purposes of the observations, some teachers manifested a highly negative attitude during the state of initial observation. Consideration was given to the use of the tape recorder during the early planning stage, however, this was abandoned for the following reasons:

a. Use of a recording device might have aggravated the uneasy attitude held by some of the teachers and preclude establishing successful rapport at a later date.

b. An excess of superfluous data would have been accumulated such as instructions to students and their various responses to questions asked. In view of the foregoing and since the focus of observation was on instructional modes (student involvement versus student passivity) and the teachers' questions (fact-seeking versus thought-provoking), written recording procedures were used.

4. Behavioral research is seldom if ever entirely free from the subjective influences of the researcher. The present investigator has made every effort to obtain and interpret the observational data in as objective a manner as possible so as to minimize factors that would tend to predispose a conclusion not otherwise indicated by the data.

Rationale for Researching the Problem

The specific nature of a research problem delineates certain limitations while simultaneously defining the appropriate area for significant research. Notwithstanding the limitations surrounding this study, the problem was researched, since it is concerned with a fundamental activity of education--the education of teachers. Although the number of individuals comprising the population under study would be considered low for a statistical appraisal based upon a normal distribution curve, the number is well within the range of populations amenable to a non-parametric test such as the Wilcoxon Matched-Pairs Signed-Ranks Test.[25] This test considers both direction and magnitude of change and was used in this study as the major statistical tool.

The Hypothesis

The hypothesis in null form will be stated as follows: There will be no significant differences in instructional behavior patterns in science and social studies on the part of teachers after a summer's experience in an inquiry science education institute.

This study investigates both of the above questions by statistically evaluating the use of convergent and divergent questions, use of the rational powers,[26] use of the essential learning experiences as described by Renner,[27] and the interpretation of the several degrees of involvement as outlined by Karplus and Thier.[28]

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[25]Sidney Siegel, Non-Parametric Statistics For The Behavioral Sciences (New York: McGraw Hill Book Co., Inc., 1956), pp. 75-83.

[26]Educational Policies Commission, op. cit.

[27]Renner and Ragan, loc. cit.

[28]Karplus and Thier, op. cit., pp. 65-68.

CHAPTER II

DATA COLLECTION AND ANALYSIS

The Use of Statistical Tests

In any statistical test the level of significance must be considered. This is commonly known as the Alpha level. A parametric statistical test based upon the normal distribution curve would employ a predetermined level of significance. Generally, this is a value that has a small possibility of occurrence. In testing a theory, the investigator may construct a null hypothesis, sometimes called the hypothesis of no effect, and he concurrently formulates an alternate hypothesis. The null hypothesis postulates that there will be no detectable difference before and after a specific treatment as it is applied to a group of individuals. If test results indicate values of a probability equal to or less than the Alpha level, the investigator assumes that these are not the result of chance but rather the results of the particular treatment having been administered. He rejects the hypothesis of no effect and accepts the alternate hypothesis which is the operational statement of the research hypothesis. The level set for Alpha gives the probability of mistakenly rejecting the null hypothesis when it is in fact true. Such an event is called a Type I error. The higher the Alpha value the greater the probability of rejecting a true null hypothesis.

The other type of error in statistical research, the Type II error, consists of accepting the null hypothesis when it is false. The probability of this type of error is called Beta. Alpha and Beta are reciprocally related, in other words, the larger value of Alpha the smaller the value of Beta for any fixed population size. The reverse is of course also true. The above comments apply to both parametric and non-parametric statistical tests such as the Wilcoxon Matched-Pairs Signed-Ranks Test. In applying the test to this research problem a significance level of .10 has been decided upon in advance as the value of Alpha. Such a level of Alpha decreases the probability of committing a Type II error which would falsely imply that innovative educational experiences created no effect upon the behavioral pattern of teachers. Plainly, if no behavioral change could be realized on the part of participating teachers no purpose would be served by providing such experience and all existing programs would be mistakenly halted. This type of error would be educationally harmful to teachers, and subsequently to children.

Conversely, the Type I error would imply the desired outcomes had been secured when they had not. The result of this type error would be to continue the new programs, when, in fact, they are no better than the old ones; this type of error could consume funds unnecessarily. All statistical inference runs the risk of committing either of these errors; but in view of the consequences of each, the significance level of Alpha being equal to .10 seems a feasible compromise to balance the probabilities of making the two types of errors described.

Selection of an Appropriate Statistical Instrument

The Wilcoxon Matched-Pairs Signed-Ranks Test[29] is appropriate for statistical analysis of the obtained data. There are two reasons for this:

1. Unlike the Sign Test[30] which considers direction of change only, the Wilcoxon Matched-Pairs Signed-Ranks Test considers both direction and magnitude of change.
2. The test is designed to compare two matched groups or to compare the same group in a "before" and "after" situation.

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[29] Siegel, loc. cit.

[30] *Ibid.*, pp. 68-75.

An Example Demonstrating the Usefulness of the Wilcoxon Matched-Pairs Signed-Ranks Test to a Similar Research Problem

Siegel[31] explains how this test would be used in a specific situation. A child psychologist, for example, may have devised a test of social perceptiveness from which a score ranging from 0 to 100 is obtained for each child. Although the psychologist would not willingly say that a youngster having a score of 60 is twice as perceptive as a child having a score of 30, he nevertheless feels that it would be meaningful to rank the scores in order of absolute size. To test his theory, eight pairs of identical twins are obtained, one twin selected at random attends nursery school while the other remains home. At the end of the term all sixteen children are given the test of social perceptiveness.

1. Null Hypothesis. H_0: the social perceptiveness of "home" and "nursery school" children does not differ. In terms of the Wilcoxon test, the sum of the positive ranks = the sum of the negative ranks. H_1: the social perceptiveness of the two groups of children differs, i.e., the sum of the positive ranks $\neq$ the sum of the negative ranks.
2. Statistical Test. The Wilcoxon matched-pairs signed-ranks test is chosen because the study employs two related samples and it yields difference scores which may be ranked in order of absolute magnitude.
3. Significance Level. Let a = .05. N = the number of pairs (8) minus any pairs whose d is zero.
4. Sampling Distribution. Table G[32] gives critical values from the sampling distribution of T, for $N \leq 25$.

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[31] Ibid., pp. 77-79.

[32] Ibid., p. 254.

5. Rejection Region. Since the direction of the difference is not predicted, a two-tailed region of rejection is appropriate. The region of rejection consists of all values of T which are so small that the probability associated with their occurrence under H_0 is equal to or less than a = .05.
6. Decision. In this fictitious study, the 8 pairs of "home" and "nursery school" children are given the test in social perceptiveness after the latter have been in school for one term. Their scores are given in Table I.[33] The table shows that only 2 pairs of twins, c and g, showed differences in the direction of greater social perceptiveness in the "home" twin. And these difference scores are among the smallest; their ranks are 1 and 3.

The smaller of the sums of the like-signed ranks = 1 + 3 = 4 = T. Table G[34] shows that for N = 8, a T of 4 allows us to reject the null hypothesis at a = .05 for a two-tailed test. Therefore we reject H_0 in favor of H_1 in this fictitious study, concluding the nursery school experience does affect the social perceptiveness of children.

