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A STUDY OF TRANSACTIONAL PATTERN DIFFERENCES BETWEEN SCHOOL MATHEMATICS STUDY GROUP CLASSES AND TRADITIONAL MATHEMATICS CLASSES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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degree of

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ROBERT THOMAS PATE

Norman, Oklahoma

1964

A STUDY OF TRANSACTIONAL PATTERN DIFFERENCES BETWEEN SCHOOL MATHEMATICS STUDY GROUP CLASSES AND TRADITIONAL MATHEMATICS CLASSES

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To my wife Betty I dedicate this study, for without her constant encouragement, patience, and understanding it would have been impossible.

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CHAPTER I

INTRODUCTION

The teaching-learning process has for many years been recognized as a problem of major concern. This concern has been reflected in a number of studies centered around the general area of the teaching-learning process. Doman and Tiedman, in a review of teacher competencies and the methods of evaluating them, found that during the period from 1890 to 1949, most of the studies were focused upon judgments of supervisors, pupils, and teachers.[1]

This tendency has continued, since most current research utilizes rating scales, questionnaires, and tests, along with instruments of prediction that follow this general pattern. Research in the field of the teaching-learning process has studied opinions, personality characteristics, student accomplishments, and tests as determinants in the area, but there seems to be a lack of study of teacher-pupil transactions that take place in the classroom itself. The importance of this area in education as one which needs further study was indicated by Smith when he stated:

[1]S. J. Doman and D. V. Tiedman, "Teacher Competence: An Annotated Bibliography," Journal of Experimental Education, XIX (September, 1950), 101-218.

> 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 "induction," "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 of pedagogy.[1]

Keeping Smith's comments in mind, it is quite possible to associate the terms "deduction," "induction," and "problem solving" with the currently emphasized "new" mathematics programs. The School Mathematics Study Group (hereafter sometimes referred to as S. M. S. G.) program basically is developed from the viewpoint of structures; the child is introduced to the language and notations of sets, some properties of real numbers, and topics from algebra and geometry. A major goal in the development of the new mathematics is the hope that after Grade 6 the child will have studied the behavior of numbers and will know that mathematics deals with systems.

A comparison was drawn by Sueltz when he stated:

> The older pattern of "explain-practice-perform" is being replaced by a new spirit, a spirit of adventure, of speculation, thinking, discovery leading to understanding and self-projected learning. It is this same spirit of adventure that has established a favorable climate for experiment. . . . The contributions of many of these experiments may be more in the spirit of discovery than in the significance of the mathematics learned. But the spirit of discovery . . . constitutes the essence of mathematics. If we could admit that a child is essentially a curious person who likes to explore, we would have the keynote to learning mathematics. He is, in fact, similar to the adult mathematician and creative, in that he naturally explores with facts and ideas and establishes conclusions. This is an inductive process.[2]

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[1]B. O. Smith, "A Concept of Teaching," Teacher's College Record, LXI (February, 1960), 241.

[2]Ben A. Sueltz, "A Time for Decision," The Arithmetic Teacher, VIII (October, 1961), 274-80.

This change in emphasis in the mathematics program could also entail changes in other facets of the program. These changes might be direct or indirect results of the program itself.

Smith[1] in 1960 and Aschner[2] in 1958 both drew the following general conclusions and suggested further research:

1. Research in classroom teaching calls for criteria expressed in terms of measurable dimensions of behavior.
2. The complexity of 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 mathematics programs and to determine whether further study was indicated. A specific statement of the problem is made following definition of terms.

Related Research

Research in the classroom has resulted in a critical look at many facets of the teaching processes. Some of this research has proved to be valuable, while other investigation provided little or no information of value. Some of the more significant developments are presented on the following pages.

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[1]Smith, loc. cit.

[2]Mary J. Aschner, "The Analysis of Classroom Discourse: A Method and Its Uses" (unpublished Ed.D. dissertation, Department of Education, University of Illinois, 1958), p. 164.

Teacher-Pupil Interaction Area

Objective descriptions of the dimensions of teacher behavior in the classroom have been recognized as a problem of major importance for many years, but the practical problems of studying so complex an operation have tended to divert research from behavioral actions. As a result there has been a tendency toward emphasis on the use of rating scales and "tests" to predict teaching success. A review of Doman and Tiedman's study of the period from 1890 to 1949 indicates a preponderance of studies based on the judgments of supervisors, pupils, teachers, and administrators.[1]

One of the earlier works that recognized and included the pupil responses as being an important factor for analysis was a conduct scale for the measurement of teaching. This scale was developed by Collings, who was at that time dean of the School of Education, University of Oklahoma. This scale was founded upon the following six related ideas:

1. Life is interpreted as purposeful activity.
2. Purposeful activity is considered in its analytical aspects as the response of boys and girls along their drive in the initiation of goal, evaluation of goal, choice of goal, initiation of means, evaluation of means, execution of means, initiation of improvement, evaluation of improvement, choice of improvement, consumation of improvement and leading to further goals. It is interpreted as a "complete act" involving the responses of children along their drive in all its component parts.
3. Growth is interpreted as continuous change in children's drive and response along the trails of purposeful activity.
4. Education is conceived as changing the drive and response of children along the trail of purposeful activity.

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[1]Doman and Tiedman, loc. cit.

5. Teaching is interpreted as stimulating and directing the purposeful activities.

6. It follows, the efficiency of teaching is revealed, through measuring the extent of the functioning of children's responses along their drive in the trails of purposeful activity, for drive is a measure of the appropriateness of stimulation and response direction.[1]

It appears that Collings realized the importance of the student responses, but did not feel it should be a major section for analysis of the teaching-learning process.

Another investigator in this general area was Barr, then at the University of Wisconsin. In an effort to develop a criterion of teaching success Barr used:

1. A composite of gains in test scores made by students during the experimental period of the Stanford Achievement Test.

2. A composite of the ratings of teachers made by the superintendents of schools on seven different rating scales twice applied.

3. A composite of the scores made by teachers on nine measures of qualities associated with teaching.

4. A composite of all the foregoing measures, the validity of each of the nineteen instruments of measurement employed in this investigation was studied. . . . In general, the values calculated were exceedingly low, most of them, when expressed in terms of coefficients of correlations, falling between 0 and .35.[2]

Barr indicated that he felt that these unsatisfactory results were due to errors in measurement on all variables and the minuteness of the contributions made by any one of the variables measured. He continued:

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[1]Elsworth Collings, "A Conduct Scale for the Means of Teaching," Journal of Educational Methods, VI (November, 1926), 97-102.

[2]A. S. Barr, "The Measurement of Teaching Ability," Journal of Educational Research, XXVIII (April, 1935), 561-69.

> In a manner we appear to fall into the same error in our measurement of teaching ability when we attempt to measure teaching ability through measures of the teacher's health, her intelligence, knowledge of subject matter, method, etc. Probably what we need to do now, is turn our attention to the development of functional tests measuring the teacher in action.[1]

A piece of research that could well be considered to be the forerunner of interaction studies was produced by C. D. Jayne of the University of Wyoming in 1945. The purpose of the study was to seek the relationships that exist between observable teacher activities and the changes produced in the pupils as measured by tests. Jayne's work was centered around the following classroom activities:

1. Total number of questions
2. Number of question facts
3. Number of prepared thought questions
4. Total prepared questions
5. Answers repeated
6. Percentage of pupil talk
7. Percentage of teacher talk
8. Recall of specified fact questions
9. Prepared fact questions
10. Answers indicated to be right
11. Unprepared fact questions[2]

The results of Jayne's studies were somewhat similar to Barr's; at the 1 per cent level approximately 6 per cent of the coefficients were statistically significant. This would be approximately 20 out of 336 subjects. As a result Jayne drew the conclusion that there was little relationship between specific observable teacher acts and the pupil gain criterion.[3]

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[1] *Ibid.*

[2] C. D. Jayne, "A Study of the Relationship Between Teaching Procedure and Educational Outcomes," *Journal of Experimental Education*, XIV (December, 1945), 101-34.

[3] *Ibid.*

Even though Jayne's work did not produce distinct relationships between observable teacher action and pupil gain, it did help to develop further the area of observable action within the classroom.

Notable among the studies in this area was that of Withall, who in 1948 categorized teacher classroom statements and questions and derived a climate index.[1] This index was developed to indicate the degree to which verbal behavior was "learner supportive" or "teacher supportive." Withall's instrument, the "Social-Emotional Climate Index," is, in part, related to the instrument used in this study, the difference being the purposes for which they were designed. The Withall instrument assesses the social-emotional climate through the evaluation of teacher statements, whereas the instrument used in this study is composed of assessments of the types of questions, the pupil's response patterns, and the major teaching functions.

