A COMPARISON STUDY OF THE EFFECTS OF PRE-SERVICE TEACHERS PRESENTING ONE OR TWO MICRO-TEACHING LESSONS TO DIFFERENT SIZED GROUPS OF PEERS ON SELECTED TEACHING BEHAVIORS AND ATTITUDES IN AN ELEMENTARY SCIENCE METHODS COURSE

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This is to certify that the

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Frederick Allan Staley

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ABSTRACT

A COMPARISON STUDY OF THE EFFECTS OF PRE-SERVICE TEACHERS PRESENTING ONE OR TWO MICRO-TEACHING LESSONS TO DIFFERENT SIZED GROUPS OF PEERS ON SELECTED TEACHING BEHAVIORS AND ATTITUDES IN AN ELEMENTARY SCIENCE METHODS COURSE

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Statement of the Problem

It was the purpose of this study to compare the effectiveness of a commonly accepted micro-teaching paradigm with other paradigms believed to be logistically more efficient for teacher preparation institutions having large pre-service teacher enrollments, limited instructional and supervisory personnel, and limited amounts of class contact time. "Effectiveness" was determined by pre-service teachers' performances on selected teaching behaviors while presenting micro-lessons in elementary school science to pre-service peers and to elementary school children. Attitudes towards teaching elementary school science and the experiences of presenting micro-lessons to peers were also considered.

Procedures

Two hundred forty pre-service teachers enrolled in an elementary science methods course during the 1970 winter term at Michigan State University were randomly assigned to one of six micro-teaching laboratory groups. From these groups a total of sixty subjects, ten from each group, were randomly selected.

The science methods course consisted of lectures, outside readings, auto-tutorial sessions and the micro-teaching experiences. In all phases of the course, live, video-taped, and symbolic models were used to provide instruction in the types of science teaching behaviors the pre-service teachers were to emulate while presenting micro-lessons.

All subjects had the same kinds of learning experiences during the course with the exception of the type of micro-teaching paradigm used for presenting micro-lessons to peers. The paradigms differed in two respects, number of micro-lessons presented (one or two) and number of pupils in the micro-teaching classes (four, eight, or twelve to sixteen peers). The treatment of presenting two micro-lessons to four peers was comparable to the commonly accepted micro-teaching paradigm.

Feedback and evaluation following these peer micro-lessons was provided the pre-service teachers via a <u>Micro-Teaching Rating Scale</u>. This evaluation was made by the pre-service teachers' peers who were the pupils or observers of the micro-lessons. Later, these evaluations were used to analyze differences in teaching behaviors between treatment groups.

Following the micro-lessons with peers, all subjects taught a micro-lesson, using the same lesson plan, to different groups of four elementary school children. These lessons were audio-tape recorded and an Audio-Tape Analysis Instrument was used to analyze pre-service teachers' behaviors.

To determine the pre-service teachers' attitudes a Semantic Differential Attitude Instrument was administered before the first class meeting and on the last day of the term.

Findings

Repeated measures, two-way analysis of variance used to analyze data from micro-lessons taught to peers indicated that there were no significant differences between treatment groups and no significant interaction effects in the pre-service teachers' science teaching behaviors.

Two-way analysis of variance used to analyze data from micro-lessons taught to elementary school children indicated that there were no significant differences between treatment groups and no significant interaction effects in the pre-service teachers' science teaching behaviors.

Two-way analysis of covariance used to analyze data collected from pre- and post-test attitude measures indicated that there were no significant differences between treatment groups. There were significant interaction effects but these were not due to significant differences between any pair of treatment groups.

The .05 level of confidence was used as the basis for determining significance.

Although few significant differences were found in pre-service teachers' teaching behaviors and attitudes between treatments, sufficient evidence was not found to indicate equality among the micro-teaching paradigms. The findings of this study can only be considered as an indication of the need for further study of the effectiveness of micro-teaching paradigms which make use of different sized micro-teaching classes and provide for the teaching of different numbers of micro-lessons.

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CHAPTER I

THE PROBLEM

The designs of current university programs for the pre-service preparation of elementary school teachers are currently receiving close scrutiny from a wide range of agencies and concerned individuals. The specific areas of science content and methods preparation included in the programs are not excluded from the focus of these inquiries. The literature is replete with statements challenging the quality and quantity of both science content and methods preparation. Smith notes, for instances, that "Teachers readily testify that formal courses in college science have not contributed in effective ways to improving their instruction."[1] Further, Gega indicates that "College science methods courses for teachers are generally of very limited functional value."[2] In addition to such statements it is often emphasized that the successful

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[1]Herbert A. Smith, "Educational Research Related to Science Instruction for the Elementary and Junior High School: A Review and Commentary," Journal of Research in Science Teaching, I (September, 1963), 221.

[2]Peter C. Gega, "College Courses in Elementary School Science and Their Relation to Teaching Programs," Science Education, XLII (October, 1958), 338.

completion of the objectives for science content and methods courses does not insure that graduating teachers will be able to transfer acquired knowledge, skills, and attitudes in a manner that will allow them to effectively teach science to elementary school children.[3]

As a method of providing pre-service teachers with opportunities to transfer their science learnings to science teaching under closely supervised conditions, micro-teaching is a relative newcomer in the field of teacher education. Yet, since its formal recognition and development in 1963 at Stanford University, micro-teaching has proven to be both a valuable and viable teacher preparation technique.

The micro-teaching format which evolved at Stanford University has become a prototype design and is utilized by many other institutions in the preparation of pre-service and in-service teachers. In this design pre-service teachers persent several short-duration lessons in specified content areas to small numbers of school-age children under the guidance of a supervisor. Each micro-lesson is designed to help pre-service teachers initiate or develop specific teaching behaviors and is followed by an evaluation-feedback session with the supervisor.

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[3]American Association for the Advancement of Science-Commission on Science Education, Preservice Science Education of Elementary School Teachers, AAAS Miscellaneous Publication 69-11, February, 1969.

Following the experiences gained in the evaluation session the lesson is then retaught to another group of pupils by the same pre-service teacher.

Need

With the undergraduate populations in elementary teacher preparation growing rapidly, the use of the original Stanford micro-teaching design becomes impractical in many institutions. For instance, the desirability of having three to five school-age pupils for each micro-lesson presents an impossible logistical demand for many institutions enrolling large numbers of teacher candidates. Where the numbers of pre-service teachers are large, there is also the problem of scheduling sufficient time for each student to present more than one micro-lesson in a given course period, thus weakening the teach-reteach pattern. An accompanying problem is that of contracting for sufficient supervisory personnel to permit the one student-to-one supervisor ratio suggested in the Stanford design.

Solutions to varying portions of these problems have already been suggested and tested. Some institutions have used other pre-service teachers as pupils for the micro-lessons without apparent hinderance to the development of appropriate teaching skills and attitudes.[4] Other

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[4]Robert B. Ashlock, "Micro-Teaching in an Elementary Science Methods Course," School Science and Mathematics, IL (January, 1968), 52-56; and Alan Steinbach, "A Comparative

institutions have been successful arranging for school-age children to come to the college campus and be pupils for micro-lessons during their off-school hours, often for pay.[5] Although not common, it is not unusual to find micro-teaching training centers on some campuses.[6] Such centers feature personnel trained specifically for providing supervisory assistance and feedback, coordinating the efforts of an entire college in establishing guidelines for the micro-teaching experiences that should be provided, scheduling pre-service teachers and school-age children, and video or audio-taping the lessons. Where centers are in existence, pre-service teachers can present several micro-lessons throughout their entire preparation period, thus over-coming the common problem of fitting five or six micro-lessons into the confines of one semester as required by one or two education courses.

Despite adaptions and improvements, the nagging problems continue to be tied to difficulties in finding pupils for the micro-lessons, too many pre-service teachers, too few supervisors, and inadequate time allotments. These

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Study of the Effects of Practice with Peers in the Science Methods Course" (unpublished Ph.D. dissertation, The University of Texas at Austin, 1968).

[5]At Stanford University, Brigham Young University, and University of Illinois, for example.

[6]William P. Johnson, "Micro-teaching: A Medium in Which to Study Teaching," The High School Journal, L (November, 1967), 86-92.

reservations have been particularly frustrating to institutions which prefer to utilize the micro-teaching technique as a means of providing first-hand teaching experience in connection with methods courses. Therefore, there is an urgent need to look at alternative designs to the Stanford format of micro-teaching; designs, for example, that will accommodate a group of 200 to 300 pre-service teachers enrolled in a ten week science methods course where micro-teaching is but one facet of the course and where limited supervisory personnel are available.

Purpose

Based on the problems and challenges to the implementation of micro-teaching experiences in the type of setting described above, it is the purpose of this study to examine the effects of certain adaptations to the Stanford design of micro-teaching on identified teaching behaviors and attitudes. The teaching behaviors and attitudes to be studied are quite similar to those studied at Stanford University as well as at other institutions using micro-teaching in teacher preparation programs. The teaching behaviors are those of (1) involving students in learning activities, (2) asking higher order questions, (3) providing neutral responses to pupil comments, and (4) pausing after asking questions and before responding to pupils. The teacher attitudes to be studied are those towards the following concept phrases: (1) teaching in the elementary school, (2) science in the elementary school, (3) myself teaching science in the elementary school, (4) student participation in science activities, (5) higher order questions in science teaching, (6) presenting a science lesson to peers for the practice of teaching elementary school science, and (7) small groups in the science methods course.

Specifically, it will be the purpose of this study to examine the effects on the above teaching behaviors of having pre-service teachers present a single micro-lesson to their peers as opposed to the procedure of presenting a second lesson following feedback and evaluation of a first lesson. This study will also examine the effects of presenting micro-lessons to peer groups numbering eight or sixteen as opposed to the more commonly recommended number of three to five pupils. Another purpose of this study will be to examine what effects the presentations of one or two micro-lessons to groups of four, eight, or sixteen peers have on the pre-service teachers' teaching behaviors while presenting micro-lessons to four elementary school children in an elementary school setting. As a final inquiry, it will be the purpose of this study to examine the effects of presenting one or two micro-lessons to groups of four, eight, or sixteen peers plus a micro-lesson to four elementary school children on the pre-service teachers' attitudes towards teaching elementary school science and towards the experiences of presenting micro-lessons to peers for the practice of teaching elementary school science.

Results of this study could (1) indicate the feasibility of alternatives to the Stanford micro-teaching design which would accommodate large numbers of pre-service teachers, limited time periods, and few supervisory personnel or (2) suggest that the recommendations and guidelines eminating from the original work at Stanford University cannot be greatly altered when dealing with defined types of teacher behaviors and attitudes.

Hypotheses

To investigate these and related possibilities, a given group of pre-service teachers enrolled in a science methods course at Michigan State University will have the opportunity to teach one or two micro-lessons to a group composed of either four, eight, or sixteen peers prior to teaching a micro-lesson to a group of elementary school children. The following general hypotheses will be tested:

1. There will be no differences in teaching behaviors while presenting micro-lessons to peers between pre-service teachers presenting one or two micro-lessons to groups of four, eight, or sixteen peers.

2. There will be no differences in teaching behaviors while presenting micro-lessons to four elementary school children between pre-service teachers who previously presented one or two micro-lessons to groups of four, eight, or sixteen peers.

3. There will be no differences in attitudes between pre-service teachers who presented one or two micro-lessons to groups of four, eight, or sixteen peers and one micro-lesson to four elementary school children.

Definition of Terms

For the purpose of this study, the following terms are defined as they should be used:

1. Micro-teaching is the teaching of an elementary science concept or process by one pre-service teacher in five to seven minutes to a group of four to sixteen peers or elementary school children.

2. A Micro-lesson is that five to seven minute activity aimed at teaching a specific concept or process which a pre-service teacher presents to a group of four to sixteen pupils.

3. A Pre-service teacher is an undergraduate student enrolled in an elementary science methods course who is preparing to become an elementary school teacher.

4. The Science Methods Course is a required course in the methods and techniques of teaching elementary school science.

5. Peers are pre-service teachers who are enrolled in the same course and who serve as pupils and evaluators

for the micro-lessons presented by their fellow pre-service teachers.

6. A Peer-Group is ten pre-service teachers of one treatment group who present their micro-lesson(s) to a specific number of peers. There are three peer-groups in this study: (1) those who present lesson(s) to four peers, (2) those who present lesson(s) to eight peers, and (3) those who present lesson(s) to twelve to sixteen peers.

7. A Lesson-Group is ten pre-service teachers of one treatment group who present either one lesson using their peers as pupils or two lessons using their peers as pupils.

8. A Supervisor is the instructor or graduate assistant who observes the micro-lessons, provides written evaluation and feedback, and coordinates the presentations of the micro-lessons.

9. The Micro-Teaching Rating Scale is an instrument used by a supervisor or peer to rate a pre-service teacher's teaching performance while presenting a micro-lesson to his peers. When returned to the pre-service teachers following their presentations this scale also serves as a feedback device (Appendix A, page 194).

10. The Audio-Tape Analysis Instrument is a three part measuring tool used to analyze the micro-lessons presented by pre-service teachers to elementary school children (Appendix C, page 200).

11. The Semantic Differential Attitude Instrument is a measuring tool used to determine the pre-service teachers' attitudes toward teaching elementary school science and the practice of presenting lessons to peers (Appendix D, page 205).

12. A Higher Order Question is a question that prompts a pupil to use ideas rather than just remember them. These might be questions which require a pupil to (a) evaluate, (b) infer, (c) compare, (d) apply a concept or principle, (e) solve a problem, (f) perceive cause and effect, or (g) make an observation.

13. A Lower Order Question is a question that requires a pupil to recognize or recall information. The pupil is not asked to compare or relate or make any inductive or deductive "leaps" on his own.

14. A Neutral Response made by a pre-service teacher is a non-evaluative verbal statement to a pupil often used to get a pupil to think about his answer or comment.

15. Attitudes, as used in this study, refer to a set of affective reactions toward teaching in the elementary school, science in the elementary school, teaching elementary school science, student participation in science activities, higher order questions in science teaching, presenting a science lesson to peers for the practice of teaching elementary school science, and small

groups in the science methods course. These reactions vary in intensity from positive through neutral to negative and are learned rather than being innate.

16. Inquiry is the process of scientific investigation which involves observing accurately and recognizing problems; formulating and stating questions or hypotheses clearly; designing and executing experiments utilizing equipment for counting and measuring; documenting evidence; classifying materials and ideas; and organizing and interpreting data to justify conclusions.

The Micro-Teaching Paradigm

The micro-teaching paradigm or model for studying teaching behaviors grew out of failures of previous attempts aimed at discovering the "criterion of teacher effectiveness" or the qualities of "good" teaching. In many cases such attempts were found lacking in supportive research and replicability. As Gage points out,

> The phrase "criterion of teacher effectiveness" betokens a degree of generality that has seldom been found in any branch of the behavioral sciences. It also reflects the mistaken notion that such a criterion, largely a matter of values, can be established on the basis of scientific method alone.[7]

With the micro-teaching paradigm, however, the first step in studying teaching behaviors is that of

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[7]Nathan L. Gage, "An Analytical Approach to Research on Instructional Methods," Phi Delta Kappan, XLIX (June, 1968), 602.

identifying and justifying those specific behaviors that are deemed important to be studied and developed. Gage, in referring to the notion of breaking down the total teaching act into specific behaviors, notes that:

> Rather than seek criterion for the over-all effectiveness of teachers in many, varied facets of their roles, we may have better success with criteria of micro-effectiveness in small, specifically defined aspects of the role. Many scientific problems have eventually been solved by being analyzed into smaller problems, whose variables were less complex.[8]

Once specific behaviors are identified the next step is to design a procedure for teaching these behaviors. After several alternative approaches were tried, a design for the teaching of these behaviors was discovered through the efforts of several people at Stanford University. Such instruction consists of various forms of perceptual and symbolic modeling techniques.