TABLE 1

SOCIAL PERCEPTIVENESS SCORES OF "NURSERY SCHOOL" AND "HOME" CHILDREN
(Artificial Data)

Pair	Social perceptiveness score of twin in nursery school	Social perceptiveness score of twin at home	d	Rank of d	Rank with less frequent sign
a	82	63	19	7	
b	69	42	27	8	
c	73	74	-1	-1	1
d	43	37	6	4	
e	58	51	7	5	
f	56	43	13	6	
g	76	80	-4	-3	3
h	65 [85]	82	3	2	
					T = 4

[33] Ibid., p. 79.

[34] Ibid., p. 254.

Procedure for Gathering Data through Observation

Referring to Table 2, "Classroom Tabulation Form," the level of activity was evident to the investigator upon visiting the classroom and was then recorded. The investigator (observer) then focused attention upon questions asked by the teacher, and upon situations tending to encourage use of the essential learning experiences and the rational powers. Classroom data were pencil and paper recorded and after class the incidence of each attribute was tabulated.

The information obtained through classroom observation has been considered with regard to four overall categories:

1. The levels of involvement, as delineated by Karplus,[35] describe classroom situations having increasing potential for development of both concepts and understanding of the structure of science in the learner. The levels are:

   a. Reading about or listening to the teacher talk about science.

   b. Discussing science with teacher or peers.

   c. Watch teacher perform demonstration.

   d. Direct involvement with science phenomena through individual observation, manipulation, and experimentation.

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[35]Karplus and Thier, loc. cit.

2. Situations involving use of the rational powers.[36] Starting with recall, the assumption was made that the following order represents one of increasing cognitive complexity: Recalling, imagining, classifying, generalizing, comparing, evaluating, analyzing, synthesizing, deducing, and inferring.
3. Situations involving the essential learning experiences[37] of observing, experimenting, measuring, interpreting, and predicting are likewise arranged in a hierarchy of increasing cognitive complexity.
4. Questions. Only questions of two distinct categories are of interest here. These are convergent and divergent questions.[38] A convergent question causes children to summarize and draw conclusions or it may be answered by recalling a specific fact. A divergent question may lead to another question or may provoke situations requiring experimentation or literary research.

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[36]Educational Policies Commission, loc. cit.

[37]Renner and Ragan, loc. cit.

[38]Karplus and Thier, op. cit., p. 86.

Selection of Data for Statistical Analysis

Referring to Table 2, "Classroom Data Tabulation Form" one can see that all the listed criteria for observation are not mutually exclusive; some listed operational practices describe traditional classroom situations, and increases of these would not represent an advance in innovative teaching. Rather, they would reflect an increased magnitude of the usual scheme of conventional teaching.

The four categories under "Degree of Involvement" are of qualitative interest only, and are not a part of the data receiving statistical treatment.

The quantitative phase of this study is based upon incidences of questions or other uses of the rational powers (exclusive of recall), the incidences of the essential learning experiences, and the use of divergent questions. Convergent questions, closely allied with and often indistinguishable from recall, were excluded; the reason for this exclusion is: The use of recall is inherent in all traditional teaching,[39] and the increased use of this lowest level rational power was not deemed a desired outcome. Consequently, the information collected on recall was not included with the data of the other rational powers used for statistical measurement. The reason for excluding recall and convergent questions is that they are the philosophical and psychological antithesis of the higher rational powers.

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[39]Renner and Ragan, op. cit., p. 52.

TABLE 2

CLASSROOM DATA TABULATION FORM

Teacher_____Grade_____Subject_____ Before After Institute

DEGREE OF INVOLVEMENT												
Listening or Reading												
Discussing												TOTAL
Watch Demonstration												
Direct Involvement												
RATIONAL POWERS (ASCENDING ORDER)												TOTAL
Recall												
Imagine												
Compare												
Classify												
Evaluate												
Generalize												
Analyze												
Synthesize												
Deduce												
Infer												
ESSENTIAL LEARNING EXPERIENCES												
Observe												
Experiment												
Measure												
Interpret												
Predict												
QUESTIONS												
Convergent												
Divergent												

Viewed in isolation, an increase in the incidences of the use of recall and convergent questions would represent a retrogression in classroom methodology and retreat in the quest for enlightened educational objectives. However, a statistically significant decrease in the use of these kinds of questions was interpreted within the scope of this study. Applying the term "favorable" or "desired" outcomes to the rational powers (excluding recall), the essential learning experiences and divergent questions allow concrete data to be collected and treated quantitatively. A statistically significant increase in those desired outcomes would allow rejection of the null hypothesis. Statistical decisions were made in the Science classes by:

1. considering the totals of desired outcomes under rational powers (excluding recall), the essential learning experiences, and divergent questions.
2. considering only the rational powers (excluding recall).
3. considering only the essential learning experiences.
4. considering only divergent questions.
5. considering decreased use of recall and convergent questions.

This identical procedure was applied to the data obtained from the classes in social studies. Accordingly, ten values demonstration, is of considerable interest. Referring to Table 3, the use of teacher demonstrations is tabulated. The total number of demonstrations performed by teachers before the institute was five (5) and the total number of demonstrations performed by teachers after the institute was six (6). Based upon this limited sampling, it seems that teachers had not altered their concept of the use of demonstrations to any marked degree. The last category, "Direct Involvement" has been pre-empted by the major category of "Essential Learning Experiences," and accordingly, no attempt was made to place any classroom activity under this heading.

Table 4 indicates totals of incidences of "Rational Powers" (except recall), "Essential Learning Experiences," and "Divergent Questions" both before and after the summer institute. These had previously been identified as desired outcomes, and earlier in this chapter a critical value for Z had been established as Z = 1.28. Values of Z equal to or greater than 1.28 mean that the null hypothesis may be rejected. From Table 4 the "T" value of 21.5 has been converted to a Z value of 3.7 by the use of the formula presented previously; therefore, since this Z score of 3.7 exceeds the critical value of 1.28, the null hypothesis may be rejected.

The component items entering into the aggregate totals of Table 4 have been analyzed separately to attempt demonstration, is of considerable interest. Referring to Table 3, the use of teacher demonstrations is tabulated. The total number of demonstrations performed by teachers before the institute was five (5) and the total number of demonstrations performed by teachers after the institute was six (6). Based upon this limited sampling, it seems that teachers had not altered their concept of the use of demonstrations to any marked degree. The last category, "Direct Involvement" has been pre-empted by the major category of "Essential Learning Experiences," and accordingly, no attempt was made to place any classroom activity under this heading.

Table 4 indicates totals of incidences of "Rational Powers" (except recall), "Essential Learning Experiences," and "Divergent Questions" both before and after the summer institute. These had previously been identified as desired outcomes, and earlier in this chapter a critical value for Z had been established as Z = 1.28. Values of Z equal to or greater than 1.28 mean that the null hypothesis may be rejected. From Table 4 the "T" value of 21.5 has been converted to a Z value of 3.7 by the use of the formula presented previously; therefore, since this Z score of 3.7 exceeds the critical value of 1.28, the null hypothesis may be rejected.