The Provo Code for the Analysis of Teaching

Late in 1961 the Provo City Schools, Provo, Utah, issued a progress report of the staff-designed merit program. One aspect of the Provo study was to produce an instrument for evaluation of teaching. The evaluation instrument encompassed by this report is a segment of the instrument used in the present study. The staff of the Provo City Schools collected specimen tape recordings of various members of the staff, analyzed them, and developed a set of definitions which can be applied to a record of actual observation of classroom teaching.

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[1]John Withall, "Assessment of the Social-Emotional Climates Experienced by a Group of Seventh Graders as They Moved from Class to Class," Educational and Psychological Measurements, XII, No. 3 (1952), 440-451.

R. L. Egbert discussed "The Provo Code for the Analysis of Teaching" as:

> . . . an instrument for which there is not a predetermined key which reduces scoring to a counting procedure. Thus, we are not sure that two people would describe a given record the same. An item of teacher behavior is not either right or wrong: it is rather an item which is classified in one of about eighty categories. Scoring this type of instrument becomes very complex, and the initial aspect of consistency which should be examined seems to be to determine whether two people see the same sort of teaching taking place in the items of a particular teaching record. If this facet of reliability, inter-rater consistency, can be established as being satisfactory, other aspects may then appropriately be investigated.[1]

It would be feasible to point out at this stage that the primary purpose of the Provo merit study was to determine what might be considered good or poor teaching.

Using the Provo City School records, Hughes and associates developed a model of good teaching which was another effort at setting a standard for teacher-pupil interaction that they could consider acceptable.[2] Using the categories of Controlling, Facilitating, Development of Content, Personal Response, Positive Affectivity, and Negative Affectivity, Hughes and associates developed a percentage scale for each category. These percentages indicated the times each major function could take place within the framework of the model and still have the teaching evaluated as sound.[3] Once again, this was a method of evaluating or categorizing teaching efforts.

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[1] R. L. Egbert, "The Provo Code for the Analysis of Teaching--Its Reliability," (unpublished report, Provo Board of Education, 1959), cited in Patterns of Effective Teaching (Provo, Utah: Provo City Schools, 1961), p. 7.

[2] Marie M. Hughes, et al., A Research Report--Assessment of the Quality of Teaching in Elementary Schools (Provo, Utah: University of Utah, 1959).

[3] Ibid.

Analysis of Patterns of Pupil Responses

In the 1960's Harris of the University of Texas was working on an analysis of pupils' responses. He felt that the manner in which teachers conduct discussions, recitations, or oral actions of any type was an important aspect of teaching, and that the pattern developed by the teacher in recognizing students and in turn eliciting responses from them could be described and analyzed.

Harris's work resulted in an instrument entitled "Analysis of Patterns of Pupil Responses," which was copyrighted in 1961.[1] It included five basic segments or divisions of response which could be tallied as they occurred. The result was a form of pattern based on the pupils' responses. This instrument has been more completely described in Chapter II of this study.

Teacher Question Inventory

During this same period Harris, in collaboration with McIntyre, was working on an instrument to analyze questions formed and asked by the teacher during the act of teaching. They developed different categories or types of questions that could be used in a teaching situation. These types were then used to form a pattern showing the types of questions employed in the individual classroom. This instrument was copyrighted in 1961 as the "Teacher Question Inventory" by its developers, Harris and McIntyre, of the University of Texas.[2]

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[1]Ben M. Harris, "Analysis of Patterns of Pupil Responses," (Austin: University of Texas, 1961). (Dittoed).

[2]Kenneth E. McIntyre and Ben M. Harris, "Teacher Question Inventory," (Austin: University of Texas, 1961). (Dittoed).

The three instruments described above and used in this study are "The Provo Code for the Analysis of Teaching," "Analysis of Patterns of Pupil Responses," and the "Teacher Question Inventory."

Mathematics Area

The field of mathematics at all levels is currently undergoing a closer scrutiny than ever before. A large number of projects intended to bring about extensive changes in the traditional curriculum are under way.[1]

This interest in a revision of the mathematics curriculum is not exclusively of recent development. It might be well to consider that mathematics in general and school mathematics in particular, are now, and have been for the past five thousand years, a dynamic element characterized by change and growth. This idea was illustrated by the first issue of The Arithmetic Teacher in February, 1954. It contained a lead article entitled "The Revolution in Arithmetic."[2]

Almost a decade later the basic title is still being used, for example, "The Revolution in School Mathematics: A Challenge for Administrators and Teachers."[3] This would be but one illustration, for one could uncover numerous speeches, panels, films, and experimental tests devoted to the same theme--the revolution in school mathematics.

Studies in Mathematics Education (Chicago: Scott, Foresman and Company, 1959), p. 57.

W. A. Brownell, "The Revolution in Arithmetic," The Arithmetic Teacher, I (February, 1954), 1-15.

"The Revolution in School Mathematics: A Challenge for Administrators and Teacher," (Washington, D. C.: The National Council of Teachers of Mathematics, 1961), p. 90.

There were times when the rate of change was hardly perceptible, but at other points in history the field of mathematics was actively revised and major curriculum changes resulted. The complete and radical change from a deductive to an inductive approach in the organization of mathematics programs brought about by Charles Colburn in 1821 would be illustrative of periodic change.

Prior to this century two theories determined the content of the school mathematics program. The first was the sociological approach, based on the need of society for mathematical training. The second was the logical approach, centered around the need for the subject to be taught as a system of related ideas.[1]

In the Roman civilization a clear-cut separation of these two approaches was made. The plebian was taught the practical uses of arithmetic, or logistics. The patrician studied arithmetic as a science of numbers, or <u>numerorum scienta</u>.

A third approach was the result of the creation in this century of more knowledge about the conditions of effective learning, the nature of human growth and development, and the nature of mental health and its relationship to classroom learning. This third theory has often been referred to as the psychological approach.

The three theories have influenced the mathematics curriculum from time to time. These influences would be felt in accordance with the emphasis placed by the schools at a particular time. Of these theories

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[1]V. J. Glennon, "Balanced Progress in School Mathematics," <u>Educational Leadership</u>, XIX (March, 1962), 354-58.

the one having the greatest impact on the school mathematics program today is the science of numbers point of view.

The child may employ both intuitive and analytic thinking in his mathematics explorations. He may get the "correct answers" to a problem even though he does not effectively utilize intuitive thought. Once he has reached the correct answer he may or may not be able to rationalize or prove it. If he cannot, the instructor is needed to help him find and see the relationships which made his solution possible.

It is generally agreed that teachers of elementary school mathematics can do much to help pupils to "discover" mathematical concepts for themselves. Bruner states that among the discovery techniques are such approaches as

> . . . use of the Socratic method, the devising of particularly apt computation problems that permit a student to find regularities, the act of stimulating the student to short cuts by which he discovers for himself certain interesting algorisms, even the projection of an attitude of interest, daring and excitement.[1]

A study by Syracuse University reported that classes beginning as low as Grade 3, with a full range of intelligence quotients, have achieved success with this nonexpositional method.[2]

Beberman developed the idea that new programs in mathematics need not be centered around questions concening new subject matter. He stated:

> The real question is whether or not students should understand the skills which are taught in both the conventional and the new programs. This is not a trivial issue. If you decide on an understanding approach, the implications of this

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[1]Jerome S. Bruner, "On Learning Mathematics," The Mathematics Teacher, LIII (December, 1960), 610-19.

[2]Robert Davis, "The Syracuse University Madison Project," The American Mathematical Monthly, LXVII (February, 1960), 178-79.

> commitment are far reaching. For example, the question of time becomes important. It requires only a few minutes of a conventional program to tell students how to solve systems of equations. It will take the better part of a class hour to use the other (discovery) approach. Moreover, to use the other (discovery) approach requires a consistency of treatment prior to this point in the curriculum in order to develop in the student a taste for and a delight in logical explanations. . . . Finally, there is the terrible hazard of thinking that any approach which emphasizes logical explanations leads to understanding.[1]

Justification

It became apparent that a basic integral portion of the current changes in mathematics programs included the discovery concept. "The discovery approach to learning is utilized to different degrees in all the new programs."[2]

In light of the preceding statement, it seemed feasible to study more closely the School Mathematics Study Group program, with special emphasis on the Teacher's Commentary, or manual. In this way a more complete and definite conclusion could be drawn as to the integral importance and position of the discovery element in the program.

From Manual Ea3 of the Teacher's Commentary, Mathematics for the Elementary School, the section entitled "Nature and Properties of Addition and Subtraction," the following was taken:

> When talking about operations to children, we shall frequently describe them as ways of thinking about numbers to get another number. When the child adds 9 and 5 to get 14 or subtracts 9 and 5 to get 4, he simply thinks of 9 and 5 in two different ways. The emphasis in this unit is on the operation of addition. Subtraction is described as the operation of

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[1]Max Beberman, "The Old Mathematics in the New Curriculum," Educational Leadership, IXX (March, 1962), pp. 373-75.

[2]National Council of Teachers of Mathematics Regional Conference Report (Washington, D. C.: National Council of Teachers of Mathematics, 1961), p. 79.