The next phase in the structure of the micro-teaching paradigm is that of presenting a lesson lasting from five to seven minutes to a small group of pupils. The purpose of this lesson is for the pre-service teacher to practice and develop those skills presented during the instruction phase. A supervisor and occasionally the pupils of the lesson then complete written evaluation

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[8]Nathan L. Gage, Handbook of Research on Teaching (Chicago: Rand McNally and Co., 1963), p. 120.

forms indicating the pre-service teacher's performance on the specific behaviors under study.

Following the micro-lesson, the pre-service teacher receives feedback and evaluation. Video-tape and audio-tape replays along with results of written evaluations are often used to provide such feedback.

Finally, the pre-service teacher replans his lesson in light of the suggestions of the supervisor and his own fresh thoughts. He then teaches the same basic lesson to a new group of students at the same grade level. At the end of the lesson the same feedback and evaluation procedures are followed. The supervisor also helps the pre-service teacher to evaluate his progress from teach to reteach session, and suggests ways the skill could be further improved.

The entire micro-teaching paradigm as outlined above is presented in Figure 1.1.

Although the specific technical skills deemed important to study may be quite debatable and there may be different variations of the micro-teaching paradigm, what is of direct importance is the

> . . . attempt to analyze teaching into limited, well-defined components that can be taught, practiced, evaluated, predicted, controlled and understood in a way that has proven to be altogether impossible for teaching viewed in the larger chunks that occur over a period of an hour, a day, a week, or a year.[9]

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[9]Gage, "An Analytical Approach," p. 602.

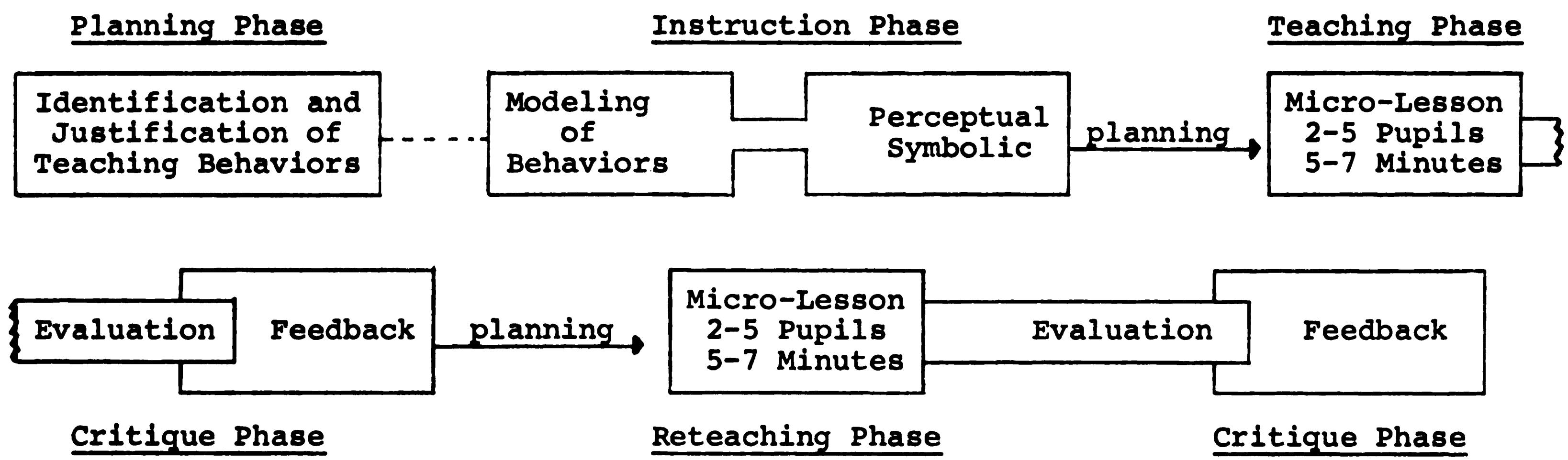

Figure 1.1.--Diagram of the Stanford micro-teaching paradigm.*

*This paradigm is an interpretation of Allen and Ryan's description of the structure of the micro-teaching paradigm. See Dwight Allen and Kevin Ryan, Microteaching (Reading, Massachusetts: Addition-Wesley Publishing Company, Inc., 1969), pp. 36-47.

Limitations of the Study

The main limitations of this study are as follows:

1. While there are several teaching behaviors and attitudes that relate to the relative effects of presenting different numbers of micro-lessons to differing numbers of peers, this study was limited to those behaviors pertaining to the asking of higher order questions, involving peers and children in verbal learning activities, providing neutral responses, and pausing after asking questions and before responding to pupil comments. The study was also limited to those attitudes towards teaching in the elementary school, science in the elementary school, teaching science in the elementary school, student participation in science activities, higher order questions in science teaching, presenting a science lesson to peers for the practice of teaching elementary school science, and small groups in the science methods course.

2. Evaluation was confined solely to pre-service teachers using the treatments described in this study and no effort was made to compare their teaching behaviors and attitudes with prospective elementary teachers who did not participate in this study.

3. In addition, this study was limited because it was impossible to determine the pre-service teachers' performance levels on the selected behaviors prior to the

beginning of the course. Thus, evaluation was confined solely to comparisons between treatment groups after treatment.

4. This study was limited in that sex as an uncontrolled variable was not investigated. This aspect was not included in this study since the random selection procedure yielded only six males out of the sixty subjects and there were no males in two of the treatment groups.

5. The investigation was limited to nine 100 minute lecture periods of which only a small portion of time could be spent on instruction of the behaviors emphasized in this study.

Basic Assumptions

In view of the nature of the study, and the techniques and instruments used, the following assumptions were made:

1. Teaching is a stylized form of human behavior and, as such, subject to study, analysis, and change.

2. Teaching can be described and the descriptions can serve as models for pre-service teachers.

3. It does not seem probable that a single style of teaching will exist for all teachers in all teaching situations. The patterns of behaviors emphasized in this study are not intrinsically good or bad. Rather,

it is assumed that these are patterns which are better suited to accomplish particular objectives.

4. In order for a pre-service teacher to develop the described skills, the skills must be learned and practiced.

5. It is better to practice such skills in a controlled and safe environment. Control and safety (physical and psychological) are brought about in micro-teaching by the use of supervisors and the structure of the micro-teaching paradigm.

6. Presenting micro-lessons to peers who do not try to assume the roles of elementary school children can be compared in effectiveness to presenting micro-lessons to elementary school children.

7. One of the goals of an elementary pre-service science methods course is to prepare teachers who will be able to effectively teach a micro-lesson in science to a small group of elementary school children.

8. The practice effect of using the Semantic Differential Attitude Instrument is negligible due to the ten week period of time between the pre- and post-tests.

9. The instruments and instructional procedures used in the study are reliable, valid, and effective for the purposes for which they were intended.

10. The time of day and day of week when the various tratment groups presented their micro-lessons did not affect the outcomes of the study.

11. The uncontrolled variable of sex differentiation, alluded to in the limitations of the study, did not affect the outcomes of this investigation.

Overview

In this chapter the needs for the study were indicated, followed by the purposes and intended uses that could be made of this study. Next, the development and structure of the micro-teaching paradigm was explained. Finally, Chapter I discussed the limitations and assumptions of this study.

In Chapter II the literature pertaining to those aspects of elementary school science which justify the emphasis on developing inquiry teaching behaviors and attitudes among pre-service elementary school teachers are reviewed. Next, literature pertaining to the use of micro-teaching as a means of developing specific teaching behaviors and attitudes among pre-service teachers are reviewed.

Chapter III contains a description of the science methods course and sample group of pre-service teachers selected from the population enrolled in this course. Information regarding procedures, design, research hypotheses, and statistical analysis used in this study are also present in Chapter III.

A description of the development and use of the three instruments designed for this study are presented in Chapter IV. The sources of data, analysis of data, and results based on the analysis are given in Chapter V. Chapter VI contains the summary, conclusions, discussion, implications, and recommendations for further research.

CHAPTER II

REVIEW OF LITERATURE

Although micro-teaching as originally conceived at Stanford University has been in use less than ten years, a review of the literature reveals that several studies have already been made of various aspects of the micro-teaching design. In an effort to establish a framework for this study and to justify some of the assumptions underlying the use of micro-teaching as a technique for learning and developing certain teaching skills and attitudes, literature and research relating to five areas of elementary science education are reviewed. These areas are: (1) Teaching Elementary School Science--The Past, (2) The Objectives of Elementary School Science, (3) Teaching Elementary School Science--The Present, (4) Specific Skills and Attitudes Required of the Teacher of Present Elementary School Science, and (5) Micro-Teaching as a Technique for Learning and Developing Teaching Skills and Attitudes.

Teaching Elementary School Science--The Past

Many current trends and changes in today's elementary school science are outcomes of some rather significant periods and philosophies of the past. Therefore, to better understand present practices in the teaching of elementary school science, it is helpful to examine the contributions resulting from the growth and development of elementary school science.

The Early Period

Lee reported that "From early colonial days until the mid-eighteenth century, no sicence was included in the school curriculum."[1] With the development of the academy in the late 1700's and the advent of public high schools in the 1820's, science finally was introduced into the secondary school curriculum.[2] It was not until the middle of the nineteenth century, however, that science became a part of the elementary school curriculum.[3] Hurd and Gallagher indicated that:

> Prior to this time, science was an incidental part of the child's studies. There were a few children's books relating to science, and some of these provided the basis for instruction. But most of the time teachers taught what they knew about the environment. Children were encouraged

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[1]Eugene C. Lee, New Developments in Science Teaching (Belmont, California: Wadsworth Publishing Company, Inc., 1967), p. 1.

[2]Ibid.

[3]Paul DeHart Hurd and James Joeseph Gallagher, New Directions in Elementary Science Teaching (Belmont, California: Wadsworth Publishing Company, Inc., 1968), p. 21.

> to observe the world about them, to identify and classify what they saw. The textbooks were written with a moralistic flavor, and each lesson closed with an exhortation to be kind, obedient, honest, and God-fearing. . . . While textbook authors sought to encourage careful observation and first-hand experiences by children, this was not always the practice. Books were more often used as readers, and there was little opportunity for direct observation and investigation. Instruction was descriptive and the content encyclopedic in nature.[4]

Object Teaching

In the years between 1850 and 1880 a method known as Object Teaching was developed and widely lauded both in this country and in Europe. Object Teaching was one of the first attempts to apply learning principles and to systematize science instruction.[5] This method grew out of the pedagogical theories of Pestalozzi, a Swiss educator.

Pestalozzi sought to bring about a change from the highly verbal and abstract approach of learning science to one relying on observing, experimenting, and reasoning. Engaged in this method, the teacher began lessons for early elementary school children with suitable objects which were observed and described. "Much of this teaching turned out to be a kind of vocabulary drill in which such technical terms as 'amorphous,' 'argilleceous,' and

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[4] Ibid.

[5] Ibid.

'excrescence' were typical."[6] Later in the child's development, training in the higher mental processes was facilitated through the reading of textbooks and charts, experimenting, and memorizing.[7]

Even though Pestalozzi's ideas were founded on some principles of learning that still hold today, the demise of Object Teaching was apparently caused by the lack of the teacher's understanding of the philosophy and skill in using the method. As Hurd and Gallagher pointed out, "Although it was Pestalozzi's ideal to maximize real experiences for children, in practice each lesson was taught as an end in itself, and the presentations (were) largely verbal."[8]

Nature-Study Movement

With the expansion of scientific knowledge in the late nineteenth century and the associated increase in science offerings in secondary schools and colleges, and with the shortcomings of Object Teaching, demands were made for more and better science in the elementary school.[9] These demands evoked a movement known as

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[6]Louis I. Kuslan and A. Harris Stone, Teaching Children Science: An Inquiry Approach (Belmont, California: Wadsworth Publishing Company, Inc., 1968), p. 113.

[7]Ibid.

[8]Hurd and Gallagher, New Directions, p. 22.

[9]Herbert A. Smith, "Historical Background of Elementary Science," in Readings in Science Education for

Nature-Study. Although the Nature-Study idea began in 1884,[10] it did not become an organized program in the elementary school until the beginning of the twentieth century.[11]

Liberty Hyde Bailey, a prime mover of the Nature-Study movement explained Nature Study in these words:

> Nature-Study is a revolt from the teaching of mere science in the elementary grades. In teaching-practice, the work and the methods of the two (science and Nature-Study) integrate . . . and as the high school and college are approached, Nature-Study passes into science-teaching, or gives way to it; but the ideals are distinct--they should be contrasted rather than compared. Nature-Study is not science. It is not facts. It is spirit. It is concerned with the child's outlook on the world.[12]

As might be expected from the title of the movement, the subject matter of the Nature-Study program dealt mainly with the study of living things in their natural environment, the unique characteristics of plants and animals, and their life histories. The stated objectives of the movement were such things as "to guide emotional

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the Elementary School, ed. by Edward Victor and Marjorie S. Lerner (New York: MacMillan Company, 1967), pp. 35-36.

[10]Kusian and Stone, Teaching Children Science, p. 115.

[11]Hurd and Gallagher, New Directions, p. 24.

[12]Liberty Hyde Bailey, The Nature Study Idea (New York: Doubleday and Company, 1903), pp. 4-5, cited by Kuslan and Stone, Teaching Children Science, p. 115.

response," "to develop a reverence for nature," and "to appreciate the value of truth."[13] These objectives were to be met by bringing the child in contact with the natural environment.

In spite of the lofty goals of Nature-Study, this movement also faultered. Its claims of ". . . aesthetic and emotional benefits to be derived from learning about nature were difficult to assess as pupil attainments."[14] "Very little time was typically spent in the out-of-doors. Children's learning experiences were mostly reading or listening to stories and fables, looking at pictures, and making and drawing models."[15] Furthermore, important goals of science education, such as the development of reasoning abilities and problem solving skills were not realized by the Nature-Study movement.[16] Finally, by its very nature, the movement almost completely excluded the physical sciences from the science curriculum.

Re-examination Period

With the wane of the Nature-Study movement in the mid-1920's other psychological, philosophical, and methodological views of education came into prominence. The

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[13] National Society for the Study of Education, Nature Study, Third Yearbook, Part II (Chicago: University of Chicago Press, 1904).

[14] Hurd and Gallagher, New Directions, p. 25.

[15] Ibid., p. 24.

[16] Ibid., p. 25.

limitations of Nature-Study, the expansion of technology, a renewed emphasis upon living in a democracy, the retreat from rural life, the growth of industrialism, and the virtual impact of science on all phases of human activity created the necessity for re-examining the place of science in the elementary school curriculum.[17]

The National Education Association, the National Society for the Study of Education, Gerald S. Craig, and John Dewey played paramount roles during this re-examination period. The National Education Association, for instance, laid groundwork by attempting to identify the major objectives of elementary school sicence.[18]

Craig followed with an extensive study of the "big ideas" which were at the core of the elementary science curriculums. The work of Craig was called by some as the ". . . most far-reaching influence on the development of elementary science of any single event in the history of the field."[19] Of this contribution Smith indicated:

> Craig saw the function of science in the elementary school to be significant in terms of general education, pointing out that the laws, generalizations, and principles of science have vital meanings to individuals regarding numerous questions which confront them. He also saw the utilitarian aspect as it related to health, safety, and the economy. He was aware, moreover,

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[17] Ibid.

[18] Ibid.

[19] Ibid.

of more than the cognitive aspects of science instruction and emphasized also the affective dimensions; attitudes, appreciations, and interests.[20]

Dewey, and other pragmatists of the time, were noteworthy for their influence in pointing out the importance of the "scientific method" as a major goal of science teaching. Smith noted that

> Dewey's contributions were numerous; but, perhaps the most significant for the developing field of elementary school science was his contention that the methodology of science is at least of equal-or-perhaps of greater significance than the actual knowledge accumulated.[21]

The Thirty-first Yearbook of the National Society for the Study of Education, published in 1932, capped the re-examination period by reaffirming Craig's research and presenting an interdisciplinary plan of teaching science.

