A STUDY OF TEACHER-PUPIL AND PUPIL-PUPIL INTERACTIONAL DIFFERENCES BETWEEN INQUIRY CENTERED SCIENCE AND TRADITIONAL SCIENCE IN ELEMENTARY SCHOOLS

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PREFACE

The work reported in this investigation was performed in nine elementary schools in Oklahoma. The primary objective of this study was to determine teacher-pupil and pupil-pupil interactional differences between elementary school science classes being taught by the Inquiry Centered Learning method and traditional methods of teaching scientific laws and facts. The writer is grateful for the excellent cooperation of the schools throughout the period of this investigation.

I am especially grateful to Dr. Kenneth E. Wiggins, chairman of the doctoral committee, for his helpful criticism and continuing encouragement. I am also indebted to Drs. Sue Hawkins, Gladys Means and L. Herbert Bruneau, who served on the doctoral committee. Special thanks are extended to Dr. Russell L. Dobson, a member of the doctoral committee and thesis adviser, for his advice and encouragement which made this study possible.

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CHAPTER I

INTRODUCTION

One of the major problems of education today, and for many years past, is the effective management of the teaching-learning process. Concern about the teaching-learning process has been the motivation for numerous studies. The complexities of the teaching act do not lend themselves to simple solutions. Campbell and Barnes (18) implied that only by isolating one or more productive micro-elements of the complex instructional process can one limit the number of variables to a manageable number which can be measured in some fashion.

One method used in the past for evaluation of teacher behavior was noted by Domas and Tiedman (23) in a study pointing out that research in this area was based on judgment, the judgment of pupils, teachers or supervisors. That this method is still in use today is illustrated by the work of Davis (22) who reported on current practices in evaluating teacher competence. Researchers today utilize rating scales, questionnaires, and tests along with instruments of prediction which fall into this general category. In any event, many approaches have been used for the evaluation of the teaching-learning process. Studies have been made which dealt with teacher personality characteristics, student achievement and the use of many tests, but only in recent years have there been any studies of interaction in the classroom where the teaching-learning process occurs. The idea of using teacher-pupil

interaction as a basis for evaluation is a newer concept. The need for more studies in this area was indicated by Smith (50) when he stated:

> Perhaps a new approach to the study of teaching will emerge if we abandon the term "method" which is associated with such heavy-laden terms as "inductive," "deduction," and "problem solving," terms for which everyone has his own preconceptions and predilections. If we cut through the verbal curtain and look at actual instructional operations in the classroom, we find them to be different from what our linguistic commitments lead us to believe. We see that teachers do many things which cannot be neatly fitted into traditional theories or pedagogy.

The currently emphasized science method, Inquiry Centered Learning Science Programs, employs the ideas of "deductive," "inductive," and "problem solving" as part of the instructional strategy. Developed around the idea that the child plays the role of the inventor or discoverer, the discovery may not be seen as a breakthrough for the scientific world but it is new information and knowledge to the student making the discovery. The knowledge is discovered by the child, not told him by the teacher; it is not so much the facts that the child, finds but the method which he uses to obtain them. The educational aim of the discovery science program is that the method by which the child learns is more important than the facts he finds or learns. It is speculated that the method he develops in his learning by discovery will have a carryover as he develops an understanding of how to inquire and make a discovery. The Oklahoma Curriculum Improvement Commission (40) stated:

> Science is a natural vehicle with which to develop a child's ability to think objectively. In order to accomplish this goal, however, the emphasis in science teaching must shift from the teaching of "facts" to the development of a child's ability to observe carefully, collect information, and draw logical inferences. In other words the child acquires his scientific information, only through his own power of observation and inductive inference. The process, therefore, of arriving at an item of scientific information becomes more

> important than the information obtained. If such logical philosophy is adopted, the actual objects used in making critical observations and drawing inferences are not important. These objects can be buttons, rocks, plants, animals, or any convenient and available item.

Changes in the science program may bring changes in the teacher-learning process in other parts of the educational program by the emphasis being placed on method of learning rather than on facts or content.

The work in interaction analysis has grown rapidly from the late 1930's when H. H. Anderson (5) began a study to analyze teacher behavior. Since that time, it has focused in varied directions. Studies have been directed toward the analysis of teacher behavior, conceptions that students held of teachers, social-emotional climate and group problem solving. Simon and Boyer (49) stated that classroom verbal interaction is a complex process and no one category system measures all of the important aspects of teacher-pupil interaction. Each system represents those dimensions which are important to the person who created the system.

Amidon and Hough (2) indicated that the recently developed system for analyzing the instructional process, interaction analysis, is the one that is currently best known and most widely used. The literature in the area of teacher-pupil interaction reflects that the process of measuring classroom behavior through observation is the most obvious approach to research on teaching.

Justification of the Study

This research was an attempt to determine teacher-pupil and pupil-pupil interactional differences, if any, between Inquiry Centered

Learning Science Programs and traditional science programs at the elementary school level.

Within the last ten years the basic characteristics of the concepts of learning have been undergoing changes which have affected the methods of teaching in many areas. Research is now being done in all areas of curricula to determine which procedure is most applicable to the promotion of learning in children.

Victor and Lerner (53) when discussing the process of inquiry stated:

> The two major objectives of science education are to help the child develop (1) knowledge of science concepts--the content of science--and (2) facility in scientific skills and attitudes--the processes of science and scientific inquiry. These objectives are essentially the same in the elementary and the secondary school, the only difference being in how much and how well these objectives will be developed.

The following are the key processes that should be used in the development of elementary programs as seen by Victor and Lerner (53):

> . . . ,observation, analysis, classification, description, interpretation, inference, deduction, hypothesis, prediction, planning, experimentation, measurement, use of controls and communication. Thus, concerted efforts are being made to bring the spirit as well as the substance of science into the classroom.
>
> New knowledge of the ways children discover and learn, together with a re-discovery of psychological principles that had almost disappeared from view, are helping us decide the kind and amount of science that children should learn....
>
> This enthusiasm about the process approach to learning science has become so great that the pendulum is swinging the other way, and process is beginning to be emphasized at the expense of content.

Inquiry science makes use of experimental learning or discovery. Rogers (44) said that a student learning by this approach learns what he needs and wants. This method makes science relevant to the student. It has personal involvment and the elements of meaning to the learner

are built into the whole experience. Bruner (14) supports this view when he said the student should not be a bench-bound listener but should take an active part in the experience. The inquiry approach is used since it incorporates the student into active participation in contrast to the traditional science in which the student is a listener and reader but not an active participant.

The theory that children learn more readily when they are free of a threatening situation is being accepted. For the child to learn at his own rate, since we now accept that each individual has distinct differences and experiences, we must provide a system which recognizes these differences within the classroom and allows for individual growth. The freedom to ask questions or discuss information with the teacher or other students may be one course of encouraging learning. Some teaching methods foster free interaction between teacher and pupil or between pupil and pupil. The introduction of a new teaching method for the presentation of science materials would seem to suggest an analysis to determine if the method permits a flow of classroom interaction that is significantly greater than that encouraged by traditional instructional technique. This research is based on the following premises:

1. Research in classroom teaching calls for criteria expressed in terms of measurable dimensions of behavior.
2. The complexity to transactions in the classroom calls for an analysis of the observable dimensions of the process, using information gathered in the classroom as the events occur.

This study was concerned with the two statements above and with the use of these measurable dimensions to determine whether differences

in interaction patterns existed between two types of elementary school science programs and to determine whether further study was indicated.

Statement of the Problem

The purpose of this study was to determine teacher-pupil and pupil-pupil interactional differences, if any, between elementary school science classes being taught by the Inquiry Centered Learning method and the traditional methods of teaching scientific laws or facts.

Answers to the following question were sought: (1) Do elementary school students who are taught using the Inquiry Centered approach have more teacher-pupil interaction than those of the traditional approach? (2) Is there more pupil-pupil interaction in the Inquiry Centered approach as compared to the traditional method?

Basic Hypothesis

This study proposes to establish a basis for the testing of the following null hypotheses: (1) There is no significant difference in the amount of teacher-pupil interaction in elementary science classes taught by the Inquiry Centered method and the traditional science method. (2) There is no significant difference in the amount of pupil-pupil interaction in the elementary science classes taught by the Inquiry Centered method or the traditional science method.

Definition of Terms

For the purposes of this study the following definitions were used:

Inquiry Centered Learning Process.--A process whereby the pupil

must make observations, do the experiments, interpret data, and draw his own conclusions. The emphasis is on the process of discovery rather than the information resulting from the process.