> finding a missing addend in an addition situation. A child should BE HELPED TO CONCLUDE THAT IF HE CAN ADD, HE CAN SUBTRACT, FOR SUBTRACTION IS FINDING A MISSING ADDEND. Thus the need to emphasize the so-called subtraction facts is eliminated.[1]

This basic idea was developed further in the Teacher's Commentary when it stated:

> We believe that the child can now come to greater understanding and greater enjoyment of his environment through more discriminating observation. He will be provided with guide lines for productive thinking about the figures with which he is now familiar by means of exploratory discussions and developmental exercises.[2]

In a discussion of the geometric aspects of the program the School Mathematics Study Group Teacher's Commentary stated:

> This is not a deductive development of geometry. It is an intuitive approach and an inductive development of some of the basic understandings and skills of geometry.[3]

The preceding excerpts substantiated and further extended the idea that the discovery technique is an integral and basic element of the School Mathematics Study Group mathematics program. It should be distinctly present in all classrooms where S. M. S. G. mathematics is being taught.

Statement of the Problem

The purpose of this study was to determine whether differences in teacher-pupil interaction patterns exist between those classes receiving

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[1]Mathematics for the Elementary School, Teacher's Commentary, Manual Ea3 (New Haven: School Mathematics Study Group, Yale University, 1960), p. T2.

[2]Ibid.

[3]Ibid.

instruction in the traditional mathematics and those receiving instruction in the "new" (School Mathematics Study Group) mathematics concepts.

Specifically, the answer to the following question was sought: What basic differences in patterns of teacher-pupil interaction exist between those conventional mathematics classes observed and those classes observed which were receiving School Mathematics Study Group conceptual instruction?

The design of this study has attempted to provide for the influencing factors that might exist between classroom teachers because of their years of experience and college preparation.

It is believed that the design of this study will serve to eliminate differences that might exist in the tallying of the observable dimensions of interaction as interaction takes place in the classroom between the teacher and the pupil.

Basic Hypothesis

This study has attempted to establish a basis for the testing of the following null hypothesis: There is no significant difference between the teacher-pupil interaction patterns that exist in those classes receiving instruction in traditional mathematics and those classes receiving instruction which includes the School Mathematics Study Group concepts.

Definition of Terms

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

<u>School Mathematics Study Group</u> - the mathematics program designed by the School Mathematics Study Group with segments copyrighted by Yale University and Stanford University.

Traditional mathematics - those mathematics programs that do not involve the use of the copyrighted School Mathematics Study Group materials.

Teacher-pupil interaction - those statements and questions posed by the teacher and the resultant responses of the students.

Major Assumptions

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

1. That the "Analysis of Patterns of Pupil Responses" as designed by Harris has provided a pattern of interaction of the teacher and pupils when used as the observation criterion in the classroom.

2. That the "Teacher Question Inventory" as designed by Harris and McIntyre has provided a method for categorization of teachers' questions.

3. That "The Provo Code for Analysis of Teaching" has provided a method for categorization of the major teaching functions.

4. That those classes using textual material which includes School Mathematics Study Group concepts were receiving instruction in experimental mathematics concepts.

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

6. That those classes using textual materials which did not include experimental mathematics could be considered to be receiving conventional mathematics instruction.

7. That the patterns which have resulted from the observations were the outcome of the subject area taught rather than the result of the teacher's personality.

Procedures and Analysis of Data

The purpose of this study was to examine the interaction pattern differences between the School Mathematics Study Group and traditional mathematics. This was accomplished through the observation and categorization of teacher-pupil interaction as it took place in the classroom. For the purposes of this study the following delimitations have applied:

1. This study involved twenty classes of boys and girls enrolled in the fourth grade in the public schools. Ten of these classes were receiving instruction in traditional mathematics. The remaining ten classes were receiving instruction in School Mathematics Study Group mathematics and using S. M. S. G. textual materials.

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

3. The conclusions which have been drawn 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 operating at the time the study was made. 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 under the following conditions:

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

   (b) On the first or last school day of the week.

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

(d) During a class period which the teacher considered a review period.

(e) At the same time or day as the previous observation unless the teacher's daily schedule rigidly required that she hold the mathematics class at the same time each day.

Data and Instrumentation

The general plan employed in conducting the study was as follows:

1. The selection and preparation of an observation guide which provided for the enumeration of interactions as they occurred in the classroom under observation.

2. The selection and notification of teachers whose classrooms would be visited.

3. The visiting of the classrooms, using the observation guide selected and the tallying of the events as they occurred.

4. The use of a small portable tape recorder to record the teacher-pupil interaction as it was being observed.

5. The validation of the observation tally by evaluation of the recorded tape of the actual observation.

6. Second visit to the classroom for purposes of again tallying and recording observable 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 Harris.[1] This "Analysis of Patterns of Pupil Responses" fulfilled the observation requirements for the area encompassed by the pupil responses.

Another segment of the observation instrument was the "Teacher Question Inventory."[2] This fulfilled the observation requirements for the area encompassed by the questions asked by the teacher.

The third and final segment of the criterion used in this study was an instrument for the observation and tabulation of the major teaching functions. It was developed by Hughes and others during a study of the Provo, Utah, City Schools as a portion of a teacher evaluation instrument. It was entitled "The Provo Code for the Analysis of Teaching."[3]

These three elements comprised the instrument used in this study. Their original designs were for the purpose of evaluating teaching. Their use in this study was for the distinct purpose of discovering patterns of interaction and not for purposes of evaluation.

Selection and notification of teachers. The building principals initially selected the teachers who were to be given the opportunity to participate in this study. They met the following criteria:

1. Each teacher selected had a minimum of three years of teaching experience in the elementary grades.

2. Each teacher selected who was teaching the School Mathematics Study Group materials must have had at least one year's prior experience teaching the new mathematics at the fourth grade level and must have

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[1]Harris, loc. cit.

[2]McIntyre and Harris, loc. cit.

[3]Hughes, loc. cit.

participated in at least one experimental mathematics workshop or have taken a college level course designed to facilitate the teaching of experimental mathematics.

3. Each teacher selected who was teaching conventional mathematics must have taught at the fourth grade level the preceding year.

Prior to the observation visit the teachers were contacted personally and the purposes of the study were outlined. They were assured that no names were to be included in the tally sheet nor in the final draft of the study. The classes were identified by number only. The teacher identification numbers were known only to this writer, who acted as the single observer during the study. The teachers were assured that the results of the tally and the tape recordings made in their rooms were not available to anyone other than the dissertation committee without the teacher's written consent.

Steps were taken to assure the teachers that the observation information was not being used in any evaluative form. Before proceeding, this observer was certain that the teachers selected were convinced and satisfied that any threatening situation involved in the study as far as the teacher was concerned was minimized. The teachers were notified in person that the observation visit was to take place during a specified five-day period.

Classroom visitation. The observer seated himself in the classroom in such a manner and position as to be able to observe adequately and hear all transactions between the teacher and the students. This seating placement was such that it caused the least possible confusion in the classroom. The observation tally was made while the interaction was taking place and being observed.

The observation period for tallying purposes began with the first teaching function that occurred and ended when the students began seat work or after thirty minutes had elapsed.

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

Use of the portable tape recorder. During each observation period a small portable tape recorder was used to record the interaction as it progressed. The recorder was capable of taping an entire period of observation without a change of tape. Each tape was marked for identification purposes.

Second observation visit. A second visit to each of the classrooms took place no sooner than five days after the first observation. This visit was for the purposes of again observing, tallying, and taping the teacher-pupil interaction. This process further validated the data already obtained.

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. At a later time and away from the classroom observed, the tape recording of the observed class was reviewed. An effort was made to validate the tallies that were made during the classroom observation period.

Organization of the data. The statistical analysis of the data encompassed a comparison of the categories of the observation instrument with each of its counterparts. A composite of the tallies in each category of the School Mathematics Study Group classes was compared with a composite of its counterpart of the traditional groups.

The statistical instrument used was the z score for comparison of observed data.[1] Level of confidence for z was set at 0.01 level. The following formula for z was used:

$$z = \frac{P_1 - P_2}{\sqrt{(P_c q_c)\,(1/N_1 + 1/N_2)}}$$

$$\text{where } P_c = \frac{X_1 + X_2}{N_1 + N_2}$$

$$\text{where } q_c = 1 - P_c$$

Format for Succeeding Chapters

The succeeding chapters of this study contain an analysis of the instruments, statistical analysis and interpretation of data, analysis of the tallies, and conclusions drawn from the study.

Chapter II presents the instruments used in the study, their component parts, their definitions, and some background as to the procedure used in the development of the instruments. Chapter III presents the data collected and its treatment. Chapter IV contains the summary, findings of the study, conclusions drawn, and recommendations for further study.

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[1]J. P. Guilford, Fundamental Statistics in Psychology (New York: McGraw-Hill Book Company, Inc., 1956), pp. 221-222.