> This yearbook for the first time offered a comprehensive program and advocated the definite organization of science instruction in all grades from first through twelfth. It proposed that all science instruction . . . be organized about certain broad generalizations or principles.[22]

As Kuslan and Stone pointed out, however,

> In the classroom . . . the study of generalizations for their own sake converted a well-planned and potentially valuable design into a travesty. The power of scientific principles to elucidate the complexities of nature, to predict physical

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[20]Herbert A. Smith, "Historical Background," p. 38.

[21]*Ibid.*, p. 37.

[22]National Society for the Study of Education, *Science Education in American Schools*, Forty-sixth Yearbook, Part I (Chicago: University of Chicago Press, 1947), p. 21.

> phenomena, and to affect social life was never fully understood by many teachers. The principles approach failed to produce any substantial agreement in the organization of curriculum materials.[23]

Post World War II Period

It has been said that science teaching came of age during World War II.[24] Realizing the importance of maintaining a scientifically literate citizenry, both government and private agencies began to channel money and talent into upgrading all aspects of the scientific enterprise.

> It was natural that the schools and their problems in training future scientists and technical workers soon became the objects of much attention. In contrast to earlier years, the scientists and the schools began operating in a science-favored climate.[25]

During this era the National Society for the Study of Education again made a major contribution in the form of the Forty-sixth Yearbook. Although many of the same objectives which characterized the Thirty-first Yearbook were reaffirmed, Smith noted that:

> There is a marked sensitivity to some of the affective objectives of science instruction in the Yearbook. There is also a more obvious reflection of sensitivity to the responsibility which educators have to prescribe the precise way in

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[23]Kulsan and Stone, Teaching Children Science, p. 126.

[24]Lee, New Developments, p. 3.

[25]Ibid.

> which statements of intangible and illusive objectives can be translated into practical programs and to determine how the effectiveness of instruction can be measured.[26]

Even though many believed the objectives stated in both the Thirty-first and Forty-sixth Yearbooks were sound, Hurd and Gallagher noted that, for the most part:

> These objectives were not achieved by children, and the way elementary science was taught could only insure that these goals would not be attained. Most of the time children simply read about science; even their textbooks were frequently identified as 'science readers.'[27]

The 1950 Decade

What occurred in the early part of the decade of the 1950's was an attempt to again formulate an interdisciplinary structure to science education. In the period between 1950 and 1960 over twenty elementary science textbook series were available and with the elementary science curriculum in the hands of textbook authors, such organizational frameworks as the "spiral curriculum" and the "block n' gap" approach came into practice.

Many of these elementary textbook series were characterized by an emphasis on "doing experiments."[28] Although it was realized that such an approach to science activities was probably fun, exciting, and caused

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[26]Herbert A. Smith, "Historical Background," p. 39.

[27]*Ibid.*, p. 29. [28]*Ibid.*

discussion, Hurd and Gallagher questioned the fact that these types of activities represented science.

> To those who know science best, the professional researchers, these activities (had) little relation to what scientists (did). To those interested in the intellectual development of children, there was little in these activities that . . . contributed to this growth.[29]

What happened in the later part of the 1950 decade was to have a direct and tremendous impact on the science in today's elementary curriculum. Through the combined efforts of scientists, researchers, and educators new experimental programs in physics, chemistry, and biological science were developed for the secondary school level. As was indicated in the Fifty-ninth Yearbook of the National Society for the Study of Education, science education was finally taking on some new dimensions.[30]

In this yearbook, appropriately titled Rethinking Science Education, both the conventional approaches to science teaching and the traditional subject-matter came under close scrutiny. As a result, many of the "old" approaches and subject matter areas were discarded in favor of those advocated in many of the new secondary science programs.[31]

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[29] Ibid.

[30] Lee, New Developments, p. 3.

[31] Ibid.

Lee indicated that there were three factors which were of primary importance in contribution to the revisions in secondary, and later in elementary, school science. These were: (1) the changes in philosophy of science education, (2) the new willingness of scientists and educators to pool their talents, and (3) new sources of money.[32]

Summary of the Past

This review of the history of elementary school science education revealed two important things:

1. Although many of the teaching practices and underlying philosophies of past elementary school science proved to be impractical or unsound, there were some characteristics of past elementary school science which withstood the advances in social, economic, scientific, technological, and educational thought and practice. These were the methods, procedures, and ideals which characterized much of present elementary school science. Among these surviving practices and ideals were the beliefs that (a) children should be provided with real experiences, (b) children should be actively involved in science activities, (c) the structure of the elementary science program should be interdisciplinary in nature, and (d) elementary school science consists of learning

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[32] Ibid., pp. 3-5.

the products of scientific endeavors as well as the methods used by scientists to discover and study science.

2. One of the apparent reasons for the failures of many of the past approaches to the teaching of elementary school science was the teacher's lack of understanding of the underlying philosophies and lack of skill needed to implement these programs.

Objectives of Elementary School Science

Substance to the conclusion that the ideals mentioned above have withstood the test of time was found in a review of the literature relating to the objectives of elementary science education. Indeed, the literature revealed that many of the objectives of present elementary school science had changed little since the time of the survey of the most commonly listed objectives for elementary science by the National Education Association in 1926.

The list of objectives published by the National Education Association was as follows:

1. To give practice in simple observation.
2. To give practice in purposeful activity.
3. To enlarge the vocabulary with the means of simple objects and processes.
4. To give experience in combining the factual and the emotional.
5. To guide emotional responses away from the highly subjective.
6. To start habits of scientific thinking in simple matters.
7. To start building attitudes toward the social effects of science.

8. To develop simple concepts such as cause and effect, the balance of nature, and the like.
9. To develop a simple reverence for nature.[33]

The thirty-first Yearbook of the National Society for the Study of Education published in 1932 indicated the importance of understanding the major generalizations and associated scientific attitudes as the objectives of science education. It was stated in the Yearbook that:

> The major generalizations and associated scientific attitudes are seen as of such importance that understandings of them are made the objectives of science teaching. These statements are so far-reaching in their implications that they may be said to encompass the fields of science. They touch life in so many ways that their attainment as educational objectives constitutes a large part of the program of life enrichment. . . . In the light of the foregoing it is proposed that the curriculum in science for a program of general education be organized about large objectives, that understanding and enlargement of these objectives shall constitute the contribution of science teaching to the ultimate aim of education, and that the course of study be so organized that each succeeding grade level shall present an increasingly enlarged and increasingly mature development of objectives.[34]

In 1947 the National Society for the Study of Education published the Forty-sixth Yearbook in which eight general categories of objectives were organized. The

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[33]National Education Association, The Nation at Work on the Public School Curriculum, Department of Superintendence, Fourth Yearbook (1926), p. 59, cited by Hurd and Gallagher, New Directions, p. 25.

[34]National Society for the Study of Education, A Program for Science Teaching, Thirty-first Yearbook, Part I (Chicago: University of Chicago Press, 1932), p. 44.

categories of objectives which would lead to the development of learning outcomes were: (1) functional information or facts, (2) functional concepts, (3) functional understanding of principles, (4) instrumental skills, (5) problem-solving skills, (6) attitudes, (7) appreciations, and (8) interests.[35]

In 1953 the Thirty-second Yearbook of the National Elementary Principal listed nine reasons for teaching science in the modern elementary school. It can be noted that the following list was a direct extension of the list of objectives formulated by the National Education Association in 1926. The nine reasons were:

1. To give practice in simple observations--as background for the future investigation and understanding of the environment.
2. To give practice in purposeful activity--as background for future experimentation and constructive labor.
3. To give experience in combining the factual and emotional (as caring for a well-loved pet or flower)--as background for future appreciations of natural law and beauty.
4. To enlarge the vocabulary with the names of simple objects and processes--as background for the future use of necessary technical terms.
5. To guide emotional responses away from the highly subjective and towards the objective--as background for future sensible attitudes and desirable behavior.
6. To start habits of scientific thinking in simple matters--as background for scientific thinking in important future decisions.

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[35]National Society for the Study of Education, Science Education, pp. 28-29.

7. To start building attitudes toward the simple social effects of science--as background for future cooperation in community programs of health and welfare.
8. To develop simple concepts such as cause and effect, balance of nature, cycles of nature, and the like--as background for future understanding of broad concepts like conservation of resources, the laws of learning, and even the sacredness of truth.
9. To develop simple reverence for nature--as background for future appreciation of the wisdom and power of God.[36]

A review of the Fifty-ninth Yearbook of the National Society for the Study of Education indicated that although the objectives for elementary science education had changed very little, there was a definite point of emphasis emerging. Such terms as "critical thinking," "scientific process," and "inquiry" indicated this point of emphasis.[37]

During the 1961-62 school year the United States Office of Education compiled a list of ten commonly accepted objectives of elementary science teaching. The list was then rated by a sample of the nations more than 87,000 elementary schools and it was found that at least forty per cent and as high as eighty-seven per cent of the schools rated the first nine objectives as "very important." The nine objectives were:

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[36]Honar A. Webb, "Nine Reasons Why," Science for Today's Children, Thirty-second Yearbook of the National Elementary Principal, Vol. XXXIII (September, 1953), p. 22.

[37]National Society for the Study of Education, Rethinking Science Education, Fifty-ninth Yearbook, Part I (Chicago: University of Chicago Press, 1960).

1. To help pupils develop curiosity.
2. To help pupils learn to think critically.
3. To introduce pupils to typical science topics--weather, electricity, and plant and animal life.
4. To help pupils acquire knowledge of their environment.
5. To help pupils develop an appreciation of their environment.
6. To develop problem-solving skills.
7. To develop in pupils a sense of responsibility for the proper use of science.
8. To prepare pupils for high school science.
9. To develop hobbies and leisure time activities.

The tenth objective which was rated as "very important" by only seventeen per cent of the schools was:

10. To develop scientists.[38]

In 1965 Newport conducted a study to determine whether the new experimental programs in elementary science education were being accompanied by changes in the objectives for elementary science, and to determine which objectives for elementary science most writers agreed upon.[39]

After reviewing objectives written between 1927 and 1962, Newport concluded that:

> Reverberations from the Space Age may have been partly responsible for the development of new science curriculum materials, but a close examination of science objectives provided no evidence

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[38]Paul E. Blackwood, "Science in the Elementary School," in Readings in Science Education for the Elementary School, ed. by Edward Victor and Marjorie S. Lerner (New York: The MacMillan Co., 1967), pp. 42-43.

[39]John F. Newport, "Are Science Objectives Changing?" School Science and Mathematics, LXV (April, 1965), 359-362.

> that a change in the objectives was occurring. Objectives stated in the 1930's seem to have survived a world war, the coming of the Atomic and Space Ages, numerous social changes, and some changes in teaching methods, science content, and other phases of science education. This study indicated that the new science materials currently being developed have probably resulted from general dissatisfaction with science teaching at the elementary school level rather than from the formulation of new purposes of science education.[40]

There were six objectives which were consistently found in most of the sources reviewed by Newport. These, listed below in order of frequency of occurrence, were to:

1. Develop scientific methods as a way of thinking and solving problems.
2. Develop understanding of the child's environment and his relationship to the physical world.
3. Develop scientific attitudes.
4. Develop the fundamental skills of measuring, observing, organizing and classifying, communicating information accurately, and manipulating science equipment and instruments.
5. Develop an appreciation of the contributions of science and the work of scientists.
6. Develop interests for leisure time activities.[41]

Finally, a review of two current methods textbooks which incorporated many of the objectives advocated by the new experimental programs in elementary science education, further indicated that certain objectives had changed very little. In Blough and Schwartz's textbook four basic objectives were listed. These were as follows:

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[40] *Ibid.*, p. 362.

[41] *Ibid.*, pp. 361-362.

1. To help children to understand some generalizations or "big meanings" or scientific principles that they can use in solving problems in their environment.

2. To help pupils to grow in ability to solve problems effectively--to use science processes.

3. To help children develop scientific attitudes.

4. To create in children an interest in and an appreciation for the world in which they live.[42]

In keeping with the current emphasis of stating objectives in behavioral terms the final listing of objectives was that proposed by Carin and Sund in their latest elementary science methods textbook. They stated that:

> A pupil after having a science course should be better able to achieve these objectives:
>
> 1. Knowledge
> Read and state the meaning of certain scientific facts and concepts. . . .
>
> 2. Instrumental Skills
> Manipulate basic science equipment, interpret and prepare maps, graphs, charts, and tables appropriate to problems.
>
> 3. Problem-Solving Skills
> Demonstrate problem-solving skills such as: observing, inferring, . . .
>
> 4. Scientific Attitudes
> Demonstrate such scientific attitudes as open-mindedness, . . .
>
> 5. Appreciations
> Describe the uses, benefits, and limitations of science to society.

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[42]Glenn O. Blough and Julius Schwartz, Elementary School Science and How to Teach It (4th ed.; New York: Holt, Rinehart and Winston, Inc., 1969), pp. 12-19.

6. Interests
   Indicate interest by reading, collecting, studying, or begoming involved in some scientific activity as a leisure time pursuit.[43]

Teaching Elėmentary School Science--The Present

Even though the objectives of teaching elementary school science had changed little since 1926, the character of present elementary school science programs was quite different. What apparently changed were the means of implementing these objectives and the veracity with which these objectives were implemented. Such changes had particular implications for revising the role of the child in learning science and the role of the teacher in teaching science.

Character of Present Elementary School Science

After science projects for the secondary school were well under way, attention was turned to science instruction in the elementary grades. Again teams of scientists, teachers, and other educators worked together and with the support of federal and private money developed new elementary science programs which equalled those at the secondary school level in terms of revolutionary changes in philosophy and procedures.

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[43]Arthur A. Carin and Robert B. Sund, Teaching Science Through Discovery (2d ed.; Columbus, Ohio: Charles E. Merrill Publishing Co., 1970), p. 25.

Even though many of the new elementary programs differed somewhat in philosophical emphasis, content, and methodology, there were many common denominators among these programs. Hurd and Gallagher, in analyzing the underlying philosophies of the new programs, discovered that what really distinguished one program from another was the emphasis which was placed on different aspects of teaching and learning. They reported that:

> Some believe that elementary school science should emphasize the process of science, others are more committed to a concept approach, a few see information-giving as a major goal, some want to combine science and mathematics, and still others feel that any topic that arouses the interest of children is sufficient.[44]

Despite these differences one thing became clear in terms of a common denominator of elementary school science: science as taught in the elementary school was to be inquiry-oriented; both in terms of the child's role in learning science and the teacher's role in teaching science.

Although no precise definition of the term "inquiry" was formulated with which there had been general agreement and although much of the literature indicated that the term "inquiry" was used interchangeably with other terms such as "scientific method," "problem-solving," "discovery," and "heuristics," the term had been frequently

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[44]Hurd and Gallagher, New Directions, pp. 33-34.

considered as meaning a process of investigation which utilized an inductive approach.[45]

One attempt to indicate what characterized elementary school science inquiry was made by Kulsan and Stone who defined inquiry as:

> . . . learning in which the following instructional characteristics (are) consistently present:
>
> 1. Scientific processes such as observing, measuring, estimating, predicting, comparing, classifying, experimenting, communicating, inferring, analyzing, and drawing out inductions are habitually employed by children and teachers.
> 2. Time is unimportant. There is no urgency to complete a topic in order to meet a deadline.
> 3. The answers sought are <u>not</u> known in advance to children. Not only <u>are</u> these answers not often found in textbooks, but textbooks and manuals are chosen because they ask questions and suggest ways of finding answers, but do not <u>give</u> answers.
> 4. The content of the inquiry is not necessarily related to that which preceds or follows, although in some of the new elementary science curricula (<u>Science--A Process Approach</u>, for example) each activity is directly connected with prior and future learnings.
> 5. Teaching and learning are 'why' centered. Questions such as 'How do we know?' 'Are we justified in this assumption?' and 'Are we justified in this conclusion?' are characteristic of the inquiry style.
> 6. A problem of some kind is identified and narrowed until it seems probably that it can be solved by the class.[46]

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[45] Robert S. Pickering, "An Experimental Study of the Effects of Inquiry Experiences on the Attitudes and Competencies of Prospective Elementary Teachers in the Area of Science" (unpublished Ph.D. dissertation, Michigan State University, 1970), p. 66.