Traditional Science Method.--A process which used lectures and assignments involving memorizing and applying of the so-called "scientific laws and facts."

Teacher-Pupil Interaction.--The flow of conversation, questions, answers and comments between the teacher and pupils.

Pupil-Pupil Interaction.--The flow of conversation, questions, answers and comments of pupil with other pupils.

Major Assumptions

For the purposes of this study the following assumptions have applied:

1. That the "Classroom Interaction Management Analysis Record" as designed by Schusler (46) has provided a valid method of categorizing interaction in the classroom.

2. That teachers monopolize the talking in class. Most of the classroom time is spent listening to the teacher.

3. That questions asked by the teacher of the students tend to have factual answers.

4. That work done in class is done as a class, not on individual levels or by small groups.

5. The activities of the observer in the class did not appreciably alter the patterns of teacher-pupil or pupil-pupil interaction at that time.

Procedures and Analysis of Data

The purpose of this study was to examine differences in the interaction patterns of the Inquiry Centered Learning Science Program as compared to the traditional science program. Observation and categorization of teacher-pupil and pupil-pupil interaction as it occurred in the classroom was used to indicate these differences. For the purpose of this study the following delimitations have applied:

1. This study involved eighteen classes of boys and girls enrolled in the fourth and fifth grades in the public schools. A traditional science program was used in nine of the classes whereas the remaining nine received instruction in the Inquiry Centered Learning Science Program.

2. The evaluation of differences in patterns of interaction were limited to differences of observable, recorded action between those classes observed.

3. The conclusions from the results of this study were limited to specific statements concerning the differences in patterns as shown by the data of this particular study, performed under the conditions existing at the time of the study. No attempt was made to draw conclusions as to the causal factors contributing to the interaction patterns that resulted from the study.

4. The classes observed were not studied during periods subject to the following conditions:

   (a) On the first or last day of the week.

   (b) During a class period which was being used as a testing session.

(c) During a class period which was used as a review by the teacher.

(d) At the same time of day as the previous observation unless the teacher's daily schedule rigidly required that she hold the science class the same time each day.

(e) Immediately prior to or following a school holiday, all school activity, school assembly, or school contest.

Data and Instrumentation

The procedure used in conducting this study was as follows:

1. An observation guide for measurement of the interaction in the classroom as it occurred was selected.

2. Schools and teachers whose classrooms would be observed were selected and notified.

3. The observational guide was used to record the interaction as it occurred during classroom visits.

4. Teacher-pupil and pupil-pupil interaction was recorded as it occurred by a cassette tape recorder.

5. Evaluation of the recorded tape of the actual observation was used to validate the observation tally.

6. Each classroom was revisited for observation and recording teacher-pupil interaction.

7. Preparation of the report of the information gathered.

Selection of the observation guide. The selection of an observation instrument was simplified when it was discovered that an instrument which would adequately fulfill one of the purposes of this study had been devised by Schusler (46). "The Classroom Interaction Management

Analysis Record" (CIMAR) is an instrument devised for observational use in the classroom. It utilizes categories related to persons and content of classroom discussion. By the use of this system, an observer can reliably separate these components from interaction syndrome.

The CIMAR is in two parts, part one is the score sheet used to report the interactions. The observations are done in series of five three minute observations per sheet. Part two is the CIMAR Matrix Interaction Categories.

The CIMAR gives an accurate record of the amount, kind and direction of verbal interaction and is adaptable to teacher-directed, pupil-directed and small group activities in a regular classroom. Perhaps, the strongest point of the instrument is that pupil interaction is described in the same detail as teacher interaction.

Selection and notification of schools and teachers. The school systems chosen to participate in this study were presenting two different methods of elementary science in the school curriculum, the inquiry centered science program and the traditional science program on either the fourth or fifth grade levels. The principals of each of the elementary schools selected the teachers who were given the opportunity to participate in the study.

The teachers selected were teaching on fourth and fifth grade level and were using either the traditional method or the Inquiry Centered approach. Prior to the observational visit the observer contacted each principal and teacher explaining the purpose of the study. The teachers were assured that no name of teacher or school would be included in the final report of the study. The classes were assigned numbers for identification purposes. The teacher identification number

was known only to the observer. The teachers were further assured that the results of the tally and the tape recording made in their rooms would not be available to anyone other than the dissertation committee without a release from the teachers.

The observer, in the initial visit, talked with each teacher to remove any threat from the situation which might be present and to assure the teachers that the observations were in no way to be used as an evaluation form.

Classroom visitation. The choice of observer location in the classroom was selected with two purposes in mind: (1) to be able to observe adequately and to hear all transactions between the teacher and the pupils and (2) to cause the least possible confusion in the classroom. The observation tally was made while the interactions were occurring in the classroom. The use of the observation tally was made during the class period and lasted for fifteen minutes.

Any announcement to the class concerning the observation visit was left to the discretion of the individual teacher.

Recorder observation. A cassette tape recorder was used to record the interaction as it occurred in the classroom. Each tape was marked with the identification number assigned to the teacher.

Second observation visit. The second visit to each classroom was used for the purpose of observing, recording and taping the teacher-pupil and pupil-pupil interaction. The second visit took place no sooner than five days after the first observation.

Analysis of Data

For the purposes of this study the following statements in

reference to the analysis of the data have applied:

Validation of the tally. A review of the score sheet and the tape recording was made after the observer was away from the school. An effort was made to validate the tallies that were made during the classroom observation period by playing the tape and rechecking the score sheet.

Organization of the data. The statistical analysis of the data encompassed a comparison between the inquiry and traditional groups on each of the categories of the observation instrument.

The statistical test used was the chi-square for comparison of observed data (48). Level of confidence for χ^2 was set at 0.05 level. The following formula for χ^2 was used:

$$\chi^2 = \frac{N \left(AD - BC - \frac{N}{2} \right)^2}{(A + B)(A + C)(B + D)(C + D)}$$

Format for Succeeding Chapters

The succeeding chapters of this study contain a review of related literature, an analysis of the instrument, statistical analysis and interpretation of data, and conclusions drawn from the study.

Following the present introductory chapter, Chapter II is devoted to a review of related research and literature. Chapter III presents a description of the instrument used in the study, its component parts, their definitions, and background as to the procedure used in the development of the instrument. Chapter IV presents a statistical treatment of the data used in the study. Finally, Chapter V summarizes the entire study, gives conclusions drawn from the findings, and suggests areas for further research.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The possibility of more objective examinations of the teaching process has come about since interaction analysis research in the classroom was introduced. As in most research much has been of value to the study of the teaching learning process while some research has contributed little or no assistance to the problem. This chapter is devoted to a review of relevant studies which have contributed to the examination of the teaching act. The first section of the chapter deals with interaction analysis research while the second section presents a review of the development in the inquiry science process.

Interaction

The study of the teaching learning process through interaction analysis is a method developed since the late thirties. A few of the earlier studies which might be considered forerunners of the current trend were conducted by Collins (21), Barr (7), Butsch (16) and Anderson (4). C. D. Jayne (34) investigated the area of observable behavior of the teacher and changes produced in the pupil. His work centered around eleven activities which occurred in the classroom. The categories dealt with such items as types of questions, percentage of talk by pupil and by teacher and prepared and unprepared questions.

Jayne found little or no relationship between teaching acts observed and student academic gains.

While Jayne's work did not produce the results he desired it did help lay the foundation for future work in classroom observation. One study which followed was in 1948 by John Withall (55) who developed a method for categorizing teacher classroom statements and questions from which he derived a measure of climate index. Withall used his index to determine whether verbal behavior was "learner supportive" or "teacher supportive." Withall's instrument, the "Social-Emotional Climate Index," assesses the social-emotional climate through the evaluation of teacher statements.

Cogan (20) did a study on the approach to the question of isolating the influence of a single teacher among the many with whom secondary pupils customarily work. The results of the study were analyzed from two different points of view. The first was a "perception" analysis--the relationship between the individual pupil's perception of the teacher's behavior and the amount of work reported by the pupil. The second analysis, termed the "trait" analysis, dealt with whether the teacher could be characterized in terms of the pupil's observations, and whether these traits are related to average productivity scores of the pupil. It may be said that the method used in this research is productive. There may be some reason to hope that the measure of teacher behavior and of pupil productivity may be of value in the development of measures of teacher competence and perhaps in the formulation of more adequate theory of the teaching-learning process.