CHAPTER II

INSTRUMENTATION OF THE STUDY

The rationale in the original development of each of the instruments used in this study was focused on the process of teacher evaluation. Each of the instruments used was developed independently of the others. The evaluation of teaching is not included as one of the elements of this present study; however, the three instruments were combined for use in this study because of the specific elements each conveyed for the total observation process. It is interesting to note that each of these instruments was developed in basically the same manner.

The Provo Code for Analysis of Teaching

The Provo City Schools study began its development in the winter of 1954-55 when the teachers and the administrative group began discussing the advisability of entering into a contract with the state to study the feasibility of merit rating. After careful consideration the teachers, through their association, voted in favor of entering into a contract with the state for the purpose of attempting to develop a valid merit system. The state at this time also entered into a contract with two other pilot districts with the same purpose in mind.

It was a definite assumption that each of the districts would design and activate its own individual approach to the problem of the evaluation of teaching. The only possible aspect of the individual studies that could be considered structured would be the point of departure for each of the schools which centered around the question, "Is merit rating feasible?"[1]

The Provo City Schools began its study by forming four sub-questions which were to be viewed as the focal point of their work. The questions were stated as follows: (1) Can teaching ranging from good to poor be described or defined satisfactorily? (2) Can teaching ranging from good to poor be measured with sufficient accuracy? (3) Can the measured quality of teaching performance be rewarded financially? (4) Can all of this be done with satisfactory over-all results?

Consultants were called upon to assist in the search for a design that could solve their problem in the most effective manner. After due consideration by staff members, consultants, and administrators, it was decided that for a program of the type desired it would be necessary to develop a scientific and valid procedure. As this idea was pursued it became apparent that if the first question could be answered (Can teaching ranging from good to poor be described or defined satisfactorily?), the balance of the project would be relatively easy. If this question could not be answered, then there would be no need to develop the ensuing questions.

The Provo study began with this basic goal. Research efforts were centered around an attempt to describe teaching in a reliable and valid manner.

To accomplish this goal it was decided that the area of teacher behavior would be most fruitful for research, since studies centered on

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[1]Gretta P. Romney (dir.), Patterns of Effective Teaching (Provo, Utah: Provo City Schools, 1961), p. 2.

the characteristics of teachers and on efforts to evaluate teaching by studying pupil growth both seemingly had been unsuccessful.

The basic assumption upon which the study by Provo City Schools was predicated was that the major responsibility of the teacher rests in his interaction with the pupils. With this idea as a focal point the suggestion then followed that teaching can profitably be seen as the quality of the interaction between the pupils and their teacher. The rationale for this particular idea was presented in "Teaching Is Interaction."[1]

Thus a basis for further development of the Provo City Schools' study of evaluation was established. The questions to be answered had been formulated and the rationale for the work involved began to take form.

For the purpose of developing criteria the teachers selected 34 staff members who were actively engaged in classroom teaching to represent the entire staff of 213 teachers. These teachers recorded specimens of their own teaching during their regular classroom teaching periods through the use of a tape recorder and three microphones. A total of 973 records of actual classroom teaching, varying in length from a few minutes to one-half hour, was obtained in this way. These tape recordings provided the basic materials for the analysis and description of the teaching that took place in the classroom while the act of teaching was proceeding.

The categories which developed as a result of the above procedure used in the Provo City Schools are as follows:[2]

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[1]Marie M. Hughes, "Teaching Is Interaction," The Elementary School Journal, LVIII (May, 1958), 457-64.

[2]Romney, op. cit., Appendix A.

1. Functions which control. These functions serve basically to control the teaching situation. They may influence content, but in a controlling way. They exercise the teacher's power to the fullest or may develop it in varying degrees of kind and quality.

2. Functions which facilitate. These functions tend to move the interaction along. The teacher clears the way or makes the factors in the situation more definite so that things may happen.

3. Functions which develop content by response. These functions respond to the data which students feed into the interaction by adding relevant information through the elaboration of what the student has said, by opening ways of exploring ideas, by clarifying concepts expressed by pupils, and by stating established values that are called for.

4. Functions which serve as a personal response. These functions serve to respond to students in terms of their personal needs. Opportunity is present to consider each student as a person with demands and needs in the situation, and to respond in a way that has real meaning to him.

5. Functions of positive affectivity. These functions serve to build positive relationships and feelings in the personal aspects of teaching interaction.

6. Functions of negative affectivity. These functions attempt to control personal relationships by responding negatively to the interaction.

The categories described above were used, as defined, to fulfill the major teaching functions aspects of this study.

Teacher Question Inventory

The basic idea used in developing the foregoing segment also applied to the development of the "Teacher Question Inventory."[1] Its developers, Harris and McIntyre, used the same general idea in compiling the various parts of the inventory. They visited schools, keeping in mind the necessary segments that might be encompassed by the process of teacher-pupil interaction.

This instrument was also developed as a part of an evaluative guide. The authors felt that it was necessary for an observer to have a guide of some kind which would give him a purpose as well as specific items to look for. The authors developed a set of categories which might fit the types of questions the teacher could ask.

The feeling was held by both authors that the formulation of a good question is a specialized teaching skill and that many teachers have difficulty formulating good questions. The following observation guide was developed so that teachers might be aware of the types of questions they are asking and be given some assistance in analyzing them. This activity might in turn help them to develop skill in questioning that leads to deeper levels of understanding:

1. Recognition. This type of question asks for a response that involves a choice or decision between items.

2. Recall. This type of question requires the student to draw from past experience, or requires simple recall of a single fact with no choices being given.

3. Demonstration of skill. This type of question requires the

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[1]McIntyre and Harris, loc. cit.

student to demonstrate in one form or another his proficiency in the area being discussed. An example might be a question asking for work to be done at the blackboard or that the student work a problem at his desk and disclose his results upon completion.

4. Comprehension. This form of questioning is exemplified by questions such as the following: Can you give me an example? What do you mean? What will we do now?

5. Analysis. This kind of question involves some analysis by the student. The questions might be stated as follows: Why did it happen? How are they similar? How are they different? Could we do this in another way?

6. Synthesis. This form of question would follow this theme: What general principle do you see in this? What wouldhappen if it were organized in another way? What is the relationship of one thing to another?

Following this same trend of thought, the authors also developed two categories for questions of an affectivity nature. They are centered around the student's beliefs, or call for him to make a value judgment of one form or another. These categories are:

7. Opinion. A question of this type might be worded thus: What do you suppose? How do you feel about this? What is your opinion on this issue?

8. Attitudes or values. This type of question, if asked, requires the student to take a position on some issue under discussion.

The types of questions described above were used to fulfill the question inventory segment of this study. Harris and McIntyre felt that there might be other types of questions that could be asked, but these eight types encompass virtually all questions relative to the subject matter or content of the lesson.

Analysis of Patterns of Pupil Responses

Teacher behavior is extremely complex. Therefore, it was felt that as many facets of the teaching act as feasible should be included in a study of this nature. It was decided that how the classroom teacher elicits oral responses from the pupils in a discussion or oral recitation period has some implications for the consideration of a pattern of interaction between the teacher and the pupil.

The "Analysis of Patterns of Pupil Responses" developed by Harris fulfilled the last of the three important segments of the observation instrument.[1] It calls for the observer to code the different types of responses that were elicited by the teacher. The responses were coded as follows:

1. Individual response, individual designated. The teacher asks for a response from a specific student and the student responds. The symbol used to indicate this type of response was (1).

2. Individual response, group designated. The teacher asks for a response from the group and selects a single student to respond. The symbol used to indicate this type of response was (Φ).

3. Individual response, no one designated. A student responds to a teacher question or other cue without being selected to respond. The symbol used for this type of response was (ɨ).

4. Spontaneous response. There is no teacher cue and no one

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[1]Harris, loc. cit.

designated. The symbol used for this occurrence was (0).

5. Mass response. All or many of the students respond simultaneously to a question or other cue from the teacher. The symbol used to indicate this event was (X).

The three observation instruments described comprised the composite criterion measure used in observing classes for the purposes of this study. In the "Teacher Question Inventory" the questions are arranged in ascending order of complexity. This arrangement allowed the observer to note the general tone of the questions as the teacher-pupil interaction proceeded. Tabulations of the questions, using the inventory, during a discussion period, has produced data which revealed a pattern of questioning.

"The Provo Code for the Analysis of Teaching" categories and the "Analysis of Patterns of Pupil Responses" also provided data that revealed a pattern of action as it took place in the classroom. The combination of these three observation instruments provided a basis for comparison of the two types of programs under observation in this study.

CHAPTER III

TREATMENT OF THE DATA

The primary purpose of this study was to examine the teacher-pupil interaction patterns between School Mathematics Study Group and traditional mathematics. This purpose was accomplished through the use of data gathered from the observation of pupils and teachers at the fourth grade level in the greater Oklahoma City area.