The component items entering into the aggregate totals of Table 4 have been analyzed separately to attempt

TABLE 3

DEGREE OF INVOLVEMENT

Criterion: Watching Demonstration (Science Classes)

Teacher	Incidence Before Institute	Incidence After Institute
A	0	1
B	0	0
C	0	0
D	0	2
E	0	1
F	0	0
G	0	1
H	0	0
I	1	0
J	0	0
K	0	0
L	0	0
M	0	0
N	4	0
O	0	1
P	0	0
TOTAL	5	6

TABLE 4

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SCIENCE CLASSES

Criteria: Total of Rational Powers (except recall), Essential Learning Experiences, and Divergent Questions

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	9	16	7	7.5	
B	3	16	16	13.0	
C	9	10	1	1.0	
D	8	24	16	13.0	
E	22	40	18	15.0	
F	16	14	-2	-2.5	2.5
G	11	14	3	4.0	
H	9	21	12	11.0	
I	2	11	9	10.0	
J	2	6	4	5.0	
K	13	11	-2	-2.5	2.5
L	17	33	16	13.0	
M	19	12	-7	-7.5	7.5
N	32	24	-8	-9.0	9.0
O	5	10	5	6.0	
P	18	18	0		
					Sum = 21.5 = T
					Z = 3.7

to determine the relative effect of each item. Referring to Table 5, the before and after incidence of the "Rational Powers" (excepting recall) have been evaluated statistically in the same manner that the totals had been evaluated. The result in this instance is a Z score of 3.6. This is greater than the critical value of 1.28 and, accordingly, the null hypothesis may be rejected. In Table 6 the "Essential Learning Experiences" have been likewise considered in isolation, and a Z value of 3.4 is obtained which is greater than the critical value of 1.28, thus allowing rejection of the null hypothesis.

The data in Table 7 allows the use of divergent questions to be evaluated. Once again the Z value of 1.68 is greater than the critical value of 1.28 thus permitting rejection of the null hypothesis.

Finally, Table 8 compares totals of recall and convergent questions. Since these kinds of questions were not identified as favored objectives, a decrease in the use of these questions might suggest a shift toward the set of desired outcomes. Looking at the raw scores first, the total of such questions for all teachers before the institute was 183, and 49 for all teachers after the institute. In terms of per cent, 79% of all questions of these kinds were asked before the institute and 21% of all recall and convergent questions were asked after the institute.

TABLE 5

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SCIENCE CLASSES

Criteria: Rational Powers (except recall)

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	1	5	4	6.5	
B	1	6	5	9.0	
C	5	5	0		
D	1	10	9	12.0	
E	9	14	5	9.0	
F	2	3	1	2.0	
G	3	2	-1	-2.0	2.0
H	3	8	5	9.0	
I	1	3	2	4.0	
J	0	1	1	2.0	
K	4	4	0		
L	10	7	-3	-5.0	5.0
M	15	3	-12	-13.0	13.0
N	16	9	-7	-11.0	11.0
O	1	7	6	10.0	
P	7	3	-4	-6.5	6.5
					Sum = 37.5 = T
					Z = 3.6

TABLE 6

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SCIENCE CLASSES

Criteria: Essential Learning Experiences

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	3	8	5	7.0	
B	0	10	10	14.0	
C	1	5	4	5.0	
D	4	10	6	10.0	
E	3	25	22	16.0	
F	10	5	-5	-7.0	7.0
G	7	10	3	3.5	
H	5	12	7	12.0	
I	1	9	8	13.0	
J	2	5	3	3.5	
K	8	7	-1	-1.5	1.5
L	7	23	16	15.0	
M	4	9	5	7.0	
N	9	15	6	10.0	
O	2	3	1	1.5	
P	9	15	6	10.0	
					Sum = 8.5 = T
					Z = 3.4

TABLE 7

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SCIENCE CLASSES

Criterion: Divergent Questions

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	4	3	-1	2.5	
B	2	0	-2	6.5	
C	3	0	-3	10.0	
D	3	0	-3	10.0	
E	10	1	-9	13.0	
F	4	6	2	6.5	6.5
G	1	2	1	2.5	2.5
H	0	1	1	2.5	2.5
I	0	0	0		
J	0	0	0		
K	1	0	-1	2.5	
L	0	3	3	10.0	10.0
M	0	0	0		
N	7	0	-7	12.0	
O	2	0	-2	6.5	
P	2	0	-2	6.5	
					Sum = 21.5 = T
					Z = 1.68

TABLE 8

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SCIENCE CLASSES

Criteria: Recall and Convergent Questions

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	18	3	15	14.0	
B	16	2	14	11.5	
C	10	0	10	8.5	
D	16	2	14	11.5	
E	30	3	27	16.0	
F	18	4	14	11.5	
G	25	3	22	15.0	
H	0	8	-8	-7.0	7.0
I	1	4	-3	-4.5	4.5
J	0	1	-1	-1.0	1.0
K	2	5	-3	-4.5	4.5
L	3	1	2	2.5	
M	6	4	2	2.5	
N	8	3	5	6.0	
O	12	2	10	8.5	
P	18	4	14	11.5	
TOTAL	183	49			Sum = 17.0 = T
					Z = 2.7
Per Cent of Total Questions	79%	21%			

By reversing the order of the before and after columns of data tabulation, the Wilcoxon test was used. The Z value of 2.7 is greater than the critical value of 1.28 allowing rejection of the null hypothesis.

Interpretation and Analysis of Data from Social Studies Classes

Table 9 indicates the total of all demonstrations performed by teachers before the institute was one (1), and the total of all demonstrations performed by teachers after the institute was also one (1).

Table 10 compares totals of "Rational Powers," "Essential Learning Experiences," and "Divergent Questions" for social studies classes before and after the institute. The Z score of 3.3 is greater than the critical value of 1.28, therefore the null hypothesis may be rejected.

Table 11 compares the use of the "Rational Powers" (except recall) in social studies classes before and after the institute. The Z score of 2.7 is greater than the critical value of 1.28 and the null hypothesis may be rejected.

Table 12 considers the "Essential Learning Experiences" in isolation; from the table a Z score of 3.1 allows rejection of the null hypothesis because it is greater than 1.28, the critical value.

Table 13 deals with the single effect of "Divergent Questions." The calculated Z score, 2.1 is greater than the critical value of 1.28, thus the null hypothesis may be rejected.

Table 14 compares totals of recall and convergent questions in social studies. As in science, a decrease in the use of these kinds of questions might suggest a shift in the direction of desired outcomes. The total of questions for all teachers before the institute was 276, and the total for all teachers after the institute is 208. Viewed as per cents, 57% of all questions of these kinds were asked before the institute and 43% of all recall and convergent questions were asked after the institute.

In Table 14 the before and after columns of data tabulation were reversed as in Table 8; by applying the Wilcoxon test a Z score of 1.4 is obtained. This exceeds the critical value of 1.28 and the null hypothesis is rejected.