Amidon (1) has stated that interaction analysis is one way to describe teacher-pupil verbal interaction. This approach has been in

use for the past twenty years, but only during the past few years has it spread to many different kinds of educational programs. The research on teacher-pupil interactional patterns has also provided the basis for the teacher's role and behavior in the classroom.

Robert S. Soar (51) in his research on teacher-pupil interaction reported that indirect teaching produced greater growth than direct. Classrooms where there was greater expression of hostility produced less learning than those with warmer emotional climate, and the combination of indirect teaching and low hostility produced the greatest gain of all.

The area of communication in the classroom is of utmost importance in analyzing classroom interaction. Bany and Johnson (6) found that when student interaction and communications were curtailed the group developed little unity, while on the other hand, when communications were fostered and encouraged the cohesiveness of the group was increased.

Harris (32) developed an instrument entitled, "Analysis of Patterns of Pupil Responses," which he copyrighted in 1961. This instrument was the result of work at the University of Texas in the area of response analysis. Harris, like Bany and Johnson, felt that the way a teacher conducted class--discussions, recitations or any oral action--was important to the aspect of teaching. The teacher set the patterns by his selection of students for response to questions or by recognition of students who initiated a response. These patterns could be described and analyzed by the instrument developed by Harris which had five basic divisions of responses and could be recorded as they occurred in the classroom.

A study of interaction patterns in the elementary school by Furst and Amidon (29) produced some interesting results. They found that primary grade teachers tend to use question-answer techniques while intermediate teachers often pursue the lecture method. Both early primary and intermediate grade teachers showed by their teaching that they consider the indirect influence as very important. In general the first and sixth grade teachers were the most persistent of the elementary school teachers in using the indirect influence.

An earlier work along this same line was reported by Anderson (4) in the late Thirties. The research was done to develop reliable techniques for recording in terms of dominative (direct) and integrative (indirect) behavior the contacts which teachers have with children. Anderson found that no behavior is entirely integrative (indirect) and none is completely dominative (direct).

In research done at a much later date with a different set of instruments, Flanders (28) established findings much like those of Anderson. The outcome of this study showed that no one method, indirect or direct, is superior. He provided a tentative explanation of why indirect and direct influence may have different outcomes in different situations.

The research done by Anderson and by Flanders was to develop a method to determine the classroom climate set by the teacher's behavior. Flanders (27) later did research on the influence teachers have on pupil attitudes and achievement. His conclusions were that achievement was significantly higher in most indirect classes and as was found in earlier studies the most constructive and independent attitudes were found to be associated with the most indirect patterns of teacher influence.

Arno A. Bellack (9) and others developed an instrument, "The Bellack System." Bellack used this instrument to collect data from high school teaching, and found that cycles of teacher and pupil behavior are rather consistent from classroom to classroom; almost as if teachers and pupils were playing a game with well defined rules. He indicated that pupils do not take the initiative in the classroom.

Amidon and Hunter (2) developed the "Verbal Interaction Category System" which is an expansion of the Flanders System in order to provide more detailed information. It has provisions for recording not only those times when the teacher accepts or rejects the ideas and feelings of the pupil, but also when he accepts or rejects the pupil's nonverbal behavior.

Richard Schusler (46) in 1965 developed the "Classroom Interaction Management Analysis Record" at the University of Missouri at Kansas City. The CIMAR gives an accurate record of the amount, kind and direction of verbal interaction and is adaptable to the teacher-directed, pupil-directed and small group activities in a regular classroom. Perhaps the strongest point of the instrument is that pupil interaction is described in the same detail as teacher interaction.

The earlier work in teacher-pupil evaluation led to the development of many instruments to analyze the many facets of teaching. The analysis of verbal interaction is one approach to understanding the teaching-learning process. The results of studies by Amidon, Soars, Anderson and Flanders in teacher-pupil interaction were much the same: students taught by indirect teachers had better attitudes toward school and teachers, and achievement was higher when compared to students taught by teachers using a direct method. Many interaction analysis

instruments have been developed but most of them measure only one aspect while the CIMAR describes both teacher-pupil and pupil-pupil interaction.

Science Area

We are living in a period of rapid change and progress. The task in science teaching is to provide young people with the kind of education which will not only provide an understanding of today's problems but help them to recognize and interpret signals for the future. In the past fifteen years two phenomena have taken place which have given the science curriculum of the public school impetus and rapid growth. The first was the vast growth of scientific technology which has produced a fantastic amount of scientific knowledge in all areas of science. The second was the effect produced by the satellite "Sputnik" on educators, the general public and the government.

This new interest awakened in science education has produced revisions in many science programs. The National Science Foundation (37) created in 1950 by congress for the purpose of exploring ways by which education might be strengthened through improvements in the teaching of science has been the major influence in developing science programs. By 1956 the National Science Foundation was beginning to develop new programs. The current trend with the many new programs is not aimed at one national curriculum but should continue to be fitted to local needs. The changes in science have been in three directions. Keith, Blake and Tiedt (37) tell us that the three directions are (1) to develop new curricula in science, (2) to make materials and facilities available, and (3) to produce adequately trained teachers. A few of

the representative programs working toward one or more of the three goals include the following:

1. American Association for the Advancement of Science-AAAS
2. Elementary Science study-ESS
3. Educational Service, Incorporated-ESI
4. Science Curriculum Improvement Study-SCIS
5. Elementary School Science Project-ESSP
6. School Science Curriculum Project-SSCP

American Association for the Advancement of Science. The AAAS program covers the elementary school, kindergarten to the sixth grade. The subject matter is drawn from various fields in science. The materials are designed to provide for experiences which improve the child's skills in using the process of science. Livermore (38) said of AAAS that the important aim is that science is best taught as a procedure of inquiry and should be guided by this philosophy.

Elementary Science Study. This program has a primary objective to develop more meaningful science materials. These materials are designed so that they inherently allow for a flow of ideas originating from the curiosity of children. Duckworth (26) reports little emphasis is given to the development of a sequential or continuing program with specific structure and assigned grade levels. The main purpose is to supply a variety of carefully thought out and tested materials which a school system may use in developing an elementary science curriculum.

Educational Service, Incorporated. This program developed at Massachusetts Institute of Technology had as a purpose to develop a number of instructional units. The student must work with equipment and materials, use observation, measurement and method to gather

information to support his conclusion.

Science Curriculum Improvement Study. This is another of the groups supported by N.S.F. It is concerned with exploring a concept of science education based on communicating scientific literacy. Karplus (35) stated that the large-scale organization of the curriculum is determined by the structure of science, by the maturity of the pupil, and by the pupil's preconceptions. The organization of individual lessons is determined by the discovery method of concept development and by the needs of the learners.

Elementary School Science Project. Salinger (45) in describing the ESSP said that the primary purpose of the program is to improve science materials for both the student and the teacher. It works on the idea of "humanistic efficiency." This approach prepares the student to recognize the nature of the times and that of the future. It enables them to see the interdependence of man.

Modern science is no longer a system of facts but has become a way of thinking and acting which employs principles of observation, attitudes of exploring and questioning, discovery, interpretation of data and drawing conclusions. Carin and Sund (19) said that science as a process of inquiry stems from human urges and needs and is guided by scientific attitudes and methods. Kessen (36) when writing on purposes of science in the elementary school said the following:

> Science is best taught as a procedure of enquiry. Just as reading is a fundamental instrument for exploring whatever may be written, so science is a fundamental instrument for exploring whatever may be tested by observation and experiment. Science is more than a body of facts, a collection of principles, and a set of machines for measurement; it is a structured and directed way of asking and answering questions. . . . The well taught child will approach human behavior and social structure and the claims of authority

> with the same spirit of alert skepticism that he adopts toward scientific theories.

Kessen is only pointing out what many others say, that the goal of the new science program is skills in inquiry which may come at the expense of science content, and concepts will be learned only as they are developed from the use of the process of inquiry. When summarizing on elements of discovery and inquiry Renner and Ragan (43) said:

> When the child is helped to discover generalizations rather than having adult generalizations imposed upon him, he is developing his rational powers, gaining an understanding of content, and learning how to learn.
>
> Authoritarian teaching consist of imposing upon the pupils the generalizations which adults think he should know; the discovery approach allows pupils to collect, classify, and interpret data to arrive at generalizations which are truly their own.
>
> The act of discovery is not restricted to finding out something that was previously unknown to anyone; rather, it includes all forms of obtaining knowledge or insight for oneself by the use of one's own mental powers.
>
> Children who learn science by the discovery approach will discover for themselves the true structure of the discipline.
>
> Motivation for learning science must come from an intrinsic need for dealing with the environment, rather than from rewards and punishments, if it is to be effective.
>
> "Invention" refers to the original introductions of a new concept; "discovery" refers to the subsequent recognition of the concept's usefulness. Both processes have a place in the elementary school science program.