The data consist of tallies made during the observation of twenty teaching periods of School Mathematics Study Group materials (hereafter sometimes referred to as S. M. S. G.) and the observation of twenty teaching periods during which traditional mathematics concepts were being presented. The tallies were placed in the various categories described in Chapter II as each of these events occurred. The raw data of this study are presented in the Appendix.

The schools to be observed were chosen on the basis of their statements concerning the extent to which they used in the fourth grade, in the purest possible form, either traditional mathematics or the S. M. S. G. program. In other words, no school was selected for this investigation which had "mixed" mathematics programs. Since the Oklahoma City Schools had only twenty schools which were presenting the S. M. S. G. program, it was deemed desirable to include also schools outside the Oklahoma City system. This same practice was carried through in the traditional observations as well. Thus the observation data were drawn from the school systems of Oklahoma City, Midwest City, Nicoma Park, and Crooked Oak.

The choice of the teachers observed was left to the discretion of the principal of each school. It was felt that the teachers thus chosen for observation would be considered by the administration to be among the better staff members, and the teachers would fulfill, in addition, the necessary requirements outlined in Chapter I.

The technique use for statistical analysis of the data was the normal standardized deviate z score (hereafter sometimes referred to as z or z statistic).[1] The appropriateness of z lay in the fact that the data represent observed frequencies. An application of z was made for each pair of categories. Level of confidence for z was set at the .01 level, which required a value that was equal to or greater than 2.57 for significance.

The null hypothesis was formulated that there were no significant differences between the teacher-pupil interaction patterns that existed in those classes receiving instruction in traditional mathematics and those classes receiving instruction which included the School Mathematics Study Group concepts.

Teacher Question Inventory

The questions that were asked by the teacher during the teaching act were categorized using the "Teacher Question Inventory" described in Chapter II.[2] Data in Tables 1 and 2 present the statistical results.

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[1]Guilford, loc. cit.

[2]McIntyre and Harris, loc. cit.

The category of Recognition, which involved a choice or decision between items by the student, obtained a z score of .528, which was below the established level of significance and could not be considered as indicating any statistical difference.

The area of Recall involved an attempt by the student to recall a single item without assistance of a choice being made between items. This category obtained a z score of 3.36, which was above the established level of significance. This would be an indication of a significant difference between the two programs under discussion for this particular category. The higher percentage of scores in this category was from the traditional program.

TABLE 1

PER CENT PROPORTIONS FOR THE TEACHER QUESTION INVENTORY CATEGORIES OF THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program	S.M.S.G. Program
Recognition	20.6	21.6
Recall	34.8	27.6
Demonstration of Skill	15.9	18.2
Comprehension	13.5	15.2
Analysis	9.5	9.8
Synthesis	.12	1.5
Opinion	5.4	5.9
Attitude	.2	.09

The area of Demonstration of Skill was tallied when the student was asked to demonstrate his proficiency by working a problem and revealing his answer immediately upon completion. The z score obtained for this classification was 1.31. At the .01 level this figure would indicate no significant difference for this category.

TABLE 2

N'S, PROPORTIONS AND RESULTANT z SCORES FOR THE TEACHER QUESTION INVENTORY CATEGORIES OF THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program		S.M.S.G. Program			
	N_1	P_1	N_2	P_2	z	
Recognition	174	.206	225	.216	.528	Not Significant
Recall	293	.348	287	.276	3.366	Significant
Demonstration of Skill	134	.159	189	.182	1.314	Not Significant
Comprehension	114	.135	158	.152	1.044	Not Significant
Analysis	80	.095	102	.098	.220	Not Significant
Synthesis	1	.0012	16	.015	3.151	Significant
Opinion	46	.054	61	.059	.466	Not Significant
Attitude	2	.0024	1	.0009	.813	Not Significant

Level of significance established at .01.

The area of Comprehension was marked when the pupil was asked by the teacher for an example or deeper explanation of an idea he was presenting. The z score obtained for this section was 1.044. This figure was not indicative of any significant difference between the two programs under investigation.

The category of Analysis was centered on questions that required more depth of thought. These questions called for an explanation of why an answer was correct or asking for further explanation of the results. This category obtained a z score of .22, indicating that there was no significant difference.

The Synthesis category was tallied when the teacher asked a question that involved a discussion of the general principle or the organization of the problem. This category obtained a z score of 3.15. At the .01 level this figure indicated a significant difference between the two mathematics programs for this segment. The S. M. S. G. program received the larger percentage of tallies in this section.

Opinion and Attitude were categories of an affectivity nature and received z scores of .466 and .813 respectively, indicating that in the area of affectivity no significant differences resulted from the tallying of these events.

The Provo Code for the Analysis of Teaching

Major teaching functions were tallied using "The Provo Code for the Analysis of Teaching."[1] Results are shown in Tables 3 and 4.

The category of Control, which was a structuring of the classroom activities, obtained a z score of 2.878. This score was slightly above the .01 level, which was previously set at 2.57. This figure indicated a significant difference between the two programs under study in relation to the area of Control.

The category of Facilitate was described as those actions by the teacher which tended to maintain the ongoing aspects of the program. This element achieved a z score of .146. This score indicated no significant difference at the .01 level.

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[1]Marie M. Hughes, et al., A Research Report--Assessment of the Quality of Teaching in Elementary Schools (Provo, Utah: University of Utah, 1959).

The category of Developing Content was tabulated when the teacher stimulated, clarified, or answered questions. The z score obtained for this category was 3.319. This figure was above the .01 level and indicated a significant difference. The S. M. S. G. program developed the larger number of tallies.

TABLE 3

PER CENT PROPORTIONS FOR THE PROVO CODE FOR THE ANALYSIS OF TEACHING CATEGORIES FOR THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program	S.M.S.G. Program
Control	33.0	27.6
Facilitate	12.8	13.0
Developing Content	24.2	30.3
Responds	4.9	9.3
Positive Affectivity	9.1	8.2
Negative Affectivity	15.9	11.5

The Responds element was described as those times when the teacher responded to the pupil in terms of content and the pupil's effort to learn, or interpreted feelings involving mistakes and pupil problems. The Responds category obtained a z score of 4.149. This score did indicate a significant difference in favor of the S. M. S. G. program.

The category of Positive Affectivity was an element of integrative behavior. The teacher encouraged, praised, gave recognition or showed positive regard for the pupils. The z score for this category was .248. This score did not indicate a significant difference for Positive Affectivity for the observations involved in this study.

The category of Negative Affectivity was classified as a dominative type of behavior which was exemplified by such actions as admonishing, reprimanding, or otherwise showing negative regard for the pupils. This portion of the observations obtained a z score of 3.141. This figure indicated a significant difference, with the higher percentage being obtained by the S. M. S. G. program.

TABLE 4

N'S, PROPORTIONS AND RESULTANT z SCORES FOR THE PROVO CODE FOR THE ANALYSIS OF TEACHING CATEGORIES FOR THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program		S.M.S.G. Program			
	N_1	P_1	N_2	P_2	z	
Control	373	.330	350	.276	2.878	Significant
Facilitate	145	.128	165	.130	.146	Not Significant
Developing Content	274	.242	383	.303	3.319	Significant
Responds	56	.049	118	.093	4.149	Significant
Positive Affectivity	103	.091	104	.082	.248	Not Significant
Negative Affectivity	180	.159	146	.115	3.141	Significant

Level of significance established at .01.

Of the major teaching functions dealt with in this study, four categories have been shown to be significant at the .01 level. The categories of Control, Developing Content, Responds, and Negative Affectivity showed significant differences between the two programs observed. All of the four mentioned categories, with the exception of the Control category obtained a larger per cent of tallies in the S. M. S. G. program.

The total number of tallies of teacher-pupil interaction developed in "The Provo Code for the Analysis of Teaching" segment was 2,397. The S. M. S. G. program developed the larger number of interaction tallies.

Analysis of Patterns of Pupil Responses

The responses elicited by the teacher from the students were tallied using the "Analysis of Patterns of Pupil Responses" described in Chapter II.[1] The information contained in Tables 5 and 6 shows the results.

TABLE 5

PER CENT PROPORTIONS FOR THE ANALYSIS OF PATTERNS OF PUPIL RESPONSES CATEGORIES FOR THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program	S.M.S.G. Program
Individual Response Individual Designated	32.3	37.9
Individual Response Group Designated	18.8	16.6
Individual Response No One Designated	20.1	5.9
Spontaneous Response	15.6	17.2
Mass Response	13.1	22.1

The Individual Response, Individual Designated, category was tallied when the teacher asked for a response from a specific student and that

[1]Harris, loc. cit.

student responded. The z score obtained for this segment was .795. This score did not indicate a significant difference. The larger number of these tallies was noted from the S. M. S. G. program.

The category of Individual Response, Group Designated, was tallied when the teacher asked for a response from the group and selected a single student to respond. This segment of the observation data achieved a z score of .364, indicating that there was no significant difference between the two programs under investigation for this particular segment.