TABLE 9

DEGREE OF INVOLVEMENT

Criterion: Watching Demonstration (Social Studies Classes)		
Teacher	Incidence Before Institute	Incidence After Institute
A	0	0
B	0	0
C	0	0
D	0	1
E	0	0
F	1	0
G	0	0
H	0	0
I	0	0
J	0	0
K	0	0
L	0	0
M	0	0
N	0	0
O	0	0
P	0	0
TOTALS	1	1

TABLE 10

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SOCIAL STUDIES CLASSES

Criteria: Total of Rational Powers (except recall), Essential Learning Experiences, and Divergent Questions

Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	3	13	10	11.0	
B	12	9	-3	-3.5	3.5
C	5	10	5	6.5	
D	1	18	17	15.0	
E	17	15	-2	-1.5	1.5
F	6	13	7	10.0	
G	1	5	4	5.0	
H	3	15	12	13.0	
I	5	18	13	14.0	
J	2	5	3	3.5	
K	9	15	6	8.5	
L	7	9	2	1.5	
M	1	34	33	16.0	
N	6	11	5	6.5	
O	4	10	6	8.5	
P	6	17	11	12.0	
					Sum = 5.0 = T
					Z = 3.25

TABLE 11

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SOCIAL STUDIES CLASSES

Criteria: Rational Powers (except recall)					
Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	0	1	3	2.0	
B	3	0	-3	-4.5	4.5
C	1	2	1	2.0	
D	0	4	4	8.0	
E	4	5	1	2.0	
F	0	4	4	8.0	
G	0	4	4	8.0	
H	0	4	4	8.0	
I	3	3	0		
J	0	0	0		
K	2	7	5	11.0	
L	1	1	0		
M	0	20	20	12.0	
N	3	7	4	8.0	
O	3	6	3	4.5	
P	0	0	0		
					Sum = 4.5 = T
					Z = 2.7

TABLE 12

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST FOR SOCIAL STUDIES CLASSES

Criteria: Essential Learning Experiences					
Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	3	6	3	7.0	
B	4	3	-1	-1.0	1.0
C	2	4	2	3.5	
D	1	5	4	9.0	
E	4	6	2	3.5	
F	1	4	3	7.0	
G	0	0	0		
H	0	6	6	10.0	
I	0	7	7	11.0	
J	1	3	2	3.5	
K	0	3	3	7.0	
L	3	5	2	3.5	
M	0	10	10	13.0	
N	2	2	0		
O	0	0	0		
P	3	11	8	12.0	

Sum = 1.0 = T

Z = 3.1

TABLE 13

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST FOR SOCIAL STUDIES CLASSES

Criterion: Divergent Questions					
Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	0	6	6	11.5	
B	5	6	1	2.0	
C	2	4	2	5.0	
D	0	9	9	13.0	
E	9	4	-5	-10.0	10.0
F	5	5	0		
G	1	1	0		
H	3	5	2	5.0	
I	2	8	6	11.5	
J	1	2	1	2.0	
K	7	5	-2	-5.0	5.0
L	3	3	0		
M	1	4	3	8.0	
N	1	2	1	2.0	
O	1	4	3	8.0	
P	3	6	3	8.0	
					Sum = 15.0 = T
					Z = 2.1

TABLE 14

WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST
FOR SOCIAL STUDIES CLASSES

Criteria: Recall and Convergent Questions					
Teacher	Incidence Before Institute	Incidence After Institute	D	Rank of D	Rank With Less Frequent Sign
A	15	19	-4	-1.0	1.0
B	35	7	28	16.0	
C	1	7	-6	-4.0	4.0
D	13	7	6	4.0	
E	9	14	-5	-2.0	2.0
F	29	13	16	13.0	
G	23	15	8	6.0	
H	5	30	-25	-15.0	15.0
I	19	10	9	8.0	
J	12	6	6	4.0	
K	20	11	9	8.0	
L	28	11	17	14.0	
M	29	15	14	11.0	
N	23	8	15	12.0	
O	6	15	-9	-8.0	8.0
P	9	20	-11	-10.0	10.0
TOTAL	276	208			Sum = 40.0 = T
					Z = 1.47
Per Cent of Total Questions	57%	43%			

CHAPTER III

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This research study was designed to investigate two problems. In the first of these, an investigation was made to determine if the instructional patterns of elementary teachers in science classes could be significantly altered after the experience of a summer institute in "new science." The direction of suggested modification was outlined by the objectives and philosophy of inquiry-centered science. The second problem investigated the possibility that social studies classes might be influenced in an analogous manner by the summer institute experience in "new science."

Initial selection of the teacher population for this study was made on the basis that no teacher having previous exposure to courses or institutes in "new science" would be included. Each teacher was observed before and after the institute experience in both science and social studies classes; a total of four observations per teacher were made.

Data from each observation were categorized and the before and after results were statistically evaluated using the Wilcoxon Matched-Pairs Signed-Ranks Test. The "T" scores from the Wilcoxon test results were converted to Z scores. The significance level of 0.10, which was established by considering the relative importance of Type I and Type II errors to this research, corresponds to a Z score of 1.28; all values of Z equal to or greater than 1.28 permitted rejection of the null hypothesis.

Conclusions From Science Classes

The results of data analysis and observations for science classes were interpreted in the following manner:

1. Considering the aggregate of "Rational Powers" (except recall), "Essential Learning Experiences," and "Divergent Questions" (Table 4), the conclusion is that teachers employed situations to engage students in these categories of activities to a statistically significant degree when the composite totals for the teachers' use of these three criteria before the summer institute were compared with the composite totals of teacher use of the same three criteria after the summer institute.
2. Regarding each of the foregoing categories separately, Table 5 for "Rational Powers" (except recall), Table 6 for "Essential Learning Experiences," and Table 7 for "Divergent Questions," the Z score based on the Wilcoxon test for each

of these categories is greater than the critical value, consequently the null hypothesis may be rejected in each case. In addition to rejection of the null hypothesis, the conclusion was that teachers can be re-educated to think and teach in a manner employing more use of rational powers, greater use of student involvement, increased use of divergent questions, and less use of the expository-recall pedagogy characteristic of most traditional classes.

3. Previously it was mentioned that a decrease in recall and convergent questions would represent a desired outcome. In Table 8 the incidences of questions after the institute are tabulated first, followed by the incidences of questions before the institute. The results from applying the Wilcoxon test indicate a Z score of 2.7 which permits rejection of the null hypothesis. Twenty-one per cent of the total number of questions were asked by teachers after the institute experience and seventy-nine per cent were asked by teachers before this experience. It is therefore concluded that teacher behavior can be modified by the previously mentioned educational experience to effect a statistically significant

decrease in questions based exclusively upon factual recall.

4. Table 3 shows incidences of demonstrations performed by teachers. From the low totals both before and after the institute experience, it is not possible to draw a conclusion.

Conclusions From Social Studies Classes

The data from social studies classes were analyzed in Tables 10 through 14 inclusive. In the statistical tests for both isolated and grouped criteria, the critical value ($Z = 1.28$) has been exceeded in all cases, thus making the null hypothesis untenable. The conclusions parallel those drawn for science classes; i.e., teacher behavior in social studies can be significantly modified by a summer educational experience in "new science."

The previous chapter indicated the totals of demonstrations performed by teachers. For all science classes, five were performed before the summer institute and six after. In all social studies classes, one was performed before the summer institute and one after. Due to the small number of observations in relation to this infrequent phenomenon, no conclusion is projected in terms of a before and after evaluation. The investigator believes, however, that the magnitudes of occurrences of demonstrations in science as compared to social studies (5:1) be interpreted as indicating either or both of the following conclusions:

1. There is less need for demonstrations in classes of social studies than in classes of science.
2. Demonstrations to illustrate concepts in social studies are much more difficult to construct than those designed to illustrate concepts in science.