CHAPTER III

INSTRUMENTATION OF THE STUDY

The instrument used in this study was developed with the purpose of measuring the verbal interaction of teachers and pupils in the classroom. It utilizes verbal interaction as opposed to nonverbal communication and in no way evaluates the teacher or the student except in the amount and kind of verbal communication in the classroom.

Classroom Interaction Management Analysis Record

The CIMAR was developed at the University of Missouri at Kansas City by Richard A. Schusler (46) in 1965. The pilot stage for CIMAR lasted approximately six years at the University of Missouri, Kansas City; Avila College, Kansas City, Missouri; the University of Missouri at Columbia, Missouri and at Park College, Parkville, Missouri. The instrument was used in the training of supervisors, principals, elementary counselors, teachers in various elementary and secondary schools in and around the area and student teachers at Park College.

The CIMAR has been constructed so as to enable the observer to more objectively observe the interaction process in the classroom. Schusler (46) said conceding that children learn better when they feel good about learning, there are certain aspects to learning atmosphere which can be discovered by the use of the CIMAR. Rewarding a child for verbal performance makes him feel as if his contribution to the

classroom situation was of worth. Even more important is the fact that when the child gives a wrong answer, the teacher does not follow his answer with a negative-type remark. A negative remark may cause the pupil to feel that failure is unacceptable in the eyes of the teacher. The fact that in some classrooms the teacher does more than seventy per cent of the talking means that some children have little chance to verbalize. This becomes increasingly important when one considers the effect of verbalization on one's own learning. Discussion in classrooms is known to promote more applicatory and long-time learning than silent rote memorization or even writing.

By using this system, the observer can reliably separate the categories related to persons and content from the interaction syndrome. Some of the categories are: (1) The manner in which the teacher distributes his interaction in the classroom, whether to certain individuals or clusters or to all individuals. (2) The type of question that the teacher asks, the type of answer he receives from the student, and the relation between these two aspects. Does a factual question generally elicit a factual answer? (3) Whether the teacher follows the interaction of the student with supporting, accepting remarks, negative remarks or silence. How she distributes this type of interaction can also be seen. (4) How often the student interacts with other students and the types of interaction exchanged. Does all interaction flow through the teacher? (5) Influence patterns in the classroom can be identified as a cluster or type of individuals. And the last one (6) ratios of all combinations of talk frequencies can be established--teacher-child, teacher-boy, teacher-girl, pupil-teacher, boy-boy, boy-girl, girl-teacher, girl-boy, and girl-girl.

Description and Use of the Instrument

The instrument is divided into two sections; the first is the CIMAR Score Sheet and the second is the CIMAR Matrix. The use of these will be described in the following: (a copy of both the score sheet and matrix will be found in the appendix).

The Score Sheet. The score sheet has a list of the interaction categories, the interaction code and activity code along with five columns for entering the observed interactions. The columns are headed by a space for marking the time of observance. The observation lasts for fifteen minutes and is divided into three-minute intervals thus the five columns. Schusler (46) deems fifteen minutes sufficient for discovering the interaction patterns in the classroom. This estimate of time for discovering the interaction patterns was based upon three hundred classroom observations by Schusler (46). Over repeated observations, this time segment is also adequate in length for discovering changes in classroom discussion patterns.

Below the space for recording time is another space for the listing of the activity code. The activity code includes such activities as discussion, lecture, listening, seat work, group work and changes of activities.

All interactions are entered first by code and then by category as they occur and as any change in code and/or category takes place. Using the interaction code which includes teacher, class, boy, girl, small group and observer, the interaction is recorded as it occurs in the classroom. The use of the interaction categories indicates the type interaction that occurred in the classroom. The categories are divided into ten sections. The interaction category is an explanation of the

form of the interaction. Schusler (46) describes the categories as follows:

1. Question a. Factual: A question asked that elicits recall of the material. It excludes any interpretation or application of the content. This category would also include checking of the lessons, i.e., when the teacher sets up the procedure for answering by merely calling the next person's name. This is probably the most used category by the teacher, the implied emphasis is upon convergent thinking.

Question b. Interpretation and/or application: A question asked that encourages its recipient to think not just within the mere memorization of content matter, but to apply it from his own system of thinking. It can be viewed as an open question which seeks the idiosyncratic aspects of the answerer. It emphasizes the answerer rather than the questioner. This category is seen as being more in the realm of thought questions or problem solving than plain recall. The implied emphasis is upon divergent thinking.

2. Answer a. Factual: A narrow reply in the sense that it does not go beyond memorizing the material. Shows the ability to recall. Represents a compliance to the asker of the question.

Answer b. Interpretation and/or application: The receiver of the question answers more from his own thinking system. The answer goes beyond memorizing content. It may be slightly off target in its content. This type of answer will generally show a better use of the facts than just stating them.

3. Statements a. Factual: This category may take the form of lecture by the teacher. The statements are not drawn from the personal experience of the person making them. If the teacher is making the

statements, they are most generally tied to the content of the lesson and are used to build into the pupil information for recall or factual information. This category assumes that the statements are volunteered and not the result of question. This is especially true if the pupil uses the category; it is then usually a remark made which follows the answer.

Statement b. Interpretation and/or application: (made either by the teacher or pupil) These statements are also volunteered and not an elicited response. They tend to show a different kind of answer than factual in that the content of it is applied or interpreted rather than just repeated. It is usually not in strict compliance to the poser of the question. When used by pupils, it is usually an addend to or follows an answer given by the same or a different pupil. The maker of the statement is more apt to use his own frame of reference.

4. Operational statements: (most often used by the teacher; may be used by the pupil) The category relates to those statements made in the classroom which have to do with mechanical ongoingness. It keeps the class involved in the task at hand or moves the class toward different tasks. It may be in the form of a statement, question or command. The statements are not made in a personal way, nor are they related to control directly.

5. Individual help a. Task related: The teacher or pupil talks directly to one other person at a time, i.e., teacher-to-pupil, pupil-to-pupil, or pupil-to-teacher. It is made privately and when the other person making the statement is in the proximity of the other person. If the statement can be heard by the observer, it must go in the 5 category; otherwise it must go in the 4 category. Task related

means that the person talks to the other person about the task at hand. It excludes any interaction about the person himself. It is not evaluative in nature.

Individual help b. Person related: This category is evaluative of the individual to which it is made. These statements are made to one individual at a time. They are personal and recognized the feelings of the person being helped. They can occur from pupil-to-pupil.

6. Supportive statements: (used by either the teacher or the pupil) This category is designed to recognize and record those remarks that encourage, approve, and support verbal and non-verbal behavior in the observed classroom. These statements are made publicly.

7. Objective control: (used by either the teacher or a pupil) The user of this category has as his intent the objective or indirect control of the classroom. Statements are made in such a way that attention is not called to a particular person as a reprimand but rather directed at some other person or episode as an example.

8. Negative statement: (made by either the teacher or the pupil) This category is used when statements are made that publicly abuse the individual or the class. They may be threats or actions.

9. Attack: This is the action category where the teacher separates the child physically from the group or room. She may set him in a corner, outside the room or send him to the principal's office. The threat is made and carried out, or there may be no previous threat but just immediate spontaneous action.

10. No Response: Self-explanatory.

The Matrix. After interactions are coded and entered on the score sheet they are transferred later to the CIMAR matrix. On the left side

of the matrix are listed the interaction codes. The interaction categories are listed across the top. Cells formed by code and category can then account for all interactions. These are entered and summed across the rows to discover the type of interaction a specific person assigned himself in the classroom mileu. Of particular importance in summing rows is finding the direction of the interaction, to whom the interactor was talking and the number of interactions, per cent of his interactions and per cent of the total available interactions sent to each type of person. Summing of these columns gives the number of times a category was used. Subtotals of these columns give the number of times a category was used by a certain type interactor. Available also to the summarizer of the matrix are the number and type of interactions types of pupils received.

The Reliability of the CIMAR. "The Classroom Interaction Management Analysis Record" has been tested and the reliability established at .7195. The reliability was determined by sending to each of the participants who had been trained in the use of the CIMAR an instrument of one hundred statements which were drawn from classroom observations made by Schusler and his colleagues. Each was sent a shortened form of the CIMAR as a guide for interpreting the categories. The participants were directed to place each statement in a category.