[46] Kulsan and Stone, <u>Teaching Children Science</u>, pp. 138-139.

Blough and Schwartz confirmed Kulsan and Stone's descriptive definition of inquiry. From their list of trends in elementary science instruction, the following four characteristics further indicated the inquiry nature of elementary science teaching:

1. More emphasis is being placed on the use of first-hand experiences whenever possible to make the learning of science more meaningful. There is more doing with definite purpose on the part of children.
2. A discovery approach is being emphasized in which children are confronted with selected phenomena and situations and in which they suggest the problems to be solved and propose methods of solution.
3. An open-ended approach is emphasized, in which the solution of problems leads to new problems, or in which there may be a number of correct but different solutions to the same problem.
4. Increasing stress is being placed on the methods of science; children are coming to understand these methods by involvement in situations which demand their use rather than by being told about 'the scientific method.'[47]

Character of the Child's Role

Great efforts were made to construct present elementary science programs on the basis of what was known about how children learn. Karplus and Their, in describing the role of the child in the Science Curriculum Improvement Study program, incorporated both Bruner's and

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[47]Blough and Schwartz, Elementary School Science, pp. 7-8.

Piaget's concepts of learning into their explanation of how children learn science. They stated that:

> The course of a child's intellectual development during ages six to fourteen changes greatly. The child's thinking undergoes a gradual transition from concrete to abstract. In order to help him achieve this, the elementary science program must provide the individual child with many concrete experiences in manipulating objects and systems in the environment. At the beginning of this period the child is achieving mastery of his muscles and gaining the ability to carry out physical manipulations; in this thinking he is dependent on direct experience. At the end the child is achieving a degree of mastery of mind; he is able to focus his thoughts consciously and to manipulate abstract relationships without constant reference to specific examples.[48]

Philip Morrison, one of the prime movers of the Elementary Science Study program, further indicated such a stance with these words: "One mandate is imperative for our style of work: there must be personal involvement. The child must work with his own hands, mind, and heart."[49]

The Commission on Science Education of the American Association for the Advancement of Science, in writing about the role of the child in the Science--A Process Approach program sponsored by the Association, similarly indicated that ". . . teaching will not proceed as a set

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[48]Robert Karplus and Herbert D. Their, A New Look at Elementary School Science (Chicago: Rand McNally and Co., 1967), pp. 65-65.

[49]Philip Morrison, "The Curriculum Triangle and Its Style," ESI Quarterly Report (Summer-Fall, 1964), 70.

routine of memorization and description. The child needs to learn things through his senses, literally to operate on reality. And he needs to do this in as many situations as possible."[50]

Finally, Kulsan and Stone mentioned the following general characteristics of the child's role in inquiry learning:

1. The questions and problems which are the subject of study often originate in the class, either from earlier work or as a result of a chance occurrence.
2. Procedures originate in child-teacher discussion, and questions and problems are cooperatively analyzed.
3. Children frequently propose hypotheses which lead to experimentation, observation, and further logical analysis.
4. Children use texts and trade books as sources of information and later verification; these sources provide additional data, not authoritative answers.
5. The data gathered from the various sources--experimentation, demonstration, reading, audiovisual aids, and personal experience--are cooperatively evaluated in order to assess a hypothesis.
6. Children evaluate their success (or lack of success) in solving the problem with which they were concerned.[51]

In addition:

7. Children investigate in small groups, as a class, and as individuals in order to gather the data by which to test the hypotheses.[52]

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[50]American Association for the Advancement of Science--Commission on Science Education, The Psychological Basis of Science--A Process Approach (Miscellaneous Publication 65-8, 1965), p. 22.

[51]Kulsan and Stone, Teaching Children Science, p. 145.

[52]Ibid., p. 139.

Character of the Teacher's Role

That the role of the teacher of inquiry science was different than the roles associated with Object-Teaching, the Nature-Study Movement, and the textbook approaches of the 1940's and 1950's was not refuted. Hurd and Gallagher noted, for instance, that

> New instructional materials have been developed that are helpful in developing inquiry skills--that is, if the materials are used properly. This means that teachers need to modify their teaching behavior to take full advantage of new materials.[53]

Lee emphasized the same point in stating that

> The success or failure of any instructional program ultimately depends upon the classroom teacher. . . . The new science programs being recommended definitely require the teacher to change his approach if he is to succeed in getting across to the students the objectives for which the courses were developed.[54]

A most comprehensive attempt to elucidate the teacher's role in inquiry learning was made by Carin and Sund. They listed the following things a teacher must do if he is to help children inquire into science:

1. The teacher must allow children to discover for themselves solutions for the problems in their work. At all times, he must resist telling where there is a chance for children to structure the learning in their own internalized way.
2. The teacher should select studies from the conceptual schemes suggested by scientists

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[53]Hurd and Gallagher, New Directions, p. 120.

[54]Lee, New Developments, p. 41.

and science educators. These studies should be obtainable for his students.
3. The teacher should be dedicated to the fact that learning by discovery takes a great deal of time but is vital for children to learn how to learn.
4. A general pattern for discovery learning should be class discussion . . . , observations or experimentation, discussions and interpretation of data from observations and experiments, identification of new problems from interpretation, and new investigation starts again, etc.
5. The teacher should supply clues when students are bogged down in discovery learning to keep the process moving. This can best be done by supplying clues and cues when children are 'stuck.'
6. The teacher should have an overall plan to guide students in their studies.
7. Asking thought provoking questions is one of the best ways of stimulating discovery learning and keeping it moving along. Questions can provide clues and motivation if they are used in a manner which leads the learner to feel that he has a definite contribution to make to the investigation.
8. The teacher in discovery learning must have access to necessary supplies for his investigations with children.[55]

Pickering summarized Suchman's concept of the teacher's role in an inquiry science classroom this way:

> Suchman envisions the teacher's role as making the child aware of the inquiry process. Science educators agree that such a role involves the presentation of material in such a way that the pupil gains skill in working independently in similar situations. The pupil needs to know what questions to ask, when to ask them, and where to find the answer. Without direction, it is difficult for the pupil to discover for himself what parts exist in scientific inquiry, what their roles and connections are, and the basic need for using the process. A teacher's

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[55]Carin and Sund, Teaching Science Through Discovery, pp. 56-57.

> question should not be designed to discover whether the pupil knows the answer, but to exemplify to the pupil the types of questions he must ask of the materials he studies and how to find the answers. The art of conducting discussions is not easy, but it is through discussion that the skill of inquiry can be conveyed.[56]

Stated a bit differently, Karplus and Their portrayed the teacher as follows:

> The classroom is the laboratory where children can make discoveries and gain experiences with natural phenomena. The teacher is the leader whose job is not primarily to <u>tell</u> children about science or to <u>listen</u> to them while they <u>read</u> about science, but rather to <u>observe</u> children while they are individually <u>involved</u> with science. Pupils are encouraged to experiment to find answers to their questions as a means for opening up new possibilities, enlarging upon discussed ideas, and in general encouraging children to probe further and think again about the observations they have made or will make of natural phenomena.[57]

Finally, in light of the fact that the inquiry approach may not be the most effective approach in all situations and for all children, Kulsan and Stone added the following comment regarding the character of the teacher's role:

> The teacher never hesitates to use more traditional procedures when they are better for her purposes; for example, it may be necessary for her to explain a particular phenomenon, either because information is unavailable, or because she can explain it more effectively.[58]

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[56]Pickering, "Effects of Inquiry," p. 67.

[57]Karplus and Their, <u>A New Look</u>, p. 93.

[58]Kulsan and Stone, <u>Teaching Children Science</u>, pp. 145-146.

The Teacher's Role:
A Conclusion

Clearly, the inquiry approach in elementary school science instruction required a different set of behaviors on the part of the teacher than that associated with traditional approaches of science instruction. Koran aptly captured the need for understanding these changes with these words:

> The investigation of effective methods of training teachers to teach the new science curricula is an essential part of curriculum research and development in science. Indeed, without teachers performing in a style required by the new curricula, it is virtually impossible to infer through evaluation, the true worth of a curriculum. How can we point to any change in student behavior and confidently state that it is due to the curriculum rather than to each teacher who teaches the curriculum? Unless we focus on ways to train teachers which produce predictable behavioral change, and use these teachers in the presentation of new curricula, we will not be able to clearly determine what is the effect of a given curriculum or the effect of a specific teacher.
>
> Perhaps more important than the above, without teachers trained to teach the new elementary and secondary science curricula, the effectiveness of the curriculum is reduced. It is not unlikely that teachers teaching the new and the old curricula, but using the same teaching style, will produce students who know equally much (or little). A tremendous sum of money has been spent to develop the best possible science materials for the secondary and the elementary schools. Their effectiveness depends on how well the teachers use them.[59]

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[59]John J. Koran, "Two Paradigms for the Training of Science Teachers Using Videotape Technology and Simulated Conditions," *Journal of Research in Science Teaching*, VI, No. 1 (1969), 23.

Specific Skills and Attitudes Required of the Teacher of Present Elementary School Science

As indicated in Chapter I, research on the global "criterion of effectiveness" models of teaching was inadequate in attempting to explain "effective" teaching. The same could be said about attempts to explain the role of the elementary teacher teaching science by inquiry. As was suggested in the use of the micro-teaching paradigm, however, specific teaching behaviors germane to the total role must first be identified and justified.

Although the literature previously reviewed indicated that there were several behaviors and attitudes associated with the role of the teacher in inquiry teaching, only four such behaviors and associated attitudes were emphasized in the presentations of micro-lessons by the pre-service teachers in this study. The behaviors studied were those of (1) involving children in learning activities, (2) asking higher order questions, (3) responding to children's comments or answers, and (4) pausing after asking questions and before responding. The attitudes studied were those of pre-service teachers towards science, teaching, the teaching of science, asking higher order questions, involving children in learning activities, and the use of peer micro-teaching to practice the teaching of elementary school science.

Involving Children in Learning Activities

As previously indicated, the child's role in inquiry science was primarily that of involvement; involvement with things, ideas, and people. While much has already been said about the necessity of allowing children to become involved physically with objects, little has been mentioned about the importance of children's verbal involvement. Actually the teacher behaviors of asking higher order questions, providing neutral responses, and pausing for longer periods of time were all skills designed to allow children to become more involved verbally and mentally with ideas and other people.

The importance of verbal activity was indicated by Smith, who, in an analysis of research on teaching, indicated that verbal activity was the dominate form of classroom instruction. Smith noted also that ". . . many significant outcomes of instruction can be accounted for only by reference to linguistic behavior in both its cognitive and affective import."[60]

Furthermore, to the claim, often associated with science teaching, that one learns by being active, or

[60]B. Othanel Smith, "Recent Research on Teaching: An Interpretation," The High School Journal, LI (November, 1967), 66.

"one learns to do by doing," Smith retorted that ". . . a large proportion of the activities the pupil engages in as he learns, including his interactions with the teacher as well as his classmates, are verbal."[61]

Asking Higher Order Questions

Of all the behaviors associated with the teacher's role in inquiry teaching that of question asking was mentioned as the most important in all the literature reviewed. Carin, for instance, stated that:

> The heart of teaching-learning science by discovery is in questions properly asked and answers to them properly used. Not only do teachers ask too many questions, they more often than not ask the wrong kinds of questions. Surveys indicate that over 90 percent of all questions teachers ask call merely for reproducing what was just read, heard or seen by children. These questions require only the lowest level of thinking by children - memorization.[62]

Further, Koran noted that:

> An important characteristic of teacher behavior in the new science curricula on both the elementary and secondary level is questioning behavior. The teacher's role here is to foster exploration and explanation rather than to give answers and reinforce facts. Teachers must learn to ask observation questions, since the behavior that these are intended to produce on the part of students - observation, is critical to scientific inquiry and concept formation.[63]

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[61] Ibid.

[62] Arthur A. Carin, "Techniques for Developing Discovery Questioning Skills," Science and Children, VII (April, 1970), 13.

[63] Koran, "Two Paradigms," p. 23.

After considerable research in attempting to develop teaching strategies designed to promote inquiry skills among elementary school children, Taba came to a similar conclusion. She stated that "The role of questions becomes crucial, and the way of asking questions by far the most influential single teaching act."[64]

Finally, Karplus and Their developed this point further by indicating that question-asking was important in teacher planning as well as in the execution of a science program.[65] In discussing different types of questions and their possible effects on learning, they also gave some clues to these planning and execution phases of question-asking. They indicated that:

> Many questions can be grouped as divergent in that they lead to further questions, cause children to carry out or plan experiences with equipment and materials, or foster the kind of inquiry that causes children to research information in the library. All of these questions foster thinking, will probably enlarge the scope of the material being studied, and usually deepen the interest of at least some children in the topic under study. Other questions can be classified as convergent, that is, they tend to cause children to summarize and draw conclusions. After sufficient experience on the children's part, such questions can prove most helpful in bringing about the combination and recombination of experiences which lead to generalizations and understanding. Questions which aim at the simple

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[64]Hilda Taba, Samuel Levine, and Freeman F. Elzey, Thinking in Elementary School Children (Cooperative Research Project No. 1574, San Francisco State College, April, 1964), p. 53.

[65]Karplus and Their, A New Look, p. 86.

> recall of facts probably fall in this convergent category. Their importance can be limited, and they should be used with caution.[66]

<u>Responding to Children's Comments or Answers</u>

In a series of studies with in-service teachers, Rowe examined, among other things, the effects of different types of teacher responses to children's answers or comments. She was attempting to discover which techniques were most effective for teaching science when utilizing some of the national experimental science programs for the elementary school. She found that when teachers changed certain verbal patterns students changed their verbal patterns as well.[67]

Based on the findings that sanctions (positive and negative rewards) constituted as much as one-quarter of teacher talk in many classrooms, Rowe recommended the following three changes in the pattern of reward and punishment delivered to elementary school children by teachers: (1) fewer teacher-administered sanctions, (2) fewer teacher-administered rewards, and (3) increase in the number of neutral responses.[68]

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[66] <u>Ibid</u>.

[67] Mary Budd Rowe, "Science, Silence, and Sanctions," <u>Science and Children</u>, VI (March, 1969), 11.

[68] Mary Budd Rowe, "Use of Micro-Teaching Situations to Train Elementary Teachers in a New Science Program" (paper presented at National Science Teachers Association-North Eastern Region and the Canadian Centennial Science Teachers Conference, Toronto, Canada, November, 1967).

The rationale for Rowe's recommendations was summarized with these words:

> When silence on the part of the teacher increases, and/or when sanctions decrease, the incidence of speculative thought on the part of the children increases. . . . When rewards are high, children tend to stop experimenting sooner than when the number of rewards is relatively lower. There is some reason to suspect that when children work on a complex task, rewards given by the teacher may interfere with logical thought processes. When children start attending to the reward rather than to the task, the incidence of error or the necessity to repeat steps increases.[69]

Kageyama, in working at the Science Curriculum Improvement Study trial center in Berkeley, California, made the following comments in reference to the specific behavior of using neutral responses:

> Teachers need to develop a repertoire of responses to the comments and responses children make. Initially children need a great deal of praise and encouragement. No one response should be used for every occasion. As the teacher and children continue to work with the materials, the teacher should try to make more neutral or less responses to the children's comments in order to promote more interaction between the children.[70]

The rationale for such recommendations seemed to be as follows:

> Modern science programs for the elementary school seek to develop self-confidence in

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[69]Rowe, "Science, Silence, Sanctions," p. 13.