Overall Conclusions From Science and Social Studies Classes

Modifying teacher instructional patterns in elementary science in accordance with objectives defined by the philosophical and operational goals of "new science" is possible. This change has been shown as statistically significant within the stated limits. There are two variables inherent in "new science" classes, namely, the methodology and the materials. These variables operate simultaneously. Which of them is the more responsible for the significant modification in the teaching patterns which were found?

The quantitative investigation of other disciplinary areas which use the "new science" methodology but not the materials should contribute to an understanding of the relative effects of the two component variables. The work of this investigator in social studies and the research of Porterfield in reading show that statistically significant modifications of teaching patterns consistent with the objectives and philosophy of inquiry can be obtained after teachers had received a specific educational experience.

This modification in teacher behavior occurs even though the participating teachers did not use materials in reading and social studies which had been specifically designed to provide inquiry-centered learning experiences. This finding allows the conclusion to be drawn that teachers who have acquired understanding of the inquiry teaching approach will implement it regardless of the availability of materials.

Recommendations and Suggestions For Further Research

Wilson researched problems dealing with the relationships between classroom behavior of teachers and instructional experiences in "new science" projects. His research centered upon "essential science experiences" and analytical thinking.[41] In a related manner, Porterfield investigated the use patterns of divergent questions in the teaching of reading on the part of teachers who had been instructed in the methodology of the Science Curriculum Improvement Study.[42] Both of the above efforts and the research of the present investigator concern the education of teachers. Programs of pre-service and in-service teacher education in inquiry science methodology should continue, and the scope of such courses should be amplified to show the wider application of inquiry to other disciplines. A significant educational experience for teachers and one having

[41]Wilson, op. cit.

[42]Porterfield, op. cit.

application to the entire subject spectrum would be one that focuses on generalized inquiry. A teacher with such a background could presumably apply the principles of inquiry to any discipline at any level, thereby increasing the utility of inquiry beyond classes in science.

Renner has alluded to a problem which, if investigated, might yield valuable educational insights. He states, "Although the data are not sufficient to warrant a general statement about the increase in vocabulary which investigative experiences in science at the kindergarten and early primary grades provide, there seems to be enough evidence to suggest that such learning experiences make an important contribution."[43]

Porterfield and the present writer have demonstrated that teachers who have been educated in the methodology of science inquiry can transfer the philosophical and operational principles of inquiry to the teaching of reading and social studies. Accordingly, additional investigations of concomitant effects in still other disciplines should go forward. If additional significant conclusions result from such studies the volume of accumulated research evidence would extend the rationale for teaching elementary-school science by the inquiry approach far beyond the scope of presently stated objectives[44] for science teaching.

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[43] Renner and Ragan, op. cit., p. 213.

[44] Ibid., pp. 54-55.

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APPENDIX

APPENDIX

This appendix contains a review of literature, most of which, while not directly bearing on the problem described, does have a parallel or analogous relationship. Whereas the dissertations of Wilson, Porterfield, and Kondo provided a connecting link with related research efforts, the other research contained in this appendix provided an intellectual and academic bridge with similar types of research problems.

Review of Related Research

Cogan, Morris L. "Research on the Behavior of Teachers: A New Phase," The Journal of Teacher Education, XIV (September, 1963), 238-243.

After noting the limitations of educational research for making inferences or predictions the author describes a paradigm for research on teacher behavior. The criterion measured is the amount of required self-initiated work on the part of students since this is closely related to learning. Teachers are classified in one of three categories in regard to relationships with students. Under the first, preclusive, the teacher's plans and actions mostly exclude the students' attitudes. The second, or inclusive, finds the teacher planning with students and making a substantial effort to show students why work is important to them. The third category, disjunctive-conjunctive, denotes a managerial attitude which can be helpful to students without generating either positive or negative emotional values.

Data obtained from surveying 987 pupils in five New England public schools indicated a greatest performance on required and self-initiated work under teachers seen as "inclusive"; least with teachers rated as "preclusive." The author concludes by reviewing some of the weaknesses of presently gathered classroom data. He sees video tape as the means to recreate the vitality of a classroom situation--both verbal and non-verbal. Being infinitely reviewable, video tape captures the intangible climate of a classroom which is almost always lost in conventional research.

Eccles, Priscilla J. "Teacher Behavior and Knowledge of Subject Matter in Sixth Grade Science," Journal of Research in Science Teaching, III (September, 1965), 345-347.

Thirty randomly-selected sixth grade teachers from the public schools of Calgary, Alberta, were given the Iowa Test of Educational Development, Test 2 (Natural Science). The author selected the five highest (mean score 53.8) and the five lowest (mean score 41.8) as two test groups. Eight ten-minute tapes were taken into each classroom and the groups were compared according to the following criteria:

1. Omitting science lessons
2. Errors in concepts
3. Use of technical terms
4. Use of teaching aids
5. Use of reference books
6. Total teacher conversation
7. Note copying by students
8. Use of demonstrations
9. Number of pupil comments
10. Proportion of teacher talk classified as direct or influence.

No significant difference was found between the two groups, although the more experienced teachers had a more polished style of presentation. These were highly traditional classes, however, since the author described the main function of teaching as information-giving.

Gage, N. L. "A Method for 'Improving' Teacher Behavior," The Journal of Teacher Education, XIV (September, 1963), 261-266.

This project can be classified broadly as an experiment in social perception. While attempting to avoid another correlational study the author sought several positive goals: to do an experiment where variables could be manipulated, to work with natural situations, and to conduct research which might improve teacher behavior.

Two groups of sixth grade teachers were used. Each group of teachers was evaluated by students using questionnaires. Feedback was immediate for the experimental group (N=86), but was delayed for the control group (N=90). The psychological theory behind the experiment was what Heider calls "imbalance." Thus the difference in views toward teacher's behavior as seen by himself and as seen by the students. When the teacher is aware of this difference, he will then make corrections to restore the imbalance. Results tended to confirm that teachers receiving feedback changed in the direction of student ideals more than those not receiving feedback.

Analysis of covariance was used to adjust for differences in initial ratings by pupils, the mean post-feedback ratings of the experimental and control groups were compared. In 10 out of 12 items the difference was in the hypothesized direction--teachers in the experimental group were rated closer to being ideal.

This study seems to imply that behavior can be changed through knowledge of feedback. This being so, the method could be extended to include other educational personnel, such as principals and supervisors.

Hayes, Robert B. "A Way to Measure Classroom Teaching Effectiveness," The Journal of Teacher Education, XIV (June, 1963), 168-176.

The author cites need for a satisfactory yardstick to measure effective teaching. He favors student evaluation because of the extensive contact between the student and the instructor. The ratings supplied by all students should be considered rather than just considering a few atypical ones. He proposes use of an unidimensional scalogram, an instrument reflecting student attitudes ranging from satisfactory to unsatisfactory and having a demonstrated accuracy of 90% in describing items reacted to favorably or unfavorably. Students can distinguish between effective and ineffective teaching as shown by a 1960 study of 660 male students at Pennsylvania State University. The best and poorest instructors were related in terms of 15 attributes plus 11 general items for cross-checking. The test items are listed and the statistical treatment is described (Cornell Scalogram).