TABLE 6

N'S, PROPORTIONS AND RESULTANT z SCORES FOR ANALYSIS OF PATTERNS OF PUPIL RESPONSES CATEGORIES FOR THE TRADITIONAL AND SCHOOL MATHEMATICS STUDY GROUP PROGRAMS

	Traditional Program		S.M.S.G. Program			
	N_1	P_1	N_2	P_2	z	
Individual Response Individual Designated	249	.323	297	.379	.795	Not Significant
Individual response Group Designated	145	.188	130	.166	.364	Not Significant
Individual Response No One Designated	155	.201	46	.059	2.705	Significant
Spontaneous Response	120	.156	135	.172	.273	Not Significant
Mass Response	101	.131	173	.221	1.49	Not Significant

Level of significance established at .01.

The category of pupil responses classified as Individual Response, No One Designated, was scored when the student responded to a teacher question or other cue without being selected to respond. This element obtained a z score of 2.705. Thus a significant difference at the .01 level was indicated in favor of the S. M. S. G. program.

The category of responses which required no teacher cue nor was any student designated was called Spontaneous Response. This category obtained a z score of .273, indicating that no significant difference could be noted.

In many classrooms there was simultaneous response by all or many of the students to a question or cue from the teacher. This category of the observations was called Mass Response and obtained a z score of 1.49. This figure was an indication of no significant difference. The S. M. S. G. program received the larger percentage of tallies in this category.

The teaching functions were categorized using "The Provo Code for the Analysis of Teaching." The two programs under observation elicited a total of 2,397 tabulations. This was an average of 2.29 units of action in the teaching functions area. These were divided between the two programs, with the S. M. S. G. program developing 2.47 units of action per minute as compared with the traditional program average of 2.10 units per minute.

The questions the teacher asked were categorized according to the "Teacher Question Inventory" described in Chapter II. This area encompassed all the questions asked by the teacher. There was a total of 1,884 tabulated teacher questions during the duration of the observations. These were tallied, with the S. M. S. G. program developing an average of 2.03 questions per minute, while the traditional program obtained an average of 1.57 units per minute.

Theoretical Considerations

As was noted in the development of Chapter I, the discovery technique is a vital aspect of the S. M. S. G. program. The discovery technique, then, should be considered a major segment of the presentations within the S. M. S. G. classrooms. A presentation of this form would be most evident in the types of questions posed by the teacher. A logical assumption might be that questions of an analysis, synthesis, and comprehension nature should comprise at least one-half of all questions posed.

The results of the tabulations did not corroborate this assumption, for within the S. M. S. G. program only 26 per cent of the questions fell into these groups. A study of both the traditional and S. M. S. G. programs revealed that the combination of programs produced less than 25 per cent in those areas associated with the discovery technique as mentioned previously.

Presentation of a question that requires depth of thought and analysis of ideas necessitates complete understanding of the subject matter areas as well as an understanding of the complex art of questioning. The teachers in this study who were presenting the S. M. S. G. program had a distinct unwillingness to present questions that required analytical thought by the student.

A cause and effect relationship is in existence at this point. The lack of utilization of the discovery technique is the effect. There may be many probable causes for this effect, but the more prominent ones stem from the lack of an inservice education program or formal course work which produces a deep commitment to the philosophy and methodology of the new mathematics. Any curricular or instructional change is predicated on the belief that there must be a basic behavioral change on the part of the individuals involved in this experience. A question may be raised as to whether or not a significant behavioral change has occurred in the experience of the teachers of the S. M. S. G. mathematics.

The S. M. S. G. program is relatively new in its present form. It is new especially in terms of its introduction and use as a major element in the classroom. The teachers have had little time to bring their attention to the real problems in the program. One might also conclude that the time spent in studying the S. M. S. G. program must have been spent on the specialized content rather than on the methodology which is espoused in the descriptions of the new math in S. M. S. G. publications. This thought is exemplified by the lack of full implementation of the unique methodology ascribed to the new math program.

A large majority of the S. M. S. G. teachers structured their presentations directly from the textbook. Presentations of this type entail reading the questions outlined in the text and rarely if ever moving away from the security of a highly structured situation. This same atmosphere of insecurity was noted when the students were spontaneously offering thoughts relative to the area being discussed which were never developed further by the teachers. In many instances the questions posed by the students offered more opportunity for insight into the discussion area than did the questions posed by the teachers.

The teachers in the S. M. S. G. program exhibited every evidence of a lack of complete understanding of one of the basic ideas inherent in the program, that being to require the child to develop and understand relationships existing in the program. This development and understanding of relationships was to be accomplished through skillful teaching utilizing the discovery technique. It was evident that a complete understanding of the ideas encompassed by the discovery technique was lacking in virtually all teachers observed.

Emphasis in the inservice programs evidently was aimed toward the content of the program with little or no effective development of the concepts of reasoning behind the presentations. The teacher was given the concrete materials with which to work, but lacked the aims necessary to accomplish the goals of the program. It could be a valid assumption to state that the teachers fail to understand the program because there has been too little time for a complete development of the program itself, much less a comprehensive understanding by the teachers. There seems to be a lack of understanding on the part of the teachers of the unique qualities which are desired for the program.

The teacher should have readily available appropriate materials to help her in using desirable procedures to develop and achieve the goals outlined for the program. The lack of assistance of this nature again fits into the category of cause, in the cause and effect relationship.

A serious breakdown in communications or lack of communications between the staff inservice leaders and the site instructional leader is apparent. The teacher of the new mathematics in the Oklahoma City area has had to rely completely on the short indoctrination period afforded by summer workshop sessions or short once-a-week meetings for a complete understanding of the program, its unique aspects, the new materials, new goals, adjustments in the teacher-pupil relationships, and the development of a technique of teaching which is new and in many instances frightening to the teacher.

In this situation no communication lines were directed toward the teacher other than those of the specialist who directs the inservice program. The classroom teacher has few avenues to follow in trying to achieve clarification of some point or for development of an idea. The teacher, when confronted with this situation, reverts to the ideas and techniques that are most familiar and have been most successful in the past.

The development and active utilization of the S. M. S. G. program has been quite rapid. In fact, the rapidity of its introduction into the curriculum is another facet of the problem of presentation within the bounds prescribed in the teacher manual.

The period between inception and the time when the program has become an active portion of the curriculum has been short in relation to that of other programs received and maintained as valued aspects of the educational program.

The teachers observed have not had time to develop a complete understanding of all goals desired by the program for its students. Little attention has been given through inservice education to helping the teacher recognize desirable responses from her students and to show her how to use these responses as learning tools themselves. The S. M. S. G. program has not had time to develop and mature in the minds of the teachers.

CHAPTER IV

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This research project was a study of differences between teacher-pupil interaction patterns of School Mathematics Study Group programs and those of traditional mathematics programs in the elementary school. It was deemed worthwhile because major changes have taken place in the mathematics program in recent years, and because the mathematics program at the elementary school level is a vital area of the school curriculum which should be subjected to continuous evaluation. This study evolved from the premise that little research had been done to determine whether the teacher changes her teaching pattern as changes are made in the mathematics program. This study was also an attempt to determine whether interaction patterns between the teacher and pupil differ as a result of changes in emphasis brought about by changes in the program.

The purpose of this study was to determine whether significant differences in teacher-pupil interaction patterns exist between those classes receiving instruction in traditional mathematics and those receiving instruction which includes the School Mathematics Study Group concepts.

In order to accomplish the purposes of the study it was necessary to analyze the total instructional behavior to determine which facets might provide a direction for research. From the investigation it became evident that transactions between the teacher and pupil would provide a depth analysis of the teaching act. In analyzing the transactional dimensions, particular attention was given to the kinds of questions asked by teachers, responses elicited from pupils, and the major teaching functions of teachers, resulting in the use in this study of the "Teacher Question Inventory," "The Provo Code for the Analysis of Teaching," and the "Analysis of Patterns of Pupil Responses" as a composite instrument for observation of instructional patterns.

Twenty classes of regularly enrolled fourth grade students participated in the study. Ten of these classes were studying S. M. S. G. materials, while the remaining ten classes were studying traditional mathematics materials. These classes were chosen on the basis of the extent to which they exemplified, in the purest form possible, either the traditional mathematics program or the School Mathematics Study Group program. In other words, no school was chosen which used a "mixed" mathematics program. All of the classes observed were located in the greater Oklahoma City area and each class participating in the study was observed two times with an interim of at least five days between observations. A small portable tape recorder was used during each observation period. The tape recording was played at a later time in order to validate each tally made by the observer.

Statistical analyses using the z ratio for difference between correlated proportions were made to determine whether differences in observed data existed. The level of significance was established at .01.

Findings

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

1. In the cognitive operation of Recall, a significant difference

was revealed between the S. M. S. G. program and the traditional program, as observed in schools in the greater Oklahoma City area. The traditional program had the higher percentage of questions in this category.