[70]Christine Kageyama, "Some Responses" (paper presented to Science Curriculum Improvement Study College Teacher Workshop on Elementary School Science, East Lansing, Michigan, Michigan State University, August, 1968), p. 1.

> by allowing them to work out their ideas in experiments. Children find out how good their ideas are by the results. When predictions no longer work or when new information makes a point of view untenable, then pupils are free to change their views. The point if that the authority for changing comes from the results of their experiments rather than from the teacher.[71]

<u>Pausing After Asking Questions and Before Responding</u>

Although relatively little has been done to investigate the effects of longer pauses after asking questions and before responding to pupils, it seemed logical that if teachers asked questions designed to tap the higher mental processes, then children needed longer periods of time to formulate answers.

In Rowe's study it was found that teachers, after asking questions, waited an average of one second for a child to start an answer. Further, it was found that after a child made a response, teachers waited less than one second to repeat what the child had said or to rephrase it or ask another question.[72]

Once the teachers in Rowe's study developed the skill of pausing for longer periods of time after asking questions and before responding to children's comments or answers, interesting things were observed in the

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[71] <u>Ibid</u>.

[72] Rowe, "Science, Silence, Sanctions," pp. 11-12.

children's verbal and cognitive processes. For instance, when the teacher's wait-times were at least five seconds, the length of the student response increased. Further, children were more likely to respond with whole sentences, and the confidence as expressed by tone was higher.[73]

Other findings when wait-time increased were that a greater amount of speculative thinking on the part of children occurred. There was also more use of arguments based on evidence. Finally, increased wait-time showed an increase in the number of questions asked by children and the number of experiments attempted to find answers to these questions.[74]

Teacher Attitudes

While the term "attitude" has been defined in a number of ways, there were common threads of agreement as to the underlying nature of attitude. Although not a definition, *per se*, the following three statements appeared to characterize these threads of agreement.

1. Attitudes are learned rather than being innate, they have specific social referents, and are relatively stable and enduring.[75]

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[73]*Ibid.* [74]*Ibid.*, pp. 12-13.

[75]M. Sherif and C. W. Sherif, *An Outline of Social Psychology* (rev. ed.; New York: Harper and Row, 1956), p. 796, cited by Pickering, "Effects of Inquiry," p. 25.

2. Attitudes vary in quality and intensity on a continuum from positive through neutral to negative, and they possess varying degrees of interrelatedness to each other.[76]
3. Attitudes are based on evaluative concepts regarding characteristics of the referent objects, and give rise to motivated behavior.[77]

Relation of attitude to performance.--Perceptual psychologists such as Combs, Kelley, Maslow, and Rogers indicated that a person's behavior was closely related to how that person perceived himself, his environment, and his place in that environment.[78] Mouly indicated that a person's perceptions were, to a great extent, determined by the person's attitudes.[79] In this sense, Mouly spoke of attitudes as constituting a highly complex system of variables involving affective, cognitive, and action

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[76]J. E. McGrath, Social Psychology: A Brief Introduction (New York: Holt, Rinehart, and Winston, 1964), p. 166, cited by Pickering, "Effects of Inquiry," p. 25.

[77]L. R. Anderson and M. Fishbein, "Prediction of Attitude from Number, Strength and Evaluative Aspects of Beliefs About the Attitude Object: A Comparison of Summation and Congruity Theories," Journal of Personal and Social Psychology, II (1965), 437-443, cited by Pickering, "Effects of Inquiry," p. 25.

[78]Association for Supervision and Curriculum Development, Perceiving, Behaving, Becoming, 1962 Yearbook of the Association (Washington, D.C.: National Education Association, 1962).

[79]George J. Mouly, Psychology for Effective Teaching (2d ed.; Atlanta: Holt, Rinehart and Winston, Inc., 1968), p. 452.

components. Therefore, because "Attitudes underlie behavior in such a fundamental way, . . . it is necessary to understand attitudes if we are to understand behavior."[80]

Teacher attitudes required of the inquiry approach.--Although recognized that attitudes were complex and many times interrelated, it was possible to find literature which indicated specific types of attitudes teachers should possess to be effective elementary school science teachers of inquiry. These were positive attitudes towards:

1. Science[81]
2. Teaching[82]
3. Teaching elementary school science (the teacher's perception of self as a science teacher).[83]
4. Involvement of children in learning activities.[84]

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[80]Ibid.

[81]Eloise M. Soy, "Attitudes of Prospective Elementary Teachers Towards Science as a Field of Speciality," School Science and Mathematics, LXVII (June, 1967), 507-517.

[82]Arthur W. Combs, The Professional Education of Teachers (Boston: Allyn and Bacon, Inc., 1965).

[83]Thomas Walker, "Teacher Image," Peabody Journal of Education, XLIII (July, 1965), 41; and Mouly, Psychology for Teaching, p. 102.

[84]Rowe, "Science, Silence, Sanctions," pp. 11-13.

5. Asking higher order questions which allow divergent thought among children.[85]

Development of positive attitudes towards science and science teaching among pre-service teachers.--Walker stated that once teachers developed mental images of science and themselves in relation to their role as science teachers, they performed this role in keeping with their image.[86] Unfortunately, as Pickering discovered, pre-service teachers often entered college with negative attitudes towards science already firmly established.[87]

The task of creating positive attitudes towards science and the teaching of science was, therefore, a large one for teacher preparation institutions. Several procedures were suggested in the literature, however, for creating situations and experiences designed to enhance attitude development among pre-service teachers. Three of these procedures were to:

1. Attempt to create an interest in science. Blough stated that creating an interest in science was of major importance in the improvement of the quality of

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[85] Karplus and Their, A New Look, p. 92.

[86] Walker, "Teacher Image," p. 41.

[87] Pickering, "Effects of Inquiry," pp. 8-9.

teachers of science.[88] Further, Decker remarked that ". . . the methods used in . . . (science content and methods) . . . courses should be those which develop both skills and attitudes that will motivate the beginning teacher to continue his study on a self-directed basis."[89]

2. Build the teacher's confidence in working with materials and content. One approach for developing pre-service teacher confidence was to remove the idea that the teacher should have answers for all questions asked by children. As Genua stated,

> The function of the elementary school science teacher is not to be a walking encyclopedia of answers for questioning children. A teacher should be taught that the main function in science is to help children learn how to get valid answers, not to provide them.[90]

The suggestion that pre-service teachers should be brought in contact with materials was offered by Washton, who found that when pre-service teachers were given the opportunity to handle and manipulate science materials

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[88]Glenn O. Blough, "Preparing Teachers for Science Teaching in the Elementary School," School Science and Mathematics, LVIII (October, 1958), 325.

[89]Donald G. Decker, "Implications for College and University Programs," Science Education in American Schools, Fifty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1960), p. 37.

[90]Albert J. Genua, "Backgrounds in Elementary Science Teaching," The Science Teacher, XXIV (March, 1957), 99.

used in scientific experiments and demonstrations, they acquired confidence and improved techniques.[91]

3. Present materials, content, and experiences that were meaningful and relevant. Stahl stated that

> Learning must be organized in terms of understandings that seem real and compelling and valuable to the learner, that engage his active purposes, that confront him with significant challenges, that lead to deeper and wider insights, more discriminating attitudes and more adequate skills.[92]

Fish added to this line of thought by saying that, "As needs and relationships are clarified and refined, the teacher will increasingly gain a psychological acceptance of the worth of what she is teaching in the science program. Acceptance will manifest itself in behavior."[93]

A final type of activity which was considered essential as well as meaningful and relevant was that of working with elementary school children in teaching situations. The American Association for the Advancement of Science-Commission on Science Education stated that

> In the beginning, the . . . (pre-service teacher) . . . is aware that he has some interest in teaching. Careful guidance is required as he

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[91]Nathan S. Washton, "Improving Elementary Teacher Education in Science," Science Education, XLV (February, 1961), 34.

[92]Stanley S. Stahl, Jr., "Methods in Teaching," in Readings in the Methods of Education, ed. by Frank L. Steeves (New York: The Odessey Press, Inc., 1964), p. 13.

[93]Alphoretta Fish, "Viewpoint on a Basic Problem in Elementary School Science," The Science Teacher, XXVI (February, 1959), 27.

> proceeds through the various experiences designed to develop his teaching competence and confidence.[94]

Experiences recommended to build this competence and confidence were those of first observing children, then working part-time as a teacher-aide, followed by opportunities to teach science lessons in controlled situations to various size groups of elementary school children.[95]

Micro-Teaching as a Technique for Learning and Developing Teaching Skills and Attitudes

Introduction

While it has been the prime responsibility of teacher preparation institutions to prepare teachers to use the inquiry approach in elementary school science, literature suggested that in many cases these institutions were failing in this responsibility.

Dressel noted, for instance, that:

> Prospective teachers are taught subject matter. What they learn about instructional methods is commonly in isolation from their major subject and largely irrelevant to the way this subject was taught to them. The would-be teacher gets little insight into his own thought processes or those of others. He is largely ignorant as to ways to stimulate students to think and is unable to focus on the process of thinking as separate

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[94] American Association for the Advancement of Science-Commission on Science Education, *Preservice Science Education of Elementary School Teachers* (Miscellaneous Publication 69-11, February, 1969), p. 20.

[95] *Ibid*., p. 21.

from the results. Quite naturally, then, the teacher finds it difficult to so plan a class that the individual students are encouraged to think for themselves.[96]

In addition, Koran stated that:

> . . . evidence suggests that science educators are doing a poor job of training science teachers to meet these demands using the traditional teacher-training methods (student teaching, shot-gun supervision, etc.). New, more efficient, and effective methods of training must be developed to keep up with the rapidly changing curriculum demands.[97]

Scientists and other curriculum developers have also been critical teacher preparation programs in elementary science education. Koran, in a review of the attempts of science curriculum developers to bring about changes in teaching beahviors which were consistent with the intents of the "newer" science programs, found that although curriculum materials were effectively distributed, the inquiry style of teaching meant to accompany these materials was little used and poorly understood.[98]

The American Association for the Advancement of Science summarized the plight of the curriculum developers and placed the blame squarely with the preservice teacher preparation institutions in this way: "While science in the elementary schools has been

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[96]Paul L. Dressell, "The Challenge," The Science Teacher, XXIII (February, 1956), 23.

[97]Koran, "Two Paradigms," p. 27.

[98]*Ibid.*, p. 22.

completely changed, most science courses for teachers at the college level have changed little or not at all."[99]

In examining the procedures traditionally employed by teacher preparation institutions it was not difficult to figure out why such institutions were criticized. Koran summarized such procedures this way:

> The usual strategy for the transmission or modification of teaching skills has been to provide some form of written or oral instruction combined with in-school observation of performance. In this approach, teacher trainees or in-service teachers receive a written or oral description of a general pattern of behavior and they subsequently attempt to approximate this pattern in the classroom, while receiving nonspecific feedback from a supervisor regarding their success. This approach is costly in time and inefficient, and under classroom conditions focus on specific responses is difficult, particularly when the responses have not been clearly described.[100]

It has been in the light of the kinds of criticism mentioned above that micro-teaching has come on the education scene as a potential technique for better preparing elementary teachers of science. Despite its newness, there has been evidence to indicate that the experience of micro-teaching was both a practical and in many ways an effective means of improving specific teaching behaviors and attitudes.

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[99]American Association for the Advancement of Sciences-Commission on Science Education, Preservice Science Education, p. 2.

[100]Koran, "Two Paradigms," pp. 22-23.

Micro-Teaching Defined

Gage defined micro-teaching as:

> . . . a scaled down teaching experience. It is scaled down in terms of time because it lasts only five to ten minutes. It is scaled down in terms of class size because the trainee teaches a group of not more than five pupils. It is scaled down in terms of the task, since the trainee attempts to perform only one of the teaching skills in any single micro-teaching session.[101]

It should be pointed out, however, that a precise definition of micro-teaching varies according to the purpose and resources of the user. As Gage continued:

> Obviously, the general idea is subject to many variations. The size of the class can be manipulated, the number of trainees teaching a given group of children can be increased, the duration of the lessons can be increased, and the nature of the teaching task can be made more complex so as to embrace a group of technical skills in their real-life combinations.[102]

Research Relating to the Use of Micro-Teaching in Teacher Preparation

Since the inception of micro-teaching in 1963, the technique has been used in many phases of teacher preparation throughout the country. The research on micro-teaching thus far has been of three main types: (1) the search for the optimal format for developing certain

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[101]N. L. Gage, "An Analytical Approach to Research on Instructional Methods," Phi Delta Kappan, XLVI (June, 1968), 602.

[102]*Ibid.*, p. 603.

skills and attitudes among pre-service and in-service teachers, (2) attempts to analyze the relationship between teacher performance and attitude with variables believed to effect such learning, and (3) attempts to compare various forms of the micro-teaching design with other forms of pre-teaching experiences. Within each type of research various variables pertaining to the micro-teaching format have often been manipulated.

<u>The search for optimal micro-teaching formats</u>.--Research of this type did not attempt to compare micro-teaching with other forms of pre-teaching experiences. Rather, attempts were made to discover such things as what arrangements of instructional sessions, critique sessions and the micro-teaching sessions were optimal in bringing teachers to meet pre-set criterion of performance. The various components of the micro-teaching design which were investigated and the research dealing with these components are listed below.

1. Number of micro-lessons presented--Harris, Lee, and Pigge conducted a study with pre-service teachers in a science methods course to determine if certain "personal items" such as personality, approach to teaching procedures, voice and grammar, and certain "classroom techniques" such as providing concrete materials, utilizing children's observations, allowing

children to develop conclusions, and helping children verify conclusions were affected by the number of micro-lessons taught by the pre-service teachers to elementary school children. An experimental group of twenty-one pre-service teachers presented six, twenty-five minute micro-lessons while a control group of twenty-two subjects presented one micro-lesson during the same semester. All subjects were enrolled in one of six elementary science methods courses taught by two different instructors. Despite different sections of the same course and different instructors all experiences provided besides the micro-teaching sessions were just about identical.[103]

Using instruments designed to measure pre- and post-test performance of the selected "personal items," the investigators found: (a) no significant gain scores for either experimental or control groups, and (b) no significant difference when experimental and control groups were compared on the pre-test and on the post-test.[104]

With reference to the "classroom techniques" studied, the investigators found: (a) no significant differences between experimental and control groups on

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[103] William N. Harris, Verlin W. Lee, and Fred L. Pigge, "Effectiveness of Micro-Teaching Experiences in Elementary Science Methods Classes," Journal of Research in Science Teaching, VII, No. 1 (1970), 31-33.

[104] Ibid., p. 32.

pre-test measures, (b) the experimental group mean was significantly higher than the control group mean on the post-test for these measures, and (c) both control and experimental groups showed significant gains in mean scores from pre- and post-test measurements.[105]

Although nonsignificant results might have been expected when dealing with something as stable as personality, the significant differences achieved on the "classroom techniques" measures tended to indicate that growth in these behaviors can be promoted when pre-service teachers have the opportunity to present at least six micro-lessons to elementary school children.

2. Type of micro-teaching students--In a study by Steinbach one of the variables of micro-teaching investigated was the effect of using either peers or elementary school children on pre-service teachers' teaching behaviors and attitudes. Each of thirty-one pre-service teachers used in this study were enrolled in a science methods course at The University of Texas at Austin and each taught six micro-lessons to different pairs of elementary school children or their pre-service peers during the semester of the course.[106]

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[105] Ibid., pp. 32-33.

[106] Alan H. Steinbach, "A Comparative Study of the Effect of Practice with Elementary School Children or with Peers in the Science Methods Course" (unpublished Ph.D. dissertation, The University of Texas at Austin, 1968).