Summarizing, the author feels students can supply valuable evidence as to the effectiveness of teachers because they are generally honest raters and seldom allow dislike of subject to color rating judgments. The author expresses cautious optimism about the possibility of developing a satisfactory teacher-rating yardstick. He suggests, however, this particular study be replicated not only on the college level but also on the high school level.

Kleinman, Gladys S. "Assessing Teaching Effectiveness: The State of the Art," Science Education, L (April, 1966), 234-238.

Numerous attempts to evaluate teachers' effectiveness are reviewed in this article and limitations of various techniques are cited. The author considers measurement of behavior by observation to be the most promising technique for evaluating teacher effectiveness. Several of the evaluative attempts referred to in this article are included earlier in this review.

Kleinman, Gladys S. "Progress Report of an Experimental In-Service Institute in Science for Elementary School Teachers of Grades K-6," Science Education, L (March, 1966), 136-140.

This in-service institute for elementary teachers consists of one semester of physical science and one of biological science. Besides enhancing subject competence, other stated objectives were: to acquaint teachers with experimentation, observation, prediction, and interpretation. Before starting the course, participants took the junior high version of TOUS (Test of Understanding Science). After thirteen 3 1/2-hour meetings the test was to be given again. Much of the instruction was done by high school teachers; the author notes the difficulty in deciding the precise make-up of the curriculum. In addition to the TOUS test another unspecified test was administered for diagnostic purposes.

No quantitative conclusions were stated, but qualitatively the author feels that elementary teachers are deficient in science but are eager to learn where the need can be shown to be relevant.

Medley, Donald M. "Experiences with the OScAR Technique," The Journal of Teacher Education, XIV (September, 1963), 267-273.

The use of OScAR technique (Observation Schedule and Record) is based on the assumption that the classroom is the best place to study the teaching-learning process. In applying this technique, no attempt is made at evaluating behavior; rather, the observer simply records it. Evaluation is postponed until the observational record is obtained.

The author describes two attempts at behavioral measurement. In the first, various criteria or "dimensions" are evaluated on a scale, for example, the way in which a teacher elicits responses from students might form such a scale. A number of these scales were developed empirically by noting which behaviors go together often enough to form a stable dimension. Each of 49 first-year teachers in grades 3-6 were observed for a total of 12 half-hour visits. Six observers were used and each teacher was visited twice. Composite data were treated by centroid factor analysis.[45]

In the second effort at measuring changes in student-teacher behavior, classroom activity was recorded by kinescope. Each student was filmed four times--twice during the first three weeks of practice and twice during the last three weeks. The OScAR evaluation used contained about 170 items. Each 25-minute film was divided into eight three

[45]Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), pp. 661-667.

minute segments; each segment was observed by three observers. After statistical treatment of existence of different variables could be observed: the greatest change was in the area of teacher role.

Some conclusions of the two studies:

1. No aspect of teacher behavior could be related to his ability to stimulate pupils to learn.

2. Supervisors' ratings of teacher effectiveness do not correlate with measurable effects the teacher may have on pupils.

3. Practice teaching has a significant effect on teachers.

4. Classroom teacher behavior can be measured objectively.

Popham, W. James. "An Experimental Attempt to Modify the Instructional Behavior of Student Teachers," The Journal of Teacher Education, XVI (December, 1965), 461-465.

The author prefaces this article with the observation that few studies have been conducted to determine the relationship between professional preparation and subsequent classroom performance. The subjects for this study were 50 UCLA graduate students engaged in secondary school teaching. The control group (N=28) was teaching their second semester and had received standard educational preparation. The experimental group (N=22) was in their first semester of teaching and had received a modified course that stressed fewer concepts but more instructional techniques and provided opportunity for reinforced practice. The 50 student teachers were evaluated by 12 doctoral candidates according to seve~ criteria taken from an instructional paradigm that was part of the modified curriculum to which the experimental group had been exposed. The directional research hypothesis posited was that the experimental group would use the instructional paradigm to a significantly greater extent than the control group. In rating teachers observers used a three-element scale ranging from A (teacher clearly not using) to C (teacher clearly using) with the intermediary value being B (teacher might be using). Each evaluation was weighed: A = 0, B = 1, C = 2. Thus a subject using no elements of the instructional paradigm would get a <u>0</u> score. The rating scores were tested by a pooled variance test and a significant difference was indicated. Both groups were given the concept mastery test and no significant difference was observed. Concluding, the author feels that educational preparation of teachers can make a significant change in classroom behavior.

Ryans, David G. "Teacher Behavior Theory and Research: Implications for Teacher Education," <u>The Journal of Teacher Education</u>, XIV (September, 1963), 274-293.

The inspiration for this article stems from <u>The Teacher Characteristic Study</u>--an eight-year investigation containing over one hundred separate but integrated research efforts.[46] Teacher behavior falls within five categories: 1) motivating--reinforcing; 2) presenting--explaining--demonstrating; 3) organizing--planning--managing; 4) evaluating; 5) counseling--advising. Teacher behavior is seen as information processing and the teacher is seen as an information system in view of this author. The functions of teachers are analyzed in the light of systems theory, which in simplest form assumes input, mediation, and output. Information or communication proceeds among the different elements (teachers and students), and is characterized by a high level of feedback.

Some important research findings about teachers' behavior:

1. Problems of semantics--trait names are not operationally defined.

2. Classes of items for content analysis are overlapping.

3. Specific items show varying degrees of concurrence among researchers.

In conclusion, the author points up some limitations to teacher behavior research:

1. Teachers in differing context (different classes, different social settings) may alter their teaching

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[46]D. G. Ryans, Characteristics of Teachers (Washington: American Council on Education, 1960).

methods and accordingly their current position on a rating scale.

2. Study findings are true only in an actuarial sense: application to specific individuals is therefore invalid.

3. Effective teaching techniques are highly variable by grade levels.

4. Survey results are descriptive only and do not imply causality.

Smith, B. Othanel. "A Conceptual Analysis of Instructional Behavior," The Journal of Teacher Education, XIV (September, 1963), 294-298.

Teaching includes all classroom activities, whereas instruction is a more limited concept. Three current theories of instruction are recognized. The first is a stimulus-response situation where reinforcement is applied at the proper instant. The writer characterizes this as a confining and restricting view, inasmuch as classroom behavior is too varied and complex to be forced into such a narrow format. The second is the interaction theory whereby students cooperatively work out unsettled but challenging situations. The hard facts of subject matter are taken from references and introduced into the situation by students themselves. The writer contends that rigor of a subject is inversely related to student involvement. The third is the eclectic theory wherein discrete items are borrowed from various sources and synthesized according to individual preferences.

In the writer's theory of instruction all teaching acts are categorized as either observing (student behavior), diagnosing (an inaccurate answer) or acting (suggesting alternative ways of thinking). The nature of the subject at hand determines to a large degree the methodology of teaching. Classroom instructional activity can be analyzed into various units of verbal behavior which can then be classified into logical categories.

Thier, Herbert D. "The Role of the Elementary School Teacher in Relation to the Curriculum Reform Movement," Science Education, LI (April, 1967), 282-286.