2. A significant difference was noted in the Synthesis category. The S. M. S. G. program had a higher percentage of questions in the Synthesis category than did the traditional program.

3. The question categories of Recognition, Demonstration of Skill, Comprehension, Analysis, Opinion, and Attitude did not show any significant differences between the S. M. S. G. program and the traditional mathematics program.

4. In the major teaching functions, the category of Control, or functions used to control the teaching situation, a significant difference was obtained. The traditional program had a higher percentage of functions in this category than did the S. M. S. G. program.

5. A significant difference was noted in the category of Developing Content, which was tallied when the teacher added relevant information, clarified concepts, and expanded ideas. The S. M. S. G. program had a higher percentage of functions in this category.

6. The category of Responds was tallied when the teacher reacted to the pupil in terms of personal needs. A significant difference was noted for this category, with the S. M. S. G. program having a higher percentage of functions in this category than the traditional mathematics program.

7. When the teacher reacted negatively in the transaction, the category of Negative Affectivity was tallied. The teachers in the traditional mathematics program produced a higher percentage of tallies

in the category of Negative Affectivity than did those in the S. M. S. G. program, and a significant difference was noted between the two programs observed.

8. In the categories of Facilitate and Positive Affectivity, no significant difference was noted between the teachers in the S. M. S. G. program and those in the traditional mathematics program.

9. The category of Individual Response, No One Designated, was tallied when a student responded to a teacher question or other cue without being selected to respond. This category was the only pupil response category in which a significant difference was found between the S. M. G. G. program and the traditional mathematics program. The traditional program had the higher percentage of responses.

10. In the pupil response categories of Individual Response, Individual Designated; Individual Response, Group Designated; Spontaneous Response; and Mass Response no significant differences were found to exist between the S. M. S. G. program and the traditional mathematics program.

Conclusions

On the basis of the findings of this study the following conclusions seem tenable:

1. Since seven of the nineteen sub-hypotheses proved to be significant at the .01 level of confidence, the null hypothesis of no significant difference between the School Mathematics Study Group program and the traditional mathematics program was rejected as untenable. However, it must be realized that although a difference was discovered between the two programs, the number of teacher functions, questions

posed by teachers, and student responses related to the system of inquiry, discovery, and causal relationships represented only a small proportion of the total number of interactional behaviors between pupils and teachers.

2. The S. M. S. G. teachers observed may be characterized as posing more questions of a divergent nature, with special reference to the general principles involved in the material under discussion. While these teachers asked more divergent questions, they also spent more time adding relevant information through elaboration of what a student had said or clarifying concepts expressed by the students. Teachers in the S. M. S. G. program developed more interaction with their students, and during this interaction they were more aware of the personal needs of their students than were their counterparts in the traditional program.

3. In this study the teachers of traditional mathematics classes may be characterized as utilizing cognitive memory operations to a greater degree than any of the other operations that might have been utilized. Even though there was greater evidence of rigidity in the traditional mathematics classes than in the S. M. S. G. classes, there was still sufficient freedom to permit the students to participate with enough enthusiasm that they would answer questions or cues for discussion in an orderly manner before being identified or designated by the teacher to respond.

4. Similarities in the S. M. S. G. and traditional programs were found in questions of a convergent nature. This similarity was also found in questions of an evaluative nature, when the students were asked to form an opinion or state an attitude. Within the questions asked by the teachers there was a similarity in the category of

of Recognition, which is a cognitive memory operation. This similarity was also apparent in the category of Analysis, which is a divergent operation. Teachers in both S. M. S. G. and traditional programs observed could be characterized as having similarities in those functions designed to add to the ongoing progress of the lesson as well as those actions designed to develop positive relationships and feelings in the personal aspects of interaction. The patterns of recognizing students developed by the teachers of the S. M. S. G. and traditional mathematics programs were similar in all aspects with the exception of those responses by the students to the teacher's question or cue without being called upon.

Recommendations

On the basis of the information drawn from this study, the following recommendations are made:

1. It was found that both the S. M. S. G. and traditional mathematics programs used a high percentage of cognitive memory operations in the interaction processes. The proportion of questions of this type should be reduced in favor of questions of greater depth.

2. The importance of positive relationships with the students has been accepted as vital for many years by child psychologists. A comparison of the areas of positive and negative affectivity indicates the need for greater interaction designed to create positive relationships between the teacher and the student.

3. It has been found that although the teachers of the S. M. S. G. program do use more questions of a divergent nature than do teachers of the traditional mathematics, the proportion of such questions should

be increased.

4. The teachers of both mathematics programs should be more cognizant of ways in which they recognize and elicit responses from their students. There should be a distinct reduction in the percentage of Individual Response, Individual Designated, responses in favor of response patterns intended to encourage all the students to participate actively.

5. An extension of the inservice programs in mathematics is recommended, to give the teacher a more complete understanding of the goals desired by the program as well as a more thorough background in the mathematics field.

6. It is recommended that an active program of follow-up be instituted after the initial inservice program.

7. Development of closer lines of communication between the instructional leader, building principal, and teachers is recommended.

8. Emphasis in the inservice program is recommended in those areas recognized as major goals of the program itself. This emphasis would include the development of techniques of teaching unique to the S. M. S. G. program.

Recommendations for Further Study

One of the major goals of interaction studies is to attempt to specify the conditions under which learning is maximized. With this goal in mind, the following suggestions for further study are tendered:

1. The use of the interaction process in other subject matter areas in an effort to determine whether differences in interaction patterns exist.

2. An extension of this area of research for a better understanding and description of the intellectual processes that occur in the classroom.

3. Child-centered research as well as teacher-centered research in the field of interaction.

4. The initiation of studies attempting to answer the question, "Why and when should a teacher react in either a dominative or integrative manner?"

5. Extension of the studies of cognition to determine the levels of complexity of cognitive encounters which take place and the reasons for variations of these levels of complexity.

6. Studies of a broad scope that will assess the role of the teacher, with emphasis on the social skills as compared with the academic skills required to release maximum learning potential in the student.

7. Instigation of research designed to facilitate the development, in the teacher, of an understanding and skill in questioning.

8. A study to identify the instructional patterns used by teachers who are considered to be highly effective teachers as opposed to those who are considered to be ineffective teachers.

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APPENDIX

APPENDIX A

RAW DATA

RAW DATA

TEACHER QUESTION INVENTORY CATEGORIES FOR THE SCHOOL MATHEMATICS STUDY GROUP PROGRAM

Teacher	Recognition	Recall	Demonstration of Skill	Comprehension
1	12	10	8	8
1a	6	12	9	8
2	9	17	12	25
2a	5	9	7	13
3	11	11	1	3
3a	21	12	16	11
4	25	15	4	0
4a	3	3	2	1
5	17	16	21	11
5a	15	27	18	3
6	11	13	5	1
6a	15	30	10	2
7	10	10	15	8
7a	7	17	1	4
8	10	31	11	21
8a	8	14	4	14
9	18	21	3	12
9a	8	9	3	0
10	11	10	21	10
10a	3	3	18	3

TEACHER QUESTION INVENTORY CATEGORIES FOR THE SCHOOL MATHEMATICS STUDY GROUP PROGRAM (Continued)

Teacher	Analysis	Synthesis	Opinion	Attitude
1	5	0	6	0
1a	3	0	5	0
2	5	1	2	0
2a	10	0	3	0
3	1	0	0	0
3a	3	0	4	0
4	9	0	2	0
4a	0	0	2	0
5	3	1	8	0
5a	2	0	1	0
6	3	1	1	0
6a	12	1	0	0
7	7	5	0	0
7a	13	2	1	1
8	5	2	0	0
8a	10	3	5	0
9	6	0	0	0
9a	1	0	7	0
10	1	0	8	0
10a	3	0	6	0

RAW DATA

TEACHER QUESTION INVENTORY CATEGORIES FOR THE TRADITIONAL MATHEMATICS PROGRAM

Teacher	Recognition	Recall	Demonstration of Skill	Comprehension
1	5	8	9	3
1a	10	7	12	0
2	12	13	3	8
2a	1	6	4	0
3	8	25	2	6
3a	12	21	4	13
4	5	9	15	15
4a	10	13	7	6
5	14	10	17	4
5a	1	4	0	1
6	11	17	1	3
6a	1	5	3	7
7	17	24	10	8
7a	11	27	3	7
8	4	10	7	2
8a	8	13	5	9
9	17	24	3	2
9a	9	30	14	5
10	3	9	10	8
10a	15	19	5	7

TEACHER QUESTION INVENTORY CATEGORIES FOR THE TRADITIONAL MATHEMATICS PROGRAM (Continued)