The CIMAR can accurately record the amount, kind and direction of verbal interaction which occurs in the classroom. The instruments are adaptable to both teacher-directed and pupil-directed as well as to small group activities in a classroom. One of the strongest points for the CIMAR is that pupil interaction can be described in the same detail as teacher interaction.

CHAPTER IV

TREATMENT OF THE DATA

This chapter presents tabulated results of data obtained from investigational procedures described in Chapter III. The data gathered in this study were used for the primary purpose of testing the following null hypotheses: (1) There is no significant difference in the amount of teacher-pupil interaction in an elementary science class taught by the Inquiry Centered method and the traditional science method. (2) There is no significant difference in the amount of pupil-pupil interaction in the elementary science classes taught by the Inquiry Centered method or the traditional science method.

The data consist of tallies made during observation of thirty-six teaching periods of science which were comprised of eighteen teaching periods of Inquiry Centered Learning Science and eighteen teaching periods traditional science. The tallies were placed in the various categories described in Chapter III as each of the events occurred.

The schools which were chosen for this study had to offer each of the two methods, Inquiry Centered Learning Science and traditional science in the respective school. Nine schools from the Stillwater Public School System and Oklahoma City Public School System were used in the study.

The choice of teachers to be observed was left to the discretion of the principal of each school. The student population (499 students)

was in grades four and five of the public school systems. The sample would be random to the extent that the investigator had no control over any student being in one group or the other. Campbell and Standley (17) refer to this situation as a natural setting. Each student in the study had an equal chance to be in either group.

The technique used for statistical analysis of the data was the median test with the use of the chi-square formula (48). Application of chi-square was made for each pair of the categories. Level of confidence for chi-square was set at the .05 level which required a value that was equal to or greater than 3.84 for significance.

Total Interaction

The interaction of both teacher-pupil and pupil-pupil that was observed during the periods when science classes were in session was categorized using the "Classroom Interaction Management Analysis Record" (44) described in Chapter III. The data in Tables I, II, III, and IV, presents the statistical results of the total interactions.

Table I illustrates a difference in number and percent of the total interaction. The traditional science method uses more interaction with teacher-pupil and pupil-teacher while the interaction between pupils is higher in Inquiry Centered Learning Science approach.

Teacher-pupil interaction, teacher interaction directed to pupils, as shown in Table II obtained a score of 5.45 which was above the established level of significance. This would be an indication of a significant difference between the two methods under discussion. Thirteen of the eighteen numbers representing the teachers of traditional science were placed above the median as compared to only five

TABLE I

NUMBER AND PERCENT OF INTERACTION FOR THE INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Teacher-Pupil	1004	49.04	1265	61.67
Pupil-Teacher	634	30.97	761	39.97
Pupil-Pupil	409	19.99	32	1.56
Total	2047	100.00	2058	100.00

TABLE II

DISTRIBUTION OF INTERACTIONS OF INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTIONS PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Teacher-Pupil	13	5	5	13	5.45*
Pupil-Teacher	10	8	8	10	.11
Pupil-Pupil	6	12	12	6	2.78

*Significant at the .05 level of confidence

of the numbers representing the teachers of the Inquiry Centered method.

The data in Table II shows that pupil-teacher interaction obtained a score of .11, indicating no significant difference between the two methods used by the teachers.

Pupil-pupil interaction as shown in Table II had a χ^2 score of 2.78 which was below the level of significance and indicated no significant difference in the two approaches of teaching science content.

The number and percent of total interaction in each category of the "Classroom Interaction Management Analysis Record," as shown in Table III points out that traditional science had more verbal communication in factual categories while the Inquiry Centered approach dealt more with interpretive categories.

A χ^2 score was obtained for each of the categories in the "Classroom Interaction Management Analysis Record." Table IV shows the results of the interaction in factual questions. A χ^2 score of 1.82 was achieved which indicated no significance in differences of the two approaches to science.

Interpretive questions, which encourage the recipient to think, received a χ^2 score of .00, indicating no significant differences in the two methods of teaching science.

The category of factual answers, an area that shows ability to recall, obtained a χ^2 score of 1.00. The score is below the .05 level of confidence and therefore indicated no significant differences in the results from tallying of occurrences.

Interpretive answers, which generally shows a better use of the facts than just stating them, gained a χ^2 score of .45 as shown on

TABLE III

NUMBER AND PERCENT FOR TOTAL INTERACTION BY CATEGORIES OF THE CLASSROOM INTERACTION MANAGEMENT ANALYSIS RECORD FOR INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

Category	Inquiry Science		Traditional Science	
	Number of Interactions	Percent	Number of Interactions	Percent
1. Question				
a. Factual	341	16.66	436	21.19
b. Interpretive	227	11.10	187	9.09
2. Answer				
a. Factual	274	13.39	360	17.49
b. Interpretive	340	16.61	276	13.41
3. Statements				
a. Factual	353	17.24	376	18.27
b. Interpretive	81	3.96	43	2.09
4. Operational Statements	251	12.26	206	10.01
5. Individual help				
a. Task related	23	1.12	10	.49
b. Person related	2	.09	1	.05
6. Supportive Statements	108	5.28	125	6.07
7. Objective Control	13	.63	23	1.11
8. Negative Statements	23	1.12	7	.34
9. Attack	1	.05	0	.00
10. No response	10	.49	8	.39
Total	2047	100.00	2058	100.00

Table IV. This figure indicated no significant differences between the two programs under study in relation to the category of interpretive answers.

The category of factual statements, those not drawn from personal experiences, received a χ^2 score of 1.01. No significant differences at the .05 level is indicated by this score.

The category of interpretive statements, which are volunteered not elicited and are from the speaker's own frame of reference, obtained a score of 2.81. This score is below the .05 level of confidence and indicated no significant difference.

Operational statements as related to those statements which have to do with mechanical ongoingness of the classroom acquired a χ^2 score of 2.78. This score did not indicate significant difference.

Individual help is task related, talking to another person about the task at hand. A χ^2 score of .11 was achieved by the task-related category. This figure indicated no significant difference between the two groups.

In the category of individual help as pertaining to person-related help deals with a feeling approach. The χ^2 score for this category was 0.00 which indicated no difference in the methods under study.

Supportive statements, those remarks to encourage and approve made publicly, received a χ^2 score of .00. The score in this category indicated there is no significant difference in the two science approaches in this category.

Objective control, which has as its intended objective indirect control of the classroom, obtained a χ^2 score of .46. At the .05 level this figure indicated no significant differences in the two science

TABLE IV

DISTRIBUTION OF TOTAL INTERACTION OF INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTIONS PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Question					
a. Factual	12	6	7	11	1.82
b. Interpretive	8	10	9	9	.00
Answer					
a. Factual	11	7	7	11	1.00
b. Interpretive	8	10	11	7	.45
Statements					
a. Factual	12	6	8	10	1.01
b. Interpretive	7	11	13	5	2.81
Operational Statements	6	12	12	6	2.78
Individual help					
a. Task related	8	10	8	10	.11
b. Person related	0*	0*	0*	0*	.00
Supportive Statements	11	7	10	8	.00
Objective Control	12	6	9	9	.46
Negative Statements	12	6	12	6	.13
Attack	0*	0*	0*	0*	.00
No Response	13	5	13	5	.14

*Not enough interaction to measure in this category

programs in this category.

The negative statements category was tallied when teachers or students made abusive remarks publicly to individuals or the class. This category obtained a χ^2 score of .13 which indicated no significant difference at the .05 level.

Attack, which is an area where threats are made and carried out or it may be a spontaneous action, had no interaction and could not be measured.

Chi-square results for no response category was .14 which indicated no significant difference between the two programs of science in relation to this category.

Teacher-Pupil Interaction

The teacher-pupil interaction includes only those verbal actions of the teacher to the pupil. This verbal interaction may be directed to an individual, a group or the class. Tables V, VI, VII and VIII show the results of the interaction.

The teacher-pupil interaction is divided into four categories as shown in Table V. Table V is designed to clarify the number and percent of the interactions of the teacher to the class, to boys, to girls and to groups which occurred in the two approaches to teaching science at the elementary school level.

The data in Table VI show total teacher-pupil interaction in Inquiry Centered Learning Science approach and the traditional science programs whose number of interactions placed at or below the median or above the median and the resultant chi-square scores.