Thier contends the major need in the preparation of elementary teachers is not additional subject matter courses but a continuous program of working with pupils. The key role for teachers is that of interaction with children; understanding can come from working actively with them (and not merely being a classroom observer). The author suggests that student teachers replicate some of the experiments of Piaget, Smedlund and Almy. Noting that teachers' instruction patterns are similar to their own patterns of previous learning, the author feels that with a background of direct involvement with students teachers will adapt more readily to curricular innovations. The practitioner in any discipline must decide its structure, then the science education specialist must translate elements of the discipline into a curricular matrix. However, the final relationship between pupil and subject is determined by the teacher who has, hopefully, a broad knowledge of the child and how he learns.

Completed Doctoral Dissertations

Paul Raymond Drumm. "A Study of Structurally Different Inferential Questions in the Comprehension of Natural Science Reading Material at the Junior High School Level." Unpublished Ed.D. dissertation, Temple University, 1965.

The purpose of this study was to increase the useful knowledge about developing and testing inferential thinking as an aspect of reading by determining the degree to which certain forms of test items were similar in kind and in difficulty. The test items constituted an experimental test of inferential thinking in reading. They were constructed and categorized as aspects of the inductive-deductive process as it may be used to infer knowledge of sense reality from stated information.

The author-constructed experimental test contained five primary categories of sixteen test items each. The categories, founded upon differences in the forms of the items, were labeled Identify the Most Suitable Generalization, Select and Write Information to Support a Generalization, Write the Most Suitable Generalization About a Designated Term, Write the Implied Deduction About a Designated Term, and Select and Write the Information Which Implies a Given Deduction. Composite categories were formed by combining appropriate primary item categories into Aspects of Generalization, Aspects of Deduction, Write the Implied Conclusion About a Designated Term, Write Given Information Supporting a Conclusion, and Total Experimental Test.

The 386 seventh and eighth grade pupils, aged twelve to fifteen years, who completed the eighty test items had received a grade score of at least 8.0 in general reading comprehension as measured by a standardized test.

The reliability coefficient of the experimental test was .88. Item-test correlation coefficients for all but four test items were significant at the .01 confidence level. Items classified as Write Given Information to Support a Conclusion tended to have the highest item-test correlation coefficients and to be above the median in difficulty.

The interrelationships among the composite test item categories indicate that either the classes of items considered to be Aspects of Induction or the classes of items considered to be Aspects of Deduction were dependably related to the Total Experimental Test. Interrelationships among the remaining composite item categories and between the composite item categories and the primary item categories were substantial to high. Interrelationships among the primary irreducible test item groups ranged from definite but low to substantial.

The ascending order of difficulty among the test item categories is as follows: State the Implied Deduction About a Given Term, Identify the Most Suitable Generalization, State the Most Suitable Generalization About a Designated Term, and the composite item category, Select and Write Given Information to Support a Conclusion. Differences in difficulty among these categories are significant at the .001 level of confidence.

The multiple choice test item, Select the Most Suitable Generalization, was as adequate for measuring inferential thinking in reading in the experimental test as any other question form. The test did not measure ability to infer information without the aid of clues beyond the bare information.

Capability in answering one form of question did not, however, indicate equal competence in making inferences when the problem was in a different form.

Louise Lance Gold. "Verbal Interaction Patterns in the Classrooms of Selected Science Teachers." Unpublished Ph.D. dissertation, The Ohio State University, 1966.

This investigation was one of two parallel studies designed to reveal whether differences existed in the verbal behavior of selected groups of science teachers. This abstract reports only the results of an investigation of the verbal patterns in the classrooms of biology teachers.

From an original population of twenty-nine biology teachers who taught in high schools located in the areas of Dayton and Columbus, Ohio, a sample of five effective and five less effective biology teachers was selected. In this study an effective teacher was defined operationally as one who had scored relatively high on the three selecting instruments. A less effective teacher was defined as one who had scored relatively low on the three selecting instruments. A brief explanation of the three selecting instruments follows.

The Teacher Rating Scale, designed by Stanley Williamson, Oregon State University, was completed by each high school principal. It was used to evaluate the participating biology teacher's attitude toward school and his or her personal adjustment. The Student Opinion Questionnaire, devised by Roy C. Bryan, Western Michigan University, was completed by the pupils of a particular section as a means of evaluating the participating biology teacher. The Teaching Situation Reaction Test was completed by each participating biology teacher. This last instrument was designed by John B. Hough and James K. Duncan, who are both presently affiliated with the Ohio State University, to measure dogmatism, ability in the area of human relations, and the direct or indirect structure used in the classroom.

The class designated by each biology teacher selected in the final sample was visited six times within a six-week period by the investigator of this study. During these visits the verbal interaction was classified by a sixteen-category system devised by John Hough. These data were plotted in matrices as outlined in Interaction Analysis as developed by Ned A. Flanders of the University of Michigan.

The data were analyzed to find support for the following hypotheses: It was hypothesized that there was a significant difference in--1. The percentage of classroom time spent in categories of classroom behavior. Each of the sixteen categories was compared independently. 2. The ratio of the total indirect to direct teacher influence. 3. The ratio of indirect to direct influence with respect to pupil orientation. 4. The ratio of total direct teacher influence to total student talk. 5. The ratio of sustained classroom behavior to transitional classroom behavior for each category. 6. The total interaction patterns of all sixteen categories.

The t-test was used to test for differences at the .05 level of significance to support the first five hypotheses. The Darwin Chi-square test was utilized to test for evidence supporting the last hypothesis.

The following conclusions were drawn from the data analyzed:

1. The percentage of classroom time spent in the

sixteen categories of classroom behavior did not differ significantly for the two groups.

2. Among the biology teachers studied, the effective ones did not have ratios of direct to indirect teacher influence that differed significantly from the less effective ones.

3. The classroom behavior of the two groups studied did not differ in the ratios of indirect to direct teacher influence regarding student orientation, of total teacher influence to total student talk, and of sustained to transitional categories.

4. Although a difference well beyond the .01 level of significance indicated that the over-all patterns of classroom behavior for the two groups were not the same, a statistical check of each individual cell did not reveal one that was significant at the .05 level.

Allan Kiichi Kondo. "A Study of the Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching the Unit on Material Objects." Unpublished Ed.D. dissertation, Columbia University, 1968.

The purpose of this project was to study the questioning behavior of teachers in the Science Curriculum Improvement Study (SCIS), and the possible relationship between their questioning behavior and the different types of lessons: 1. Invention lessons in which teachers introduce a concept to children, and 2. Discovery lessons in which children apply the concept to new situations.

The same sequence of four lessons, two Invention and two Discovery, in the SCIS unit on Material Objects, was tape recorded for four first-grade teachers in the same school. The transcripts of the tapes were analyzed in terms of 1. the complexity of their questioning behavior using question-response-comment units called <u>incidents</u>, 2. the question types (Routine, Cognitive-Memory, Convergent, Evaluative, and Divergent), 3. teacher reaction to responses or to her own questions, and 4. the transition probabilities of one question type followed by the same or other types.

The analyses of the questioning behavior of the four teachers in the SCIS revealed the following results:

1. Overall, there was a fairly consistent pattern of questioning by the four teachers across the four lessons. The most complex lesson was Lesson 20 (Invention of the Comparison of Objects Using Signs).