In conclusion to his study Steinbach stated that:

> Since children are a vital part of the regular classroom situation, practice with children, in contrast to practice with peers, was expected to yield greater changes in each of the performance skills described in this study. Except for a few areas, those students who taught peers developed competencies and attitudes similar to those of students who taught children.[107]

In analyzing the procedures used by Steinbach, one of the reasons for these unexpected results seemed to be that lesson materials were chosen to provide a challenge to both groups of learners, therefore, peers might well have been equivalent to children as each exhibited behaviors characteristic of a learner.

Another, less formal, study involving the use of peers as micro-students was conducted by Ashlock. In an in-service elementary science methods course, teachers taught and then retaught the same five minute lesson to two different sets of four peers. The purpose of these lessons was to provide opportunities for the teachers to plan, carry out, and conclude an actual lesson in science. Although no formal research and evaluation was attempted, Ashlock found that the reactions of the in-service teachers were generally quite favorable toward the micro-teaching experience.[108]

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[107] Ibid., pp. 94-95.

[108] Robert B. Ashlock, "Micro-Teaching in an Elementary Science Methods Course," School Science and Mathematics, LXVIII (January, 1968), 52-56.

3. Team micro-teaching approach--At the State University of New York, College at Brockport the technique of having individual pre-service teachers observe in a classroom, plan a lesson, and then teach that lesson in the same classroom had been tried and found wanting in several respects. As an alternative to this approach Drumheller and Paris designed and implemented a program which allowed groups of approximately ten pre-service teachers to work together in planning a four week unit for a particular class of children. This team then went into the classroom three times a week for a four week period and each member individually presented the unit to small groups of from two to four children. Each twenty-five minute lesson was followed by an evaluation seminar involving the team and the classroom teacher.[109]

Evaluation of the team approach in connection with micro-teaching was based upon the reactions of the college students, the cooperating teachers, and the cooperating school pupils. It was found that the approach was highly efficient and effective from the point of view of the college and cooperating school instructors and highly effective with regard to the college students' and cooperating school pupils' achievement.[110]

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[109]Sidney J. Drumheller and John Paris, "An Effective Approach for Incorporating Teaching Experiences in Methods Courses," The Journal of Teacher Education, XVII, No. 3 (Fall, 1966), 290-295.

[110]*Ibid.*, pp. 293-295.

4. Other studies--Both Stanford University and Brigham Young University have been using micro-teaching for at least five years and some of the studies eminating from these programs have yielded information regarding the optimal micro-teaching format, especially in terms of pre-service teacher reactions to the use of the micro-teaching technique.

In a series of studies at Stanford University Fortune, Cooper, and Allen sought to determine how the pre-service teachers completing micro-teaching requirements felt about the worth of such experiences. The conclusions reached in these studies were that:

> The micro-teaching clinic produced significant behavior changes in teacher education candidates over the six week period. A questionnaire designed to evaluate student acceptance of micro-teaching indicated that less than fifteen percent of the interns reported that the experience was of little or no value. In every week, micro-teaching was felt to be either very or extremely valuable by more than sixty percent of the interns returning the questionnaires.[111]

At Bringham Young University the following conclusions were reached concerning pre-service teachers' attitudes toward the use of micro-teaching in connection with their teacher education courses:

1. Students react positively to the technique; ninety-five percent of those who have

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[111]Jimmie C. Fortune, James M. Cooper, and Dwight W. Allen, "The Stanford Summer Micro-Teaching Clinic, 1965," The Journal of Teacher Education, XVIII (Winter, 1967), 389-393.

received micro-teaching training judge the experience to be valuable or very valuable.

2. Students do not see themselves as performing atypically because of the "threatening" nature of the micro-teaching experience. This expression concurs with that of the micro-teaching instructors; anxiety reactions among micro-teachers at Bringham Young University were essentially negligible. Only in the initial experience, and rarely then, was evidence of performance-distorting reaction found.
3. Students who have received micro-teaching rate themselves as more nearly like the "ideal teacher" than do students who have not received micro-teaching.
4. Experience at Bringham Young University corroborates the conclusion suggested by the Stanford research; observing a trainee's teaching performance globally is much less valuable than observing, and helping him to observe, one or two specific, discriminable actions within the teaching act. Further, the micro-teacher must prepare his brief lesson to achieve a similarly specific skill or competency.[112]

Effects of modeling and feedback on behavior and attitude modification in micro-teaching situations.--This category of studies was related closely to the previous category in that few attempts were made to compare the micro-teaching technique with other pre-teaching experiences. Rather, these studies attempted to investigate variables in the micro-teaching format which were believed to have significant bearing on the pre-service

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[112]Clark Webb and Hugh Baird, "Selected Research on Micro-Teaching," in Teacher Education in Transition, Vol. II, ed. by Howard E. Bosley (Baltimore: Multi-State Teacher Education Project, May, 1969), pp. 90-91.

teacher's learning of skills and attitudes. Two such variables and accompanying research are reported below.

1. Modeling variables--Two kinds of modeling procedures were investigated: perceptual and symbolic. A perceptual model in teacher education was a live, video, or audio-tape representation of a teaching episode which exemplified a specific or series of teaching behaviors. A symbolic model was a written description of specific teaching behaviors to be acquired by the pre-service teacher.

Young, in reviewing efforts of Orme,[113] and Young[114] to investigate modeling effects, noted that:

> Studies investigating the relative effectiveness of perceptual and symbolic modeling reveal that teachers (interns) viewing a perceptual model incorporate more of the modeled teaching behavior into subsequent teaching than when studying a symbolic model. A combination of the two modeling modes was more effective than was either alone.[115]

In line with Young's last observation, Allen, et al., found that for a teaching behavior such as asking

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[113]Michael E. J. Orme, "The Effects of Modeling and Feedback Variables on the Acquisition of Complex Teaching Strategy," Dissertation Abstracts, XXVII, No. 10-A (1967), 3320-3321.

[114]David B. Young, "The Effectiveness of Self-Instruction in Teacher Education Using Modeling" (paper presented at the meeting of the American Educational Research Association in Chicago, February, 1968).

[115]David B. Young, "The Modification of Teacher Behavior Using Audio Video-Taped Models in a Micro-Teaching Sequence," Educational Leadership, XXVI (January, 1969), 389-399.

higher order questions, both the perceptual and symbolic models produced a greater number of higher order questions, and that neither model used singly was more effective than the other.[116]

In another review of research on modeling, Koran noted that evidence has been gathered that indicated that film-mediated models were as effective in producing behavioral change as live models. Furthermore, perceptual models appeared to be more useful than symbolic models due to their distinctive cueing properties. For this reason they were recommended over the symbolic models for the acquisition of verbal behaviors. Finally, Koran noted that various kinds of modeling procedures could be beneficial in developing inquiry verbal skills.[117]

2. Feedback variable--In the preparation of teachers feedback referred to the provision of information to the teacher regarding performance. In the studies reviewed, feedback was commonly provided by means of (1) video or audio-tape replays, (2) oral or written comments from supervisors, and (3) oral or written comments from the students involved as pupils in the microlessons.

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[116]Dwight W. Allen, et al., "A Comparison of Different Modeling Procedures in the Acquisition of a Teaching Skill" (paper presented at the annual meeting of the American Educational Research Association in Chicago, February, 1967).

[117]Koran, "Two Paradigms," pp. 26-27.

Aubertine, at Stanford University, found that pre-service teachers provided with video-taped feedback following the presentation of micro-lessons performed significantly better on certain verbal behaviors during subsequent observations than a control group deprived of feedback.[118]

Less conclusive results were obtained by Smith, Steinbach, and Borg who also attempted to compare the effects of feedback.

In Smith's study, for instance, a control and an experimental group received similar instruction and supervisory assistance while presenting a series of nine micro-lessons to elementary school children. The experimental group had the advantage of receiving immediate visual and auditory feedback in the form of video-taped playback. Despite greater gains by the experimental group on all of the post-test measures, the differences were not large enough to reach the .05 level of significance. Thus, caution was needed in assuming that the aid of video-taped feedback was beneficial for these particular students.[119]

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[118]Horace E. Aubertine, "An Experiment in the Set Induction Process and Its Application to Teaching" (unpublished Ph.D. dissertation, Stanford University, 1964), cited by Koran, "Two Paradigms," p. 25.

[119]Lillian C. Smith, "A Study of the Use of Micro-Teaching in the Preparation of Elementary Teachers," in Teacher Education in Transition, Vol. II, ed. by Howard E. Bosley (Baltimore: Multi-State Teacher Education Project, May, 1969), pp. 121-13.

In another phase of Steinbach's study, previously reported, two groups of subjects who had received oral and written feedback by experienced teachers were compared to two groups of subjects who had received no feedback. Although there were no significant differences between groups on a majority of the behaviors and attitudes measured, certain skills, such as pacing of the lesson and presenting the lesson with clarity, were significantly more developed in the feedback groups.[120]

In Borg's study both feedback and modeling variables were manipulated. Five groups of students were used in this study, one group acting as a control. Students in each group taught six teach-reteach microlessons to groups of four to eight elementary school children. Groups differed, however, as to whether they received a series of modeling lessons to accompany the micro-teaching and whether they received feedback following their lessons.[121]

Results of Borg's study indicated that students who completed the entire sequence which included modeling and feedback sessions showed significant gains in terms of the skills under study when compared to students in the

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[120] Steinbach, "A Comparative Study."

[121] Walter R. Borg, _et al._, "Videotape Feedback and Microteaching in a Teacher Training Model," _The Journal of Experimental Education_, XXXVII (Summer, 1969), 9-16.

control group who received no demonstration or feedback experiences. The groups that completed the entire sequence, however, did not make significant changes in behavior when compared to groups in which some element of the sequence was omitted.[122]

In addition to the studies which tended to suggest that some feedback was better than no feedback in developing pre-service teachers' behaviors using micro-teaching, there were other studies which attempted to compare the effectiveness of various forms of feedback. The results of these studies were as follows:

1. At Hunter College pre-service teachers receiving video-tape feedback showed no significant differences in performances during micro-lessons than pre-service teachers who received oral feedback from a supervisor.[123]

2. Acheson found that a combination of television feedback and supervisory conferences produced significantly greater effects on teacher verbal behavior than did supervisory conferences without television feedback.[124]

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[122]Ibid.

[123]Webb and Baird, "Selected Research," pp. 89-90.

[124]K. A. Acheson, "The Effects of Feedback from Television Recordings and Three Types of Supervisory Treatment on Selected Teacher Behaviors" (unpublished Ph.D. dissertation, Stanford University, 1964), cited by Koran, "Two Paradigms," p. 25.

3. Olivero concluded that in micro-teaching videotape playbacks plus verbal feedback produced greater changes in selected behaviors than verbal feedback alone.[125]

4. The McDonald and Allen studies suggested that the most successful feedback conditions appeared to be those in which a supervisor provided both discrimination training and reinforcement accompanying a playback of the pre-service teacher's performance.[126]

Comparisons of micro-teaching with other forms of pre-classroom teaching.--From 1963 to 1966 attempts were made at Stanford University to compare the effectiveness of the micro-teaching experience with the more traditional form of student teaching. Experimental and control groups were formed with the control groups given field observation and experiences in classrooms as teacher aides. The experimental groups had three micro-teaching experiences per week for eight weeks. Teaching performances of members of both groups were derived from evaluations made by

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[125]J. L. Olivero, "Video Recordings as a Substitute for Live Observation in Teacher Education" (unpublished Ph.D. dissertation, Stanford University, 1964), cited by Koran, "Two Paradigms," p. 25.

[126]Frederick J. McDonald and Dwight W. Allen, Training Effects of Feedback and Modeling Procedures on Teacher Performance (United States Office of Education, 6-10-078, School of Education, Stanford University, 1967).

the high school students who served as the micro-students and were the students during the control groups' teacher aid experiences. Webb and Baird, in summarizing the results of these early studies, indicated that:

> 1. Candidates trained through micro-teaching techniques over an eight week period and spending less than ten hours a week in training, performed at a higher level of teaching competence than a similar group of candidates receiving separate instruction and theory with an associated teacher-aid experience. . . .
> 2. Performance in the micro-teaching situation predicted subsequent classroom performance.
> 3. Over an eight week period, there is a significant increase in the accuracy of the candidate's self-perception of his teaching performance through identification of weaknesses as well as strengths.
> 4. Ratings of video transcriptions of teaching encounters correlate positively with live ratings of the same encounters.
> 5. Trainee's acceptance of the value of micro-teaching is high.
> 6. Micro-students' ratings of teaching performance are more stable than any other, including those of supervisors.[127]

A study by Limbacher at Illinois University confirmed the results obtained at Stanford University. In this study one group of student teachers was provided the opportunity to do some micro-teaching as part of their student teaching experience while a control group was denied the experience. Results indicated that the group receiving micro-teaching experiences in connection with student teaching received significantly higher

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[127]Webb and Baird, "Selected Research," pp. 87-88.

scores on all the instruments used to measure teacher behavior and effectiveness.[128]

Finally, in studying the effects of micro-teaching on pre-service teachers' attitudes, Stang came to conclusions which differed from Limbacher's results. In Stang's study pre-service teachers having a micro-teaching experience were compared to a similar group receiving only an observation experience. Results indicated that there were very few differences in the pre-service teachers' attitudes towards (1) teaching in general, (2) themselves teaching elementary school science, and (3) using the process approach in teaching science.[129] A lack of difference could have been due to the fact that only one micro-lesson was taught by the experimental group; thus, there was insufficient exposure to micro-teaching to influence attitudes.

Discussion of the Research Relating to Micro-Teaching

Literature relating to the history, objectives, present character of elementary school science, and the

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[128] Philip Carl Limbacher, "A Study of the Effects of Microteaching Experiences Upon Practice Teaching Classroom Behavior," Dissertation Abstracts, XXX, No. 1 (1969), 189-A.

[129] Genevieve Elaine Stang, "The Effects of a Micro-Teaching Experience on Modifying the Attitudes Toward Teaching Science Held by Prospective Women Elementary School Teachers," Dissertation Abstracts, XXIX, No. 12 (1968), 4940-A.

inquiry role of the teacher has suggested that for teachers to be effective in their science instruction, they should possess certain inquiry teaching behaviors and associated attitudes. Micro-Teaching has been identified as a possible means of providing pre-service teachers with opportunities to acquire such behaviors and attitudes. Research on the use of micro-teaching since 1963 has revealed the following:

1. Observing pre-service teacher's teaching performances with respect to a limited number of specific, discernable teaching behaviors was more valuable than observing teaching performances in a global fashion.[130]

2. Micro-teaching resulted in changes in pre-service and in-service teacher behaviors. The conditions under which behavior was changed, however, have not been clearly identified. For instance:

a. There was no convincing evidence regarding the optimal number of lessons that should be presented by the pre-service teacher for changes to occur in behavior. In the studies reviewed, from one to twenty-four micro-lessons were presented with varying degrees of success in bringing about behavioral changes.

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[130]Harris, Lee, and Pigge, "Effectiveness in Micro-Teaching," p. 33; Fortune, Cooper, and Allen, "Stanford Summer Micro-Teaching," p. 393; Webb and Baird, "Selected Research," pp. 89-90.

b. There was conflicting evidence and opinion regarding the type of micro-teaching student that should be used. While Steinbach and Ashlock found peers to be effective and efficient, Allen and Ryan suggested that only school-aged children could provide realism in the micro-teaching situation.[131]

c. There was no convincing evidence regarding the optimal number of students that should be used in the micro-teaching sessions.[132] In the studies reported from two to eight students were used in the micro-lessons with varying degrees of success in bringing about changes in behavior. The research did not indicate whether larger groups of students could be effectively used in micro-lessons.

d. The combination of perceptual and symbolic modeling techniques appeared to be effective in bringing about changes in the behaviors that were modeled.[133]

e. Feedback in the form of video or audio replays of lessons and oral or written

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[131] Steinbach, "A Comparative Study"; Ashlock, "Micro-Teaching"; Dwight W. Allen and Kevin Ryan, <u>Microteaching</u> (Reading, Mass: Addison-Wesley Publishing Co., 1969), pp. 47-48.