The teacher-class interaction category as shown in Table VI

TABLE V

NUMBER AND PERCENT FOR THE TOTAL TEACHER-PUPIL INTERACTION OF THE INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Teacher-Class	426	42.43	673	53.20
Teacher-Boy	356	35.46	365	28.85
Teacher-Girl	207	20.61	227	17.95
Teacher-Group	15	1.49	0	0.00
Total	1004	100.00	1265	100.00

TABLE VI

DISTRIBUTION OF TOTAL TEACHER-PUPIL INTERACTION IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTIONS PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Teacher-Class	13	5	5	13	5.44*
Teacher-Boy	9	9	10	8	.00
Teacher-Girl	11	7	7	11	1.00
Teacher-Group	0**	0**	0**	0**	.00

*Significant at the .05 level of confidence
**Not enough interaction to measure in this category

was verbal interaction to the entire class. The χ^2 score obtained by this category was 5.44. This score is above the established level of significance; consequently, this would indicate a significant difference between the two programs. The teachers using the traditional science approach had significantly more interaction with the class as a whole than did those teachers using the Inquiry Centered Learning approach.

A tally was made for each verbal action the teacher directed to a boy in teacher-boy interaction as shown in Table VI. This category received a χ^2 score of .00 which indicated no significant difference between the two groups.

A χ^2 score of 1.00 which indicated there was no significant difference at the established level of confidence was obtained for the category of teacher-girl interaction.

The category of teacher-group interaction did not have enough interaction to measure by use of the median test and chi-square formula.

The data resulting from analyzing the teacher-pupil interaction in the ten categories of the CIMAR is shown in Table VII by number and percent. It is interesting to note that though traditional science method has more total verbal interaction, the Inquiry Centered approach has a higher number of interactions in one category, that of interpretive interactions.

Chi-square scores resulting from the analysis of the distribution of total teacher-pupil interaction by categories of the CIMAR are shown in Table VIII on the following page.

Factual question, which implies emphasis upon convergent thinking, received a χ^2 score of 1.25, as shown in Table VIII. The score being

TABLE VII

NUMBER AND PERCENT FOR THE TOTAL OF TEACHER-PUPIL INTERACTION BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Question				
a. Factual	232	23.10	407	32.18
b. Interpretive	195	19.42	182	14.38
Answer				
a. Factual	33	3.28	13	1.03
b. Interpretive	10	1.00	5	.39
Statements				
a. Factual	169	16.83	282	22.29
b. Interpretive	11	1.10	21	1.66
Operational Statements	186	18.53	189	14.94
Individual Help				
a. Task related	23	2.29	10	.79
b. Person related	2	.20	1	.08
Supportive Statements	106	10.56	125	9.89
Objective Control	12	1.20	23	1.82
Negative Statements	23	2.29	7	.56
Attack	1	.10	0	0.00
No Response	1	.10	0	0.00

below the established level of confidence indicated no significant differences in the two approaches.

Interpretive questions which implied that emphasis was on divergent thinking obtained a χ^2 score of .03. The score indicated no significant differences between the two groups.

The category of answers that are factual, the ability to memorize or recall, achieved a χ^2 score of .01, indicating no significant difference.

Interpretive answers goes beyond memorizing content and comes from one's own thinking system. This category did not have enough interaction to measure by the median test and chi-square formula.

A χ^2 score of 3.73 was attained by the category of factual statements, which usually takes the form of lectures by teachers. This score is below the .05 level of confidence, indicating that there was no significant difference between the two programs under investigation for this particular category.

Table VIII shows that the category of interpretive statements, which tend to show some personal or original thinking, received a score of .00. This score indicated that there is no significant difference in the two approaches under study in this category.

Operational statements, most often used by teachers for classroom control, may be in the form of a statement, question, or command. This category obtained a χ^2 score of 1.00. This score indicated no significant difference at the .05 level.

The category of individual help, as shown in Table VIII concerns the work at hand and is not evaluative in nature. The χ^2 score achieved by this category was .16, indicating no significance since it is

TABLE VIII

DISTRIBUTION OF TOTAL INTERACTION OF TEACHER-PUPIL BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTION FELL AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Question					
a. Factual	12	6	6	12	1.25
b. Interpretive	9	9	10	8	.03
Answer					
a. Factual	8	10	10	8	.01
b. Interpretive*	0	0	0	0	.00
Statements					
a. Factual	12	6	5	13	3.73
b. Interpretive	12	6	10	8	.03
Operational Statements	8	10	12	6	1.00
Individual Help					
a. Task Related*	10	8	10	8	.16
b. Person Related	0	0	0	0	.00
Supportive Statements	11	7	10	8	.00
Objective Control	12	6	7	11	1.82
Negative Statements	12	6	12	6	.00
Attack*	0	0	0	0	.00
No Response*	0	0	0	0	.00

*Not enough interaction to measure in this category

below the established level of confidence.

The person-related portion of individual help recognizes the feelings of the person. This area did not receive a sufficient amount of interaction to make use of the median test or chi-square formula.

Supportive statements used in the classroom for encouragement or approval obtained a χ^2 score of .00. This score did not indicate a significant difference for positive affectivity for the observation involved in this study.

Objective control, which tends toward indirect control of the classroom, achieved a χ^2 score of 1.82. This score, which was below the established level of significance, could not be considered as indication of any statistical difference.

Negative statements obtained a χ^2 score of .00. This would indicate, for this classification, no significant difference between the two approaches used by teachers of elementary science.

Nonsignificant results obtained by applying the chi-square test to the interactions of attack are reported in Table VIII.

The category of no response had so little interaction that it could not be measured by the use of median test nor the chi-square formula.

Boy-Teacher and Boy-Pupil Interaction

The boy-teacher and boy-pupil interactions were those verbal actions the boy directed to the teacher or to fellow classmates. Tables IX, X, XI, and XII show the results of this interaction.

The number and percent of boy-teacher and boy-pupil interactions illustrated by Table IX shows the action is almost completely confined

to communicating with the traditional science teacher while twenty-three percent less verbal action to the teacher was used in the Inquiry Centered approach.

TABLE IX

NUMBER AND PERCENT FOR BOY-TEACHER AND BOY-PUPIL INTERACTION OF INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Boy-Teacher	364	70.00	346	93.77
Boy-Girl	103	19.81	5	1.35
Boy-Boy	53	10.19	18	4.88
Boy-Group	0	0.00	0	0.00
Total	520	100.00	369	100.00

The data reported in Table X gives the results of the chi-square formula being applied to the categories of interaction directed by boys toward their teachers or fellow classmates.

Non significant results obtained by applying the chi-square test to the interactions of boy to teacher are shown in Table X. The data in Table X reveals that the same amount of interaction was placed above the median as was placed below in both approaches to teaching science.

TABLE X

DISTRIBUTION OF INTERACTION OF BOY-TEACHER AND BOY-PUPIL OF INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTION PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORE

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Boy-Teacher	9	9	9	9	0.00
Boy-Girl	6	12	13	5	4.01*
Boy-Boy	9	9	5	13	1.05
Boy-Group	0**	0**	0**	0**	0.00

*Significant at the .05 level of confidence
**Not enough interaction to measure this category

Significant results were obtained in the boy-girl interaction. A χ^2 score of 4.01 was achieved by this category. This figure was indicative of a significant difference between the two programs under investigation, with boys in the Inquiry Centered Learning Science having more interaction with girls than those of the traditional method.

The category of boy-boy interaction received a χ^2 score of 1.05. This figure indicated no significant difference between the two programs under study in relation to the category of boy-boy-interaction.

Boy-Group interaction had so little action that it could not be measured by the median test nor the chi-square formula.

Table XI illustrates the number and percent of boy-teacher

TABLE XI

NUMBER AND PERCENT FOR BOY-TEACHER INTERACTION BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Question				
a. Factual	20	5.48	7	2.02
b. Interpretive	3	.82	3	.87
Answer				
a. Factual	89	24.38	121	34.97
b. Interpretive	167	45.75	143	41.32
Statement				
a. Factual	49	13.43	49	14.16
b. Interpretive	24	6.58	13	3.76
Operational Statements	4	1.10	5	1.45
Individual Help				
a. Task Related	1	.27	0	0.00
b. Person Related*				
Supportive Statements	1	.27	0	0.00
Objective Control*				
Attack*				
No Response	7	1.92	5	1.45
Total	365	100.00	346	100.00

*Not enough interaction to measure in this category

interactions by categories of the CIMAR. It is interesting to note, through the use of Table XI, that the use of the interpretive categories by the Inquiry Centered approach and the use of the factual categories by the traditional method was true of boy-teacher interactions as it is shown in Table XI.