2. Differences in the complexity of questioning patterns were more striking when individual teachers were compared. Certain teachers had a more complex pattern than others.

3. On the average, the percentages of Routine and Cognitive-Memory questions across lessons seemed to be influenced by the lesson being taught, but not by whether the lesson was an Invention or a Discovery lesson <u>per se</u>. The way the lesson was approached--i.e., teacher demonstration,

children handling materials, etc., seemed to have a greater influence. When the lesson was largely handled through a demonstration, the percentages of Routine questions were relatively low and the percentages of Cognitive-Memory questions were relatively high.

4. There was a fairly uniform percentage of Convergent questions across all lessons, about one-half of all questions asked being Convergent.

5. The relative frequencies of Evaluative questions were low in all lessons.

6. While there were low percentages of Divergent questions over-all across the lessons, the Invention lessons (Lessons 20 and 21a) produced the highest percentages.

7. In general, it is suggested from the data that the way the lesson is approached has a greater influence on the types of questions asked than the type of lesson _per se_.

8. In most cases, the differences of question types among individual teachers were more striking than the averages across lessons. This points out the importance of the individual teacher's style in the types of questions she asks.

9. In terms of the teacher reactions to children's responses and to her own questions, the most pronounced differences across lessons were found in Lessons 20 (Invention) and 22 (Discovery) on the one hand, and Lessons 21a (Invention) and 21b (Discovery) on the other. The percentages in

categories of Repetition of responses and Question following question were higher in the first pair mentioned than in the second. Again, vast differences were found between individual teachers. This revealed the characteristic ways in which different teachers react to children's responses and to her own questions.

10. One type of question tends to be followed by questions of the same type to a greater extent than would be indicated by the overall distribution.

The information gained in this study might be used in the consideration of teaching strategies, curriculum modification, and teacher education.

Denzil Ray Porterfield. "Influence of Preparation in Science Improvement Study on Question Behavior of Selected Second and Fourth Grade Reading Teachers." Unpublished Ed.D. dissertation, the University of Oklahoma, 1969.

Purpose of the Study:

This study was conducted to determine whether differences exist between the types of questions asked while teaching reading by teachers educated in the Science Curriculum Improvement Study (SCIS), inquiry-discovery method of science instruction and teachers of reading not so educated.

Procedures:

Eight second and eight fourth grade reading teachers who had been instructed to teach by the SCIS, inquiry-discovery approach to science instruction were selected. Eight second and eight fourth grade reading teachers who had received no instruction in any of the "new" inquiry-discovery approaches to science instruction were also selected. The two groups of teachers were similar in terms of years of teaching experience, level of educational attainment, and age. Data were collected with a tape recorder from two complete reading lessons for each reading group within each of the thirty-two classrooms. Transcriptions of these lessons were used to classify each question into one of nine categories of an adapted form of the Teacher-Question Inventory by Harris and McIntyre. For each group of teachers, composite tabulations for each question category were determined and converted into proportions. Statistical analyses using the normal standardized Z score were used to determine whether differences in observed proportions existed.

Findings of the Study:

Recognition and recall questions were used significantly more by both second and fourth grade non-SCIS educated reading teachers. Translation, interpretation, analysis, synthesis, and attitude or value questions were used significantly more by both second and fourth grade SCIS-educated reading teachers. Opinion questions were used significantly more by second grade reading teachers. For questions categorized demonstration of skills, the results indicated no significant difference between the SCIS and non-SCIS-educated teachers. Recall questions were used more than any other type of question in all teacher groups. Recall questions accounted for thirty-four per cent of the questions asked by the SCIS-educated teachers and forty-four per cent of the questions asked by the non-SCIS educated teachers.

Conclusions:

The null hypothesis of no significant difference between the questioning behavior of SCIS-educated and non-SCIS educated reading teachers was rejected as untenable, since twenty-three of the twenty-seven comparisons revealed differences significant to the 0.05 level of confidence. SCIS-educated second and fourth grade teachers asked greater proportions of questions which called for higher levels of thought than teachers in the study not so instructed. This may, in part at least, be attributable to the methodology used in the inquiry-discovery science instruction. One may assume that teachers transferred the theoretical and practical use of questions and questioning learned in the science course into the area of reading instruction.

Dennis Burton Redburn. "A Follow-up Study of National Science Foundation Institute Participants at East Texas State University." Unpublished Ph.D. dissertation, East Texas State University, 1966.

The purpose of this study was to follow-up the biology teaching participants in the National Science

Foundation Sequential In-Service Institutes conducted at East Texas State University during the fall and spring of 1962-63, 1963-64, and 1964-65. It was designed to determine the effects of the institutes on the participating teachers in the four following areas:

1. The status or nature of the participants upon entrance to the institutes in relation to their background training, placement, occupational duties and scientific activities.

2. The changes the participants had made in this status since institute attendance.

3. An evaluation of the institute sequence based upon twenty National Science Foundation Institute objectives and a used/learned coefficient of effect for each of the concepts or topics taught in the institute sequence.

4. Suggestions for improvement in meeting the needs of biology teachers in future institutes.

The descriptive survey technique of structures interviews was used to obtain data from the fifty participants who represented 67.5 per cent of the participants in the institute sequence. This interview provided the medium by which the participants could relate their status upon entrance (background, occupational information, science activities); state changes in this status after institute completion; give a general evaluation of the institutes and evidence of concepts learned in the institute and used in the classroom; and offer suggestions for future institutes.

Statistical analysis was made of the data obtained in the structured interviews and was presented in appropriate tables. The value of the institutes in the opinions of the participants was computed from the ratio of institute concepts learned and used, yielding a coefficient of effect. Percentage item analysis was also made for each concept taught in the institute sequence with respect to selected learned/used variables.

The findings based on the data analyzed were:

1. The participants entering the institutes were basically two groups, one, young inexperienced teachers with few graduate hours who were working toward advanced degrees, and, two older professionally mature teachers who were seeking to update themselves and gain depth in the latest biological subject matter.

2. Most of the entering participants taught in secondary schools having more than 215 students.

3. More than one-half of the entering participants were prepared in teaching fields other than biology and were devoting time to classes and duties in addition to their biology teaching assignment.

4. Nearly three-fourths of the entering participants rated their own general knowledge and course subject matter in biology as being only fair or poor.

5. Forty-two per cent of all degrees presently held by participants were indicated as a result of institute attendance. Seventy per cent of the participants now hold a master's degree.

6. The participants felt that the institutes were successful in broadening and deepening their biological science training.

7. There were trends toward increased biological science specialization, continuation of graduate study, increased specialization in teaching exclusively biology, and increased science activity and periodical use as a result of institute attendance.

Major Conclusions:

1. The in-service institute program at East Texas State University made a major contribution to the training of on-the-job biology teachers and should be expanded.

2. Most of the concepts learned in this particular institute were used extensively by the participants in their own teaching experiences.

3. The participants rated this institute sequence highly successful in meeting the objectives of the National Science Foundation and the participants' individual teaching needs.

4. The major suggestions for improvement emphasized the fact that participants need more practical information which could be of use to them in their own teaching situation.