[132] Dwight W. Allen and Arthur W. Eve, "Microteaching," <u>Theory Into Practice</u>, VII (December, 1968), 184.

[133] Young, "The Modification of Teacher Behavior"; Allen, "A Comparison"; Koran, "Two Paradigms," pp. 26-27.

comments from a supervisor promoted behavioral changes.[134]

3. Micro-teaching was viewed by pre-service teachers as a worthwhile experience.[135] Attempts to measure other attitude changes resulted in inconclusive results.[136] This was apparently caused by the inability of researchers to measure minor changes or the particular resistance to change of some attitudes.

4. Apparently the learning of specific behaviors and attitudes was a complex task involving the inter-relationships of many variables including the pre-service teacher, the behaviors and attitudes to be learned, the nature of learning, and the nature of the micro-teaching design.

Summary

The emphasis on inquiry teaching behaviors and attitudes and the use of micro-teaching in this study was influenced by five aspects of elementary science education and teacher education.

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[134] Aubertine, "An Experiment"; Borg, "Video-tape Feedback"; Acheson, "The Effects"; Olivero, "Video Recordings"; McDonald and Allen, "Training Effects."

[135] Fortune, Cooper and Allen, "Stanford Summer Micro-Teaching"; McDonald and Allen, "Training Effects."

[136] Harris, Lee, and Pigge, "Effectiveness of Micro-Teaching"; Steinbach, "A Comparative Study"; Stang, "The Effects of Micro-Teaching."

First, the review of the literature relating to the history of elementary school science education revealed that there were several procedures to the teaching of science which, because of their soundness in philosophy and agreement with theories of learning, withstood many changes in thought and practice and became the bases for much of present elementary school science. Among these enduring approaches were the beliefs that: (1) learning was greatly influenced by opportunities for direct involvement in learning activities, (2) real experiences were more appropriate than contrived experiences, (3) elementary school science was interdisciplinary, and (4) elementary school science consisted of learning the products as well as the processes of science.

Also revealed in the literature of the history of elementary school science was the fact that one of the primary reasons for the failure of many approaches to science education was the teacher's lack of understanding of the underlying philosophies of these programs and lack of appropriate teaching skills.

The second aspect of elementary science education which influenced this study were the objectives, as stated from 1926 to the present, of elementary school science. Literature relating to these objectives revealed two things: (1) the objectives of elementary school science had changed little between 1926 and 1970, and (2) that, despite the over-all lack of change in objectives, there was an increased emphasis on such things as "critical thinking," the "scientific processes," and "inquiry" expressed in present objectives of elementary school science.

As the third aspect of elementary science education, the present character of elementary school science was examined. Literature relating to this area confirmed what had already been found in previously reviewed literature; namely, the present character of elementary school science was characterized by an emphasis on inquiry learning. Specifically, it was found that the child's role in present elementary school science was one of active involvement with materials, ideas, and people. It was also discovered that such an emphasis required a definite change in the elementary school teacher's role as well. No longer was the teacher viewed as the "fountain of knowledge," rather, he was depicted as one whose primary function was to guide the learning activities of children.

The fourth aspect of elementary science education which influenced this study were the suggestions in the literature relative to the specific behaviors and attitudes required of the inquiry role of the elementary school teacher. From the literature it was found that there were several behaviors and associated attitudes which were essential to an effective inquiry teaching approach. The important behaviors and associated attitudes examined were those relating to involving children in learning activities, asking higher order questions, providing neutral responses, and pausing for longer periods of time.

Finally, after a study of the literature pertaining to the efforts of teacher preparation institutions to prepare teachers for inquiry teaching, a thorough review of the literature was made on micro-teaching as a potential technique for providing experiences leading to the development of inquiry teaching behaviors and attitudes among pre-service teachers. This review concluded that micro-teaching was a useful technique in this respect but that considerable research was needed to more adequately investigate the effects of the variables of the micro-teaching format.

CHAPTER III

DESIGN OF THE STUDY

The investigation involved three distinct phases. The peer teaching phase of the study was conducted throughout nine weeks of the ten week Winter term of the elementary science methods course at Michigan State University during the 1970 academic year. This phase was concerned with the presentation and rating of micro-lessons presented by pre-service teachers to their peers in a university laboratory setting. The second phase was conducted during the last week of the same term. The purposes of this phase were to present and rate micro-lessons presented by pre-service teachers to elementary school children in an elementary school setting. A third phase was the pre- and post-test administration and evaluation of an attitude measure. The purpose of this phase was to determine the relative effects of the micro-teaching experiences on the attitudes of pre-service teachers towards teaching, science, the teaching of science, higher order questions, involving children in learning activities, and the procedure of presenting micro-lessons to their peers.

Sample

The subjects of this study were sixty pre-service teachers randomly selected from a population of 240 students enrolled in the Education 325F elementary science methods course offered during the Winter term of 1970 at Michigan State University.

The population consisted of students who: (1) were either special education or elementary education majors, (2) had completed the prerequisites for entrance into the methods course (one course in physical science and/or one course in biological science, a course in educational psychology, and one week of classroom experience as an observer-aide), (3) were preparing to become teachers of grades kindergarden through six, (4) were also enrolled in the Common Elements of Teaching (Ed 321A) course (a general methods course of teaching where one experience had was that of participating as a student aide in an elementary school for seven school days during the term), and (5) had not had any extended previous teaching experience as an elementary school teacher.

As part of the ten week elementary science methods course, students attended eight, fifty minute microteaching laboratory sessions, being randomly assigned to one of six such groups. Ten students were then randomly selected from each of these six groups to become the subjects for the study.

The Science Methods Course

The elementary science methods course was a three-term hour course normally taken concurrently with other elementary methods courses. The total academic load of the average student during this term was seventeen hours.

There were three types of activities that constituted the science methods course in addition to the micro-teaching laboratory sessions. These were large group lectures, outside readings and assignments, and autotutorial learning sessions.

Nine large group lectures were presented throughout the ten week term. Such topics as the philosophy and history of science education, methods and techniques of giving a science demonstration, conducting a field trip, obtaining and using free and inexpensive materials in science teaching, using science textbooks, new science curriculum programs, and controversial issues in science were discussed. Modeling techniques were also employed with the use of two video-tapes of pre-service teachers and the instructor presenting science lessons to peers and to elementary school children.

The science autotutorial sessions were experiences in individual and small group learning. The purposes of these experiences were to allow the pre-service teachers to (1) see science as a natural and enjoyable experience, (2) observe the role of the teacher in an inquiry session,

(3) sample lessons from three of the major elementary science programs, Science Curriculum Improvement Study, American Association for the Advancement of Science: Science--A Process Approach, and Elementary Science Study.

In these autotutorial sessions pre-service teachers had the opportunity to participate as elementary students might in inquiry learning sessions involving units from the three programs mentioned above. In so doing, these pre-service teachers were being taught by an experienced teacher who assumed the role of a teacher in an inquiry teaching situation.

In addition to exposure to methods and techniques of teaching in lectures, readings, and observations of live and video-taped models, the pre-service teachers were provided with the opportunity to apply and practice these methods and techniques in actual micro-teaching situations with their peers acting as the pupils for their lessons.

During the term the pre-service teachers in the study taught either one or two micro-lessons to groups of four, eight, or twelve to sixteen peers. The lessons ranged from five to seven minutes in length and dealt with topics in elementary science of the pre-service teacher's choosing. To compensate for the extra time and work which would be required of the pre-service teachers in the study, one of the outside of class assignments was eliminated from their course requirements.

Regardless of the number of peers that were taught in the micro-lessons there were always a number of other peers who observed the lessons. The peers acting as pupils for the lessons were instructed to act their normal roles as learners and not to try and assume the roles of elementary school children. At the same time the micro-teachers were instructed to use materials and activities appropriate for their selected grade level and topic but to avoid attempting to use the vocabulary of children at that grade level.

Peers acting as pupils and observers supplied feedback for each lesson in the form of a written evaluation using the Micro-Teaching Rating Scale (see Appendix A, page 194). A supervisor also completed a written evaluation which was available for the student following the lesson. Oral feedback and evaluation was occasionally provided in the form of class discussions following the completion of the micro-lessons for any one laboratory period. Rather than being specific to any one pre-service teacher's performance, these oral feedback sessions centered on such topics as: student-teacher interaction, student involvement in the lessons, inquiry development, questioning techniques, the construction and use of behavioral objectives, reinforcement techniques, the use of equipment, and the designs of science activities.

Procedures

Prior to the beginning of the first lecture meeting a Semantic Differential Attitude Instrument (see Appendix D, page 205) was administered to all students in the course. This instrument was again administered at the completion of the term to the sixty pre-service teachers who comprised the sample in the study.

Once the term was under way stduents attended lectures, autotutorial, and micro-teaching sessions. Each of the micro-teaching groups received a different treatment. The six treatment groups were as follows:

Group 4P/1L - taught one micro-lesson to four peers.

Group 4P/2L - taught two micro-lessons to four peers.

Group 8P/1L - taught one micro-lesson to eight peers.

Group 8P/2L - taught two micro-lessons to eight peers.

Group 12-16P/1L - taught one micro-lesson to twelve to sixteen peers.

Group 12-16P/2L - taught two micro-lessons to twelve to sixteen peers.

During the second week of the course the pre-service teachers in the study were given an Information sheet (see Appendix E, page 215) which informed them of the procedures germane to their participation in the study, the nature of the micro-lesson they would present to elementary school children, and the nature of the elementary school children.

Two weeks prior to their micro-lessons with elementary school children, these pre-service teachers were given another information sheet explaining the logistics of the presentations as well as providing an outline of the lesson they were to teach. The lesson, a version of Science: A Process Approach, Part D-v, entitled "Observing Falling Objects," contained: (1) the student objectives they were to use, (2) the rationale and background information for the lesson, (3) an outline of the activities, and (4) an evaluation measure to administer to the children upon completion of the lesson (the evaluation measure was Part III of the Audio-Tape Analysis Instrument). A complete copy of the lesson and accompanying instructions are given in Appendix F, page 219.

During the last two weeks of the term the sixty pre-service teachers in the study (ten from each treatment group) were taken in groups of five to one of two elementary schools in the East Lansing, Michigan school district. Both schools were similar to the extent that the pupils attending were, in most instances, children of parents who were connected in some way with Michigan

State University, either as faculty, students, or other types of workers. The pre-service teachers each presented one five to seven minute lesson to four elementary school children of grades two, three, or four. The average grade level for any of the six treatment groups was third grade.

The pre-service teachers were aware that the lesson had been revised in such a manner that examples of teacher questions and procedures for initiating child involvement were excluded. Revamping of the lesson to incorporate appropriate questions and involvement of children in the lesson was the responsibility of the pre-service teacher.

Each of the micro-lessons with elementary school children was audio-taped with a cassette-type tape recorder and the recorded lessons were analyzed with the Audio-Tape Analysis Instrument (see Appendix C, page 200). The specific behaviors analyzed were: (1) types of pre-service teacher questions, (2) types of pre-service teacher responses, (3) amount of children's verbal involvement, (4) the pre-service teacher's wait-time following questions, and (5) the pre-service teacher's wait-time before a response was given by a child.[1]

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[1]A complete description of the three instruments used in the study is presented in Chapter IV.

Structure of the Design

The structure of the design for this study can be represented by the following design and data paradigms for the three dependent variables listed below:

1. Teacher Behaviors in Presenting Micro-Lesson(s) to Peers

Design Paradigm

	$X_{4P/1L}$	Y_a
	$X_{4P/2L}$	Y_a
(R)	$X_{8P/1L}$	Y_a
	$X_{8P/2L}$	Y_a
	$X_{12\text{-}16P/1L}$	Y_a
	$X_{12\text{-}16P/2L}$	Y_a

All subjects were randomly assigned (R). The X's represented the treatments of which there were six. The study involved the manipulation of two active variables within these treatment groups: number of peers in the micro-class (4P, 8P, or 12-16P) and number of micro-lessons presented (1L or 2L). Y_a represented the pre-service teachers' performances on four measures of the Micro-Teaching Rating Scale, as measured by their peers. The four Y measures were indications of the pre-service teachers' abilities to: (1) involve pupils in learning activities, (2) ask higher order questions, (3) ask questions appropriately, and (4) provide a variety of reinforcement to pupils in the micro-class.

Data Paradigm

Number of Peers in the Micro-Teaching Groups

Y Measures	X_4		X_8		X_{12-16}	
Number of Lessons	1L	2L	1L	2L	1L	2L
Involvement of Pupils						
Higher Order Questions						
Questioning Behavior						
Reinforcement to Pupils						

2. Teacher Behavior in Presenting Micro-Lesson(s) to Elementary School Children

Design Paradigm

	$X_{4P/1L}$	Z_a
	$X_{4P/2L}$	Z_a
(R)	$X_{8P/1L}$	Z_a
	$X_{8P/2L}$	Z_a
	$X_{12-16P/1L}$	Z_a
	$X_{12-16P/2l}$	Z_a

The same set of randomly assigned, (R), treatment groups, the X's, were used. Z_a refer to the measures of the pre-service teachers' performances while teaching micro-lessons to elementary school children as indicated by scores on the Audio-Tape Analysis Instrument. Six of the Z measures were indications of the pre-service teachers' abilities to: (1) verbally involve children in the lesson, (2) pause after asking a question, (3) pause before responding to a child's comment or answer, (4) ask higher order questions, (5) provide neutral responses, and (6) ask questions to which children give responses. A seventh Z measure was an indication of the elementary school childrens' performances on the process test taken at the completion of the lesson.

Data Paradigm

Number of Peers in the Micro-Teaching Groups

	X_4		X_8		X_{12-16}	
Number of Lessons	1L	2L	1L	2L	1L	2L
Z Measures: Student Verbal Invol.						
Wait-time After Quest.						
Wait-time Before Res.						
Higher Order Questions						
Neutral Responses						
Questions with Resp.						
Children's Performance						

3. Pre-Service Teacher Attitude

Design Paradigm

	SD_b	$X_{4P/1L}$	SD_a
	SD_b	$X_{4P/2L}$	SD_a
(R)	SD_b	$X_{8P/1L}$	SD_a
	SD_b	$X_{8P/2L}$	SD_a
	SD_b	$X_{12-16P/1L}$	SD_a
	SD_b	$X_{12-16P/2L}$	SD_a

Here all subjects were randomly assigned (R). SD_b represents the attitude pre-test and the SD_a represents the post-test attitude score as measured by the Semantic Differential Attitude Measure. The X's represent the same six treatment groups indicated in previous designs.

Seven attitude concept phrases composed the Semantic Differential Attitude Instrument. These were: teaching in the elementary school, science in the elementary school, myself teaching science in the elementary school, student participation in science activities, higher order questions in science teaching, presenting a science lesson to peers for the practice of teaching elementary school science, and small groups in the science methods course.

Data Paradigm

Number of Peers in the Micro-Teaching Groups

		X_4		X_8		X_{12-16}	
	Number of Lessons	1L	2L	1L	2L	1L	2L
SD Measures	Tchng in Elem Sch						
	Sci in the Elem Sch						
	Myself Tch Sci						
	St Part in Sci						
	H O Quest in Sci						
	Pres less to Peers						
	Sm Grps in Course						

Hypotheses

Hypotheses tested for this study were grouped under three headings: (1) Micro-Lesson With Peers hypotheses, (2) Micro-Lessons With Elementary School Children hypotheses, and (3) Pre-service Teacher Attitude hypotheses.

Micro-Lesson(s) With Peers

H_{01}: There will be no differences in the presentations of micro-lessons to peers in an elementary science methods micro-teaching laboratory as indicated by the mean of the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale between groups presenting one lesson and groups presenting two lessons when the second lesson of the two-lesson groups are compared to the one lesson of the one-lesson groups.