The chi-square results of the boy-teacher interactional differences by category of the CIMAR are reported in Table XII.

TABLE XII

DISTRIBUTION OF INTERACTION OF BOY-TEACHER BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTIONS PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Question					
a. Factual	9	9	13	5	1.05
b. Interpretive*					
Answer					
a. Factual	13	5	7	11	2.79
b. Interpretive	8	10	10	8	.44
Statements					
a. Factual	13	5	9	9	1.05
b. Interpretive	12	6	11	7	.00

*Not enough interaction to measure in this category

In the category of factual question for boy-teacher interactions, shown in Table XII, obtained a χ^2 score of 1.05. This figure indicated no significant differences between the two programs under study in relation to the factual questions.

No measure could be made for interpretive questions since so little interaction occurred in this category.

Factual answers, represents a compliance to the asker of the question, obtained a χ^2 score of 2.79. This figure was below the established level of confidence and indicated no significant difference between the two programs under study in relation to the category of factual answers.

A χ^2 score of .44 was received by the category of interpretive answers. This score indicated no significant difference at the .05 level.

Table XII shows the category of factual statements achieving a χ^2 score of 1.05. This figure indicated no significant difference between the two science approaches in relation to the category of factual statements.

A χ^2 score of .00 was obtained by the category of interpretive statements. This score indicated that no significant difference at the established level of confidence.

Girl-Teacher and Girl-Pupil Interaction

The interaction in this section was the action directed by girls to the teacher or to other classmates during science classes. Tables XIII, XIV, XV, and XVI show the results of this interaction.

The girl-teacher and girl-pupil interaction which is shown in Table XIII deals with the number of exchanges of action and the percent

TABLE XIII

NUMBER AND PERCENT FOR GIRL-TEACHER AND GIRL-PUPIL INTERACTION OF INQUIRY CENTERED SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interactions	Percent	Number of Interactions	Percent
Girl-Teacher	199	44.03	239	96.37
Girl-Girl	146	32.30	6	2.42
Girl-Boy	99	21.90	3	1.21
Girl-Group	8	1.77	0	0.00
Total	452	100.00	248	100.00

TABLE XIV

DISTRIBUTION OF INTERACTION OF GIRL-TEACHER OF INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTIONS PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Girl-Teacher	11	7	8	10	.11
Girl-Girl*	7	11	1	17	.00
Girl-Boy*	12	6	2	15	.00
Girl-Group*	15	3	18	0	.00

*Not enough interaction to measure in this category

the category has of the total interaction. It is interesting to note in Table XIII that the percent of interactions between girl-teacher is 96.37 in the traditional approach while the inquiry had a percentage of only 44.03 yet the total interactions for each group showed a total of 452 interactions for the Inquiry Centered approach while only 248 interactions for the traditional method.

Girl-teacher interaction obtaine a χ^2 score of .11 which is shown in Table XIV. This score indicated at the established .05 level of confidence there was no significant difference in the category of girl-teacher interaction.

There was insufficient action in the category of girl-girl action to be measured by the use of the median test and the chi-square formula.

Girl-boy interaction also fell into the category of insufficient action. It could not be measured on the scale used in this study.

Girl-group interaction as shown in Table XIV had so little action that it could not be measured by the median test nor applied to the chi-square formula.

The results of girl-teacher interaction by the categories of "Classroom Interaction Management Analysis Record" are shown in Tables XV and XVI. Table XV gives the results of the number and percent of girl-teacher interaction. It is seen in Table XV as in all the number and percent tables that answers given by the students of traditional science tend to be factual while the Inquiry Centered approach tends to have interpretive answers.

Factual questions, as it deals with girl-teacher interaction is illustrated in Table XVI. The category obtained a χ^2 score of .11,

TABLE XV

NUMBER AND PERCENT FOR GIRL-TEACHER AND INTERACTION BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS

	Inquiry Science		Traditional Science	
Category	Number of Interaction	Percent	Number of Interaction	Percent
Question				
a. Factual	17	8.13	12	5.02
b. Interpretive	1	.48	1	.42
Answer				
a. Factual	59	28.23	112	46.86
b. Interpretive	106	50.72	66	27.62
Statements				
a. Factual	20	9.56	38	15.90
b. Interpretive	3	1.44	5	2.09
Operational Statements	1	.48	3	1.26
Individual Help*				
Supportive Statements	1	.48	0	0.00
Objective Control*				
Attack*				
No Response	1	.48	2	.83
Total	209	100.00	239	100.00

*Not enough interaction to measure in this category

indicating no significant difference at the established level of confidence.

Interpretive questions lacked sufficient interaction to be measurable by the scales employed in this study.

The category of factual answers, the ability to recall, obtained a χ^2 score of 2.82. This score indicated no significant difference at the .05 level of confidence.

A χ^2 score of 2.47 was obtained in the category of interpretive answers. This score indicated no significant difference between the programs under study in relation to the girl-teacher interaction of interpretive answers.

As shown by Table XVI the category of factual statements, usually taking the form of lectures by teachers, obtained a χ^2 score of .55. This score indicated there was no significance at the level of confidence.

The category of interpretive statements is apt to be in the maker's own frame of reference. The χ^2 score for this category was .00 as shown in Table XVI on page 52. This figure indicated no significant difference between the methods of presenting science at the elementary school level.

This study was designed to test two specific hypotheses. Each of these hypotheses was related to the verbal interactions of teacher-pupil and pupil-pupil using two approaches to elementary science. The results indicated that the two approaches to science in the fourth and fifth grades produced significant differences in the teacher-pupil interaction while the pupil-pupil interaction in these approaches indicated no significant differences at the .05 level of confidence.

The hypothesis that there is no significant difference in the amount of teacher-pupil interaction in elementary science classes taught by the Inquiry Centered method and the traditional science method was rejected at the .05 level of confidence. Evidence indicated that teachers of the traditional science method had more verbal interaction in their classrooms.

TABLE XVI

DISTRIBUTION OF INTERACTIONS OF GIRL-TEACHER BY CATEGORIES IN INQUIRY CENTERED LEARNING SCIENCE PROGRAMS AND TRADITIONAL SCIENCE PROGRAMS WHOSE NUMBER OF INTERACTION PLACED AT OR BELOW OR ABOVE THE MEDIAN AND THE RESULTANT CHI-SQUARE SCORES

	Inquiry Science		Traditional Science		χ^2
Category	At or Below Median	Above Median	At or Below Median	Above Median	
Question					
a. Factual	10	8	10	8	.11
b. Interpretive*	1	17	1	17	.00
Answer					
a. Factual	13	5	7	11	2.82
b. Interpretive	6	12	12	6	2.47
Statements					
a. Factual	13	5	8	10	.55
b. Interpretive	12	6	11	7	.00

*Not enough to measure in this category

The hypothesis that there is no significant difference in the amount of pupil-pupil interaction in the elementary science classes taught by the Inquiry Centered method or the traditional science method was not rejected.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine teacher-pupil and pupil-pupil interactional differences, if any, between elementary school science classes being taught by Inquiry Centered Learning Science programs and the traditional method of teaching scientific laws and facts.

The last ten years have brought changes to the basic characteristics of the concepts of the teaching-learning process which affected the methods of instruction in many subject matter areas. New programs in science are being tested to find the ones most adaptable to the learning styles of students. New methods and beliefs are being adopted to stimulate learning for for the student at his own level of development; such changes are worthy of analysis.

The new Inquiry Centered Learning Science programs are based on procedures associated with the discovery method. The inquiry approach to science teaching necessitates that teachers adopt the attitude that science is an intellectual process. Since this is an inherent commitment in terms of methodology, interactional variables associated with those processes should reveal significant differences between the Inquiry Centered Learning Science program and the traditional science program.

Earlier work in teacher-pupil evaluation has led to the development of many instruments to analyze the many facets of teaching. The

analysis of verbal interaction is one approach to understanding the teaching-learning process. From an analysis of the literature it becomes evident that the instructional pattern could be analyzed in terms of verbal interaction of teacher-pupil and pupil-pupil in the classroom. The instrument used in this study to record teacher-pupil and pupil-pupil interaction was the "Classroom Interaction Management Analysis Record."