Teacher	Analysis	Synthesis	Opinion	Attitude
1	1	0	4	0
1a	6	0	6	0
2	2	0	3	0
2a	0	0	0	1
3	16	0	10	0
3a	7	0	1	0
4	9	0	0	0
4a	0	0	4	0
5	2	0	1	0
5a	0	0	0	0
6	1	0	0	0
6a	1	0	7	1
7	6	0	0	0
7a	5	0	3	0
8	3	0	1	0
8a	3	0	1	0
9	9	1	1	0
9a	1	0	0	0
10	1	0	0	0
10a	7	0	4	0

RAW DATA

ANALYSIS OF TEACHING CATEGORIES FOR THE SCHOOL MATHEMATICS STUDY GROUP PROGRAM

Teacher	Control	Facili-tate	Developing Content	Responds	Positive Affec-tivity	Negative Affec-tivity
1	14	7	15	1	3	4
1a	21	5	24	0	9	9
2	14	12	32	3	5	3
2a	8	5	29	3	2	2
3	12	8	16	0	4	3
3a	19	8	20	6	8	8
4	30	8	20	10	2	5
4a	15	3	3	1	1	2
5	15	18	21	15	7	7
5a	34	7	14	25	7	3
6	5	14	23	5	8	11
6a	21	13	26	3	1	6
7	9	12	11	0	0	7
7a	22	5	20	9	5	6
8	5	4	19	3	4	4
8a	13	3	16	1	5	6
9	5	6	25	1	2	8
9a	26	10	20	5	13	14
10	31	8	16	11	9	20
10a	31	9	13	16	9	18

RAW DATA

ANALYSIS OF TEACHING CATEGORIES FOR THE TRADITIONAL MATHEMATICS PROGRAM

Teacher	Control	Facilitate	Developing Content	Responds	Positive Affectivity	Negative Affectivity
1	15	4	12	1	7	7
1a	23	9	21	8	2	11
2	1	5	19	1	2	1
2a	19	5	5	6	11	8
3	3	12	17	0	8	15
3a	11	7	17	2	4	16
4	7	9	19	0	6	3
4a	11	3	8	0	4	0
5	36	7	24	0	2	37
5a	13	2	5	0	0	4
6	29	5	14	6	2	15
6a	32	7	10	7	5	22
7	16	8	20	7	8	4
7a	16	2	19	2	5	1
8	36	12	10	4	12	6
8a	22	7	7	3	13	0
9	27	4	18	3	1	9
9a	22	13	8	4	2	10
10	19	13	8	0	6	1
10a	15	11	13	2	3	10

RAW DATA

ANALYSIS OF PATTERNS OF PUPIL RESPONSES CATEGORIES
FOR THE SCHOOL MATHEMATICS STUDY GROUP PROGRAM

Teacher	Individual Response Individual Designated	Individual Response Group Designated	Individual Response No One Designated	Spontaneous Response	Mass Response
1	14	14	0	2	10
1a	16	9	0	5	5
2	27	0	1	8	0
2a	3	0	3	3	3
3	23	8	0	5	1
3a	18	6	5	4	3
4	0	0	16	6	5
4a	9	0	3	1	3
5	1	0	5	6	12
5a	16	0	2	10	21
6	17	2	1	12	6
6a	17	11	0	10	25
7	29	12	0	5	3
7a	28	11	0	17	18
8	33	23	0	16	12
8a	12	3	1	8	7
9	14	16	2	17	3
9a	8	3	1	0	5
10	10	6	2	0	27
10a	3	6	4	0	4

RAW DATA

ANALYSIS OF PATTERNS OF PUPIL RESPONSES CATEGORIES
FOR THE TRADITIONAL MATHEMATICS PROGRAM

Teacher	Individual Response Individual Designated	Individual Response Group Designated	Individual Response No One Designated	Spontaneous Response	Mass Response
1	1	0	25	4	7
1a	6	8	4	2	10
2	3	2	9	2	4
2a	1	1	9	1	1
3	13	11	2	33	7
3a	14	12	16	7	10
4	11	8	0	11	0
4a	4	3	32	1	0
5	16	7	0	3	6
5a	4	0	0	1	0
6	21	9	0	12	11
6a	2	5	0	0	2
7	12	10	0	4	9
7a	3	0	29	2	6
8	11	16	0	8	8
8a	0	0	26	8	0
9	40	25	0	8	3
9a	34	11	0	5	12
10	29	5	3	3	2
10a	24	12	0	5	3

APPENDIX B

OBSERVATION INSTRUMENTS

OBSERVATION INSTRUMENT

TEACHER QUESTION INVENTORY*

Teacher________________________ Grade or level________________

Subject________________________ Topic________________________

Date__________ Time__________ Observer______________________

Question Types	Frequency	Total	Per Cent
A. COGNITION			
1. Recognition (Which of these? Was it this way or that? etc.)			
2. Recall (Who? What? When? etc.)			
3. Demonstration of skill (What is English translation? How would you work the problem? etc.)			
4. Comprehension (Can you give me an example? What do you mean? etc.)			
5. Analysis (Why did it happen? How are they similar? How do they differ? etc.)			
6. Synthesis (What general principle can you see in this? What would happen if it were organized some other way? etc.)			
B. AFFECTIVITY			
1. Opinion (What do you suppose? How would you feel? What is your opinion? etc.)			
2. Attitudes or values (What is your position on that issue? etc.)			
TOTAL - All Types			

*To be presented in greater detail in forthcoming book by Kenneth E. McIntyre and Ben M. Harris. Copyright by authors, 1961.

OBSERVATION INSTRUMENT

MAJOR TEACHING FUNCTIONS*

Control

These functions serve to control the teaching situation. They may influence content but in a controlling way.

Facilitate

These functions add to the on-going progress of the lesson--tend to move the interaction along.

Developing Content

These functions respond to the data which students feed into the interaction by adding relevant information through elaboration of what the student has said, by opening ways of exploring ideas, and by clarifying concepts expressed by pupils.

Responds

These functions serve to respond to students in terms of their personal needs.

Positive Affectivity

These functions serve to build positive relationships and feelings in the personal aspects of teaching interaction.

Negative Affectivity

These functions attempt to control personal relationships by negatively responding to the interaction.

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*Gretta P. Romney, (dir.), Patterns of Effective Teaching, (Provo, Utah: Provo City Schools, June 1961).

OBSERVATION INSTRUMENT

ANALYSIS OF PATTERNS OF PUPIL RESPONSES*

The way teachers conduct discussions, recitations, or oral tests in the classroom is one important aspect of teaching. The teacher's pattern of recognizing students and eliciting responses from them can be described and analyzed.

INSTRUCTIONS

Tabulations of the frequency and type of response by each pupil in the classroom provide the basis for analyzing this aspect of teaching. A seating chart is used as the tabulation sheet. Each pupil response is coded in the square for each responding pupil.

A variety of types of student responses should be tabulated with a distinguishing symbol for each, as follows:

<u>Symbol</u>	
1	<u>Individual response, individual designated</u>. The teacher asks for a response from a specific student and that student responds.
Φ	<u>Individual response, group designated</u>. The teacher asks for a response from the group and selects a single student to respond.
~~1~~	<u>Individual response, no one designated</u>. A student responds to teacher question or other cue without being selected to respond.
O	<u>Spontaneous response</u>. There is no teacher cue and no one designated.
x	<u>Mass response</u>. All or many students respond simultaneously to a question or other cue from the teacher.

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*Ben M. Harris, "Analysis of Patterns of Pupil Responses," Austin: University of Texas, 1961).

APPENDIX C

OBSERVATION TALLY SHEET

OBSERVATION TALLY SHEET

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						
7						

<u>Response symbols</u>

1 indiv resp
Φ group desig
ɨ no one desig
0 spontaneous resp
X mass response

Time begin__________
end__________

Locational info

____
____
____

QUESTIONS

RECOG	RECALL	DEMO OF SKILL	COMPRE	ANALYSIS	SYNTHESIS	OPINION	ATTITUDE

TEACHING FUNCTIONS

CONTROL	FACILITATE	DEVELOP CONTENT	RESPONDS	POS AFFECT	NEG AFFECT

APPENDIX D

PERMISSION FOR USE OF TEACHER QUESTION INVENTORY

THE UNIVERSITY OF TEXAS
College of Education
Austin 12

Department of Educational Administration

September 25, 1963

Mr. Robert G. Pate
2408 Maple Drive
Midwest City, Oklahoma

Dear Mr. Pate:

I have discussed your intended use of instruments developed by Dr. McIntyre and myself. We will be happy to have you use the pupil response analyzer and the teacher question instruments for your doctoral studies. We have revised the teacher question instrument substantially and you may want to consider using the new one. A copy is enclosed.

Since we do intend to use these instruments in forthcoming publications, we must ask that you indicate their source and designate them as copyrighted by us. With this in mind, we will be happy to have you use them and will be very interested in knowing about your findings.

Very truly yours,

(Signed) Ben M. Harris
Associate Professor and
Supervision Program Director

BMH:pa

Enclosure: 1