Eighteen classes of regularly enrolled fourth and fifth grade students were participants in the study. Nine of the classes used in the study were taught by the Inquiry Centered Learning Science approach. The remaining nine were taught by the traditional science method. These classes were chosen on the basis of the extent to which they met the requirements of the Inquiry Centered Learning Science program or the traditional science program. All of the classes observed were located in Stillwater or Oklahoma City area and each class participating in the study was observed twice with at least five days between visits. A small tape recorder was used during each observation period. The tape recording was used by the observer as a means of validating the tallies made during an observation.

Statistical analysis was made using the median test and chi-square formula to determine differences between the number of teacher-pupil and pupil-pupil interaction that placed at or below or above the median. Significance was established at the .05 level of confidence.

Findings

The findings of this study which were considered to be most significant were the following:

1. Teachers of traditional science used significantly more verbal interaction in total interaction than did the teachers of the Inquiry Centered approach. In total interaction thirteen of the eighteen teachers of traditional science ranked above the median. In the category of teacher-pupil interaction the chi-square score was significant at the .05 level of confidence.

2. The individual category of teacher-class, a part of the teacher-pupil interaction, received a significant score of the .05 level of confidence. The traditional science teacher has more verbal interaction with the class as a whole than did the teachers of Inquiry methods.

3. In the area of pupil-pupil interaction boy-girl interaction taught by Inquiry Centered Learning Science method had a total of twelve which ranked above the median as compared to a ranking of five above the median for those taught by the traditional science approach. The boy-girl category within the area of pupil-pupil interaction was significant at the .05 level.

4. There was more interaction between teacher-boy and boy-teacher in both approaches than teacher-girl or girl-teacher.

5. The number and per cent for total interaction was higher in the categories of factual questions, factual answers, and factual statements for teachers using traditional science methods than by those using Inquiry Centered Learning Science method.

6. The number and per cent for total interaction was higher in interpretive questions, interpretive answers, and interpretive statements for teachers using the Inquiry Centered Learning Science method than by those using the traditional science method.

7. There were more operational statements made by teachers using Inquiry Centered Science methods than by those using traditional science methods.

8. There was more individual help given to students by teachers using Inquiry Centered Learning Science method than those using the traditional science methods.

9. There were more supportive statements used by teachers in traditional science approach than those in the Inquiry Centered approach.

Conclusions

The following conclusions have been drawn from the findings of this study:

1. The null hypothesis of no significant difference in the amount of teacher-pupil interaction in elementary science classes taught by the Inquiry Centered Learning Science method and the traditional science method was rejected.

2. The null hypothesis of no significant difference in the amount of pupil-pupil interaction in the elementary science classes taught by the Inquiry Centered Learning Science method or the traditional science method was not rejected.

3. In pupil-pupil interaction the area of boy-girl interaction was significant at the .05 level of confidence which indicated more interaction took place among pupils in the Inquiry Centered Learning Science approach than in the traditional science method. This was further indicated by the number and per cent of pupil-pupil interaction in the area of inquiry approach to science when compared to the same

area of interaction in the traditional approach.

4. It was evident that more interaction is exchanged between teacher-boy and boy-teacher than girl-teacher or teacher-girl. A question may be raised concerning the interest in science expressed by boys and by girls.

5. The prevailing use of factual information by the traditional science methods points up the use of recall, memorizing and study of content emphasizing convergent thinking.

6. The evidence, while small, did indicate more interpretive information was sought by the Inquiry Centered Science method putting the emphasis on divergent thinking.

7. That there were more operational statements used in Inquiry Centered Science method would indicate that teachers keep the class involved in the task in which it is engaged or moving toward a different task since much of the work is individualized or in small groups.

8. Although a difference was found in the area of individual help, it was not large, but more group work was done in Inquiry Centered Science method thus allowing for individual attention as opposed to a whole class method.

9. Although a difference in the category of supportive statements was found, it was very small, and pointed up the fact that the traditional science approach was more verbal than the Inquiry Centered method.

Recommendations

The following recommendations are based on the findings and conclusions derived from this study:

1. It is recommended that further research be done in pupil-pupil interaction in relationship to the freedom of students to have verbal interaction and to what degree this promotes progress in achievement and social-emotional growth.

2. It is recommended that further study is needed in the teacher-boy and teacher-girl interaction to determine if the amount of interaction is due to interest and/or ability in the area of science or some other factor.

3. It is recommended that inservice teachers and student-teachers training to teach the new science program receive special instruction in the area recognized as major goals of the program. In other words, teacher training is needed for the development of the process of teaching how to learn rather than teaching of facts.

4. Both programs, the Inquiry Centered and Traditional Science, use a high percentage of factual question, answers and statements. It is recommended that the per cent of these interactions be reduced in favor of interpretive questions, answers and statements which aid in developing divergent thinking.

5. Teachers in both science programs have a need for greater interaction aimed to create more positive relationships with the students. It is recommended that the use of supportive statements and individual attention to the students be increased.

6. It is recommended that research be done to determine the effect that teachers trained in traditional approaches who have adopted the inquiry approach have on the science classroom as compared to the teachers who have been trained in only Inquiry Centered approach to science. In other words, can traditionally trained teachers completely change

their approach to teaching science?

One method of producing a better understanding of teachers and pupils in the classroom is through interaction analysis. An analysis of classroom activities provides a point from which other approaches may be applied to produce a more effective teaching-learning situation. This may contribute to the development of situations where both the teacher and the student perform new roles for greater achievement in relationships as well as academic accomplishment.

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APPENDIX A

C.I.M.A.R. INTERACTION SCORE SHEET 1

Teacher _____ School _____ Date _____ Observer _____

Subject 1 _____ 2 _____ 3 _____

	1	2	3	4	5
Time (3 min.)					
Activity					
Interaction Categories					
1. Questions					
a. Factual					
b. Inter./or Applica					
2. Answers					
a. Factual					
b. Inter./ or Applica					
3. Statements					
a. Factual					
b. Inter./ or Applica					
4. Operational Statement					
5. Individual Help					
a. Content Approach					
b. Feeling Approach					
6. Supportive Statements					
7. Objective Control					
8. Negative Statements					
a. Individual					
b. Class					
9. Attack					
a. Individual					
b. Class					
10. No Response					
Interaction Code					
T. Teacher					
C. Class					
B. Boy					
G. Girl					
ob. Observer					
Activity Code					
S. Wk. Seat Work					
Disc. Discussion					
Lect. Lecture					
Lis. Listening					
Gr. Wk. Group Work					
Chng. Activity Change					
Conf. Confusion					
Proximity: Desk-Peri-Aisle					
Voice: Warm-Cold-Hostile					
Interaction: Dist-Concen					
Noise Level: 1-2-3-4-5					

C.I.M.A.R. Matrix

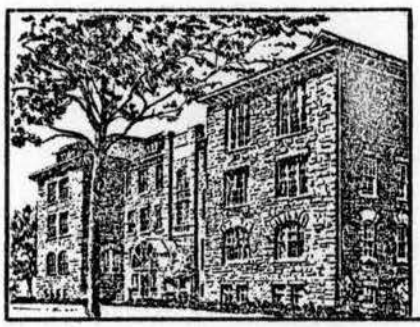
Date _____ Teacher _____ Obs. _____

Subject _____

Categories
Number of Interactions

Inter-actions	1a	1b	2a	2b	3a	3b	4	5a	5b	6	7	8	9	10	Total Inter.	% of code	% of Total
T-C																	
T-B																	
T-G																	
T-(G)																	
Sub.																	
B-T																	
B-G																	
B-B																	
B-(G)																	
Sub.																	
G-T																	
G-G																	
G-B																	
G-(G)																	
Sub.																	
C-T																	
Sub.																	
Total																	

APPENDIX B



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August 10, 1969

Mr. Ohren W. Rains
29 Summit Circle
Stillwater, Oklahoma

Dear Mr. Rains:

I received your letter of July 23 asking permission to use the CIMAR as a possible dissertation instrument. It would be a pleasure to have you do this. At the present time I am revising the manual and should have it finished by September 1 of this year. I will be glad to mail you a copy. In the meantime, if you have any questions you may write me at K.U. after August 21st.

Sincerely,

Richard A. Schusler

Richard A. Schusler, PhD.
Assistant Professor of Educ.
University of Kansas
Lawrence, Kansas 66044

RAS:ms

VITA

Ohren Willis Rains

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF TEACHER-PUPIL AND PUPIL-PUPIL INTERACTIONAL DIFFERENCES BETWEEN INQUIRY CENTERED SCIENCE AND TRADITIONAL SCIENCE IN ELEMENTARY SCHOOLS

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