H_{02}: There will be no differences between peer-groups of four, eight, and twelve to sixteen in the presentations of micro-lessons to peers in an elementary science methods micro-teaching laboratory, as indicated by the mean of the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

H_{03}: There will be no differences between the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

H_{04}: There will be no interactions between peer-groups, lesson-groups, and measures, where the measures used are the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

Micro-Lessons With Elementary School Children

H_{05}: There will be no differences between one-lesson and two-lesson groups in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the Audio-Tape Analysis Instrument and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

$H_{05.1}$: There will be no differences in the amount of children's verbal involvement in the lesson compared to the total teacher and children verbal involvement time.

$H_{05.2}$: There will be no differences in the teacher's average wait-time after asking a question.

$H_{05.3}$: There will be no differences in the teacher's average wait-time before responding to a child's answer or comment.

$H_{05.4}$: There will be no differences in the percentage of higher order questions asked by the teacher.

$H_{05.5}$: There will be no differences in the percentage of neutral verbal responses given by the teacher.

$H_{05.6}$: There will be no differences in the percentage of questions asked by the teacher which are responded to by children.

$H_{05.7}$: There will be no differences in the mean of the scores received by the elementary school children on the process measure administered to the children following the micro-lesson.

H_{06}: There will be no differences between peer-groups of four, eight, and twelve to sixteen in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the <u>Audio-Tape Analysis Instrument</u> and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

$H_{06.1}$: There will be no differences in the amount of children's verbal involvement in the lessons compared to the total teacher and children verbal involvement time.

$H_{06.2}$: There will be no differences in the teacher's average wait-time after asking a question.

$H_{06.3}$: There will be no differences in the teacher's wait-time before responding to a child's answer or comment.

$H_{06.4}$: There will be no differences in the percentage of higher order questions asked by the teacher.

$H_{06.5}$: There will be no differences in the percentage of neutral verbal responses given by the teacher.

$H_{06.6}$: There will be no differences in the percentage of questions asked by the teacher which are responded to by the children.

$H_{06.7}$: There will be no differences in the mean of the scores received by the elementary school children on the process measure administered to the children following the micro-lesson.

H_{07}: There will be no interactions between peer-groups and lesson-groups in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the Audio-Tape Analysis Instrument and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

$H_{07.1}$: There will be no differences in the amount of children's verbal involvement in the lesson compared to the total teacher and children verbal involvement time.

$H_{07.2}$: There will be no differences in the teacher's average wait-time after asking a question.

$H_{07.3}$: There will be no differences in the teacher's average wait time before responding to a child's answer or comment.

$H_{07.4}$: There will be no differences in the percentage of higher order questions asked by the teacher.

$H_{07.5}$: There will be no differences in the percentage of questions asked by the teacher which are responded to by children.

$H_{07.6}$: There will be no differences in the mean of the scores received by the elementary school children on the process measure administered to the children following the micro-lesson.

Pre-Service Teacher Attitude

H_{08}: There will be no differences between one-lesson and two-lesson groups in attitudes, as measured by the total group mean scores of the Semantic Differential Attitude Instrument.

H_{09}: There will be no differences between peer-groups of four, eight, and twelve to sixteen in attitudes, as measured by the total group mean scores of the Semantic Differential Attitude Instrument.

H_{010}: There will be no interactions between lesson-groups and peer-groups in attitudes, as measured by the total group mean scores on the Semantic Differential Attitude Instrument.

H_{011}: There will be no differences between one-lesson and two-lesson groups in attitudes, as measured by group mean scores for each of the seven concept phrases of the Semantic Differential Attitude Instrument.

$H_{011.1}$: There will be no differences in attitude toward "Teaching in the Elementary School."

$H_{011.2}$: There will be no differences in attitude toward "Science in the Elementary School."

$H_{011.3}$: There will be no differences in attitude toward "Myself Teaching Science in the Elementary School."

$H_{011.4}$: There will be no differences in attitude toward "Student Participation in Science Activities."

$H_{011.5}$: There will be no differences in attitude toward "Higher Order Questions in Science Teaching."

$H_{011.6}$: There will be no difference in attitude toward "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science."

$H_{011.7}$: There will be no differences in attitude toward "Small Groups in the Science Methods Course."

H_{012}: There will be no differences between peer-groups of four, eight, and twelve to sixteen in attitudes, as measured by group mean scores for each of the seven concept phrases of the <u>Semantic Differential Attitude Instrument</u>.

$H_{012.1}$: There will be no differences in attitude twoard "Teaching in the Elementary School."

$H_{012.2}$: There will be no differences in attitude toward "Science in the Elementary School."

$H_{012.3}$: There will be no differences in attitude toward "Myself Teaching Science in the Elementary School."

$H_{012.4}$: There will be no differences in attitude toward "Student Participation in Science Activities."

$H_{012.5}$: There will be no differences in attitude toward "Higher Order Questions in Science Teaching."

$H_{012.6}$: There will be no differences in attitude toward "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science."

$H_{012.7}$: There will be no differences in attitude toward "Small Groups in the Science Methods Course."

H_{013}: There will be no interactions between peer-groups and lesson-groups in attitudes, as measured by group mean scores for each of the seven concept phrases of the <u>Semantic Differential Attitude Instrument</u>.

$H_{013.1}$: There will be no interaction in attitude toward "Teaching in the Elementary School."

$H_{013.2}$: There will be no interaction in attitude toward "Science in the Elementary School."

$H_{013.3}$: There will be no interaction in attitude toward "Myself Teaching Science in the Elementary School."

$H_{013.4}$: There will be no interaction in attitude toward "Student Participation in Science Activities."

$H_{013.5}$: There will be no interaction in attitude toward "Higher Order Questions in Science Teaching."

$H_{013.6}$: There will be no interaction in attitude toward "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science."

$H_{013.7}$: There will be no interaction in attitude toward "Small Groups in the Science Methods Course."

Analysis

To analyze the data collected, three statistical treatments were used for purposes of testing the hypotheses stated above.

A repeated measures--two-way analysis of variance procedure, as described by Winer,[2] was selected for analyzing the data relevant to the testing of hypotheses one through four. This statistical treatment was chosen for two reasons. First, the two-way analysis of variance

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[2]B. J. Winer, Statistical Principles in Experimental Design (New York: McGraw Hill Book Co., 1962), p. 105.

segment of the statistical analysis provided information required in the testing for significant differences between the main effects of presenting lessons to different numbers of peers and presenting different numbers of lessons, as well as testing for interaction effects resulting from the combinations of lesson-treatment and peer-treatment. Second, the repeated measures aspect of the procedure provided information which would reveal whether there were significant differences between the four measures of the Micro-Teaching Rating Scale. In this way differences which could have been due to dissimilarities in the characteristics of the measures were quantified and separated from the differences due only to the treatment effects and experimental error. Thus, this analysis procedure for testing differences between treatment groups was more sensitive.

To test hypotheses five through seven a separate two-way analysis of variance procedure, as suggested by Hays,[3] was used with each of the seven measures of the Audio-Tape Analysis Instrument. This procedure provided information required in the testing for significant differences between the separate experimental variables of number of lessons taught and number of peers in the micro-classes. As pointed out above, the use of the two-way

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[3]William L. Hays, Statistics for Psychologists (New York: Holt, Rinehart and Winston, 1963), p. 387.

analysis of variance procedure also provided information relevant to the existence of interaction effects, or differences apparently caused by the unique combination of the lesson and peer treatments.

Finally, in testing hypotheses eight through thirteen, a two-way analysis of covariance procedure, as described by Winer,[4] was used. Although subjects were randomly assigned to treatment groups and randomly selected from these groups, a two-way analysis of variance procedure used to test differences in treatment groups for each of the seven concept phrases of the pre-test _Semantic Differential Attitude Instrument_ indicated that enough differences existed to warrant the use of the two-way analysis of covariance procedure. Use of the two-way analysis of covariance procedure increased the power of the analysis because it allowed for the adjustment of the mean scores on the post-test _Semantic Differential Attitude Instrument_ in accordance with the differences in groups which were indicated by the _Semantic Differential Attitude Instrument_ pre-test scores. Once these adjustments were made for the differences displayed on the pretest, the two-way analysis of variance procedure provided information required in the testing for significant differences between the experimental variables of the number of

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[4]Winer, _Statistical Principles_, p. 578.

lessons taught and number of peers in the micro-classes, as well as for testing the presence of interaction effects.

Summary

Out of 240 students enrolled in a pre-service elementary science methods course at Michigan State University, sixty students were randomly selected to serve as the subjects for this study. These students completed all the requirements for the course including attending lectures, reading outside assignments, participating in autotutorial experiences, and participating in micro-teaching sessions.

Each of the micro-teaching laboratory sessions differed, however, with respect to the number of peers used in the micro-lessons. Two groups presented lessons to four peers, two groups presented lessons to eight peers, and two groups presented lessons to from twelve to sixteen peers. The subjects in the study, ten from each of the six treatment groups, taught either one micro-lesson or two micro-lessons during the course. These lessons were rated by their pre-service peers using the *Micro-Teaching Rating Scale*. Hypotheses one through four relative to the differences between peer-treatment groups, lesson-treatment groups, interaction effects, and scores on the four measures of the instrument were tested through the use of a repeated measures--two-way analysis of variance procedure.

The pre-service teachers in the study then presented one micro-lesson to different sets of four elementary school children. Using audio-tape recordings of these lessons, an Audio-Tape Analysis Instrument was employed to rate the performances of these pre-service teachers. Hypotheses five through seven relative to the differences between peer-treatment groups, lesson-treatment groups, and the interaction effects of the combinations of these treatments were tested through the use of a two-way analysis of variance procedure.

Prior to the beginning of the elementary science methods course and at the completion of the course the pre-service teachers in the study completed a Semantic Differential Attitude Instrument which indicated attitudes towards concept phrases related to the teaching of elementary school science and the use of micro-teaching with peers. Using a two-way analysis of covariance procedure, hypotheses eight through thirteen pertaining to the differences in peer-treatment groups, lesson-treatment groups, and interaction effects were tested.

All hypotheses were rejected when the value of the F-test exceeded the .05 confidence level.

CHAPTER IV

INSTRUMENTATION

The educational literature revealed that some instruments had been developed which could be used to rate behaviors and attitudes associated with micro-teaching. The measures developed by Stanford University, Ashlock, Hall, Steinbach, Ulhorn, Stang, L. C. Smith and the recommendations for constructing rating scales by Guilford and O. B. Smith were especially pertinent to this study.[1]

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[1]Jimmie C. Fortune, James M. Cooper, and Dwight W. Allen, "The Stanford Summer Micro-Teaching Clinic, 1965," The Journal of Teacher Education, XVIII (Winter, 1967), 389-393; Robert B. Ashlock, "Micro-Teaching in an Elementary Science Methods Course," School Science and Mathematics, LXVII (January, 1968), 52-56; Gene Erwin Hall, "A Comparison of the Teaching Behaviors of Second Grade Teachers Teaching Science--A Process Approach with Second Grade Teachers Not Teaching a Recently Developed Science Curriculum," Dissertation Abstracts, XXIX, No. 12 (1969), p. 4348-A; Alan H. Steinbach, "A Comparative Study of the Effects of Practice with Elementary School Chidlren or with Peers in the Science Methods Course" (unpublished Ph.D. dissertation, The University of Texas at Austin, 1968); Kenneth W. Ulhorn, "Pre-Student Teaching Experiences in Science," Journal of Research in Science Teaching, V (1967-1968), 367-372; Genevieve Elaine Stang, "The Effect of a Micro-Teaching Experience on Modifying the Attitudes Toward Teaching Science Held by Prospective Women Elementary School Teachers," Dissertation Abstracts, XXVIII (1968), pp. 66-67; Lillian C. Smith, "A Study of the Use of Micro-Teaching in the Preparation of Elementary Teachers," in Teacher Education in Transition, Vol. II, ed. by Howard E. Bosley (Baltimore: Multi-State

While these studies provided guidelines for setting up rating scales and attitude measures, none of the instruments dealt with the same behaviors and attitudes that were of concern in this study. Therefore, it was necessary to construct three instruments to specifically measure the behaviors and attitudes which were of concern in this study. The three instruments developed were the Micro-Teaching Rating Scale (see Appendix A, page 194) used to rate the pre-service teachers' performances while presenting micro-lessons to peers, the Audio-Tape Analysis Instrument (see Appendix C, page 200) used to evaluate verbal performances from tape recordings and transcriptions of pre-service teachers presenting micro-lessons to elementary school children, and the Semantic Differential Attitude Instrument (see Appendix D, page 205) used to determine pre-service teachers' attitudes before and after the elementary science methods course.

Micro-Teaching Rating Scale

Selection of the Behaviors

As indicated in Chapter I, the primary task in the development of the micro-teaching model was that of

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Teacher Education Project, May, 1969), pp. 121-135; J. P. Guilford, "Rating Scales," Psychometric Methods (New York: McGraw-Hill Book Co., 1954), pp. 263-301; B. O. Smith, "Recent Research on Teaching: An Interpretation," The High School Journal, LI (November, 1967), 63-73.

identifying the specific teaching behaviors to be learned and developed during micro-teaching sessions and instruction periods. Identification of the behaviors to be emphasized during micro-teaching and in this study was a four step process.

First, the objectives for the elementary science methods course were identified. One basic objective was that the pre-service teachers be able to "effectively" present a micro-lesson to four elementary school children on a given topic in science in a five to ten minute period. To determine what was expected of an "effective" performance, the activities, methods, and techniques used by the instructor as well as the assignments designed for the pre-service teachers were analyzed with respect to the kinds of teaching behaviors that were being emphasized.

Second, literature relating to inquiry teaching in elementary school science was reviewed to determine teaching behaviors recommended for "effective" inquiry science teaching. Third, studies involving micro-teaching as a means of improving pre-service and in-service teaching behaviors were analyzed. These behaviors were discussed in Chapter II.

Finally, the three different lists of teaching behaviors contributing to "effective" inquiry teaching were compared. Fifteen behaviors were found to be in common among all three lists. From these behaviors four were selected to receive special emphasis during the micro-lessons and to serve as the criterion measures of teacher "effectiveness" in this study.

The behaviors selected were: (1) involving pupils in learning activities, (2) using higher order questions, (3) asking question appropriately, and (4) providing a variety of responses to pupil comments and answers. Despite the emphasis which was placed on these four behaviors, it was believed necessary to augment them with six other traits in the final design of the Micro-Teaching Rating Scale. As a group these ten items created an instrument which was representative of the major behaviors that could be demonstrated in the total micro-lesson.

The reason for using a ten item instrument rather than an instrument composed of the four items which were of primary concern was because approximately eighty-seven per cent of the pre-service teachers in the science methods course would have an opportunity to teach only one micro-lesson. Therefore, it was thought that for these pre-service teachers an exposure to a greater array of teaching behaviors would be more appropriate than a concentration on a limited number.

Construction of the Instrument

Once the specific behaviors to be performed were decided, it was necessary to design an instrument that would allow raters to evaluate these behaviors while they would be demonstrated in a five to seven minute presentation of a micro-lesson.

Literature relating to the ten behaviors (actually nine behaviors and one over-all evaluation item) comprising the Micro-Teaching Rating Scale was specific enough so that descriptions of adequate and inadequate performances of these behaviors could be written. After these descriptions were written, criteria suggested by Guilford was used to construct a "standard scale" type of rating form.[2]

The completed rating from consisted of the ten behaviors to be rated along with sets of five boxes labeled 5, 4, 3, 2, 1, where the rater could check the appropriate box for each behavior. An Item Explanation sheet was also constructed which defined the standards of performance for each behavior (see Appendix B, page). Three basic "standards" statements were included for each behavior: one which corresponded to the "highest standard" of performance and was assigned a value of 5, another corresponding to a "middle standard" of performance and was assigned a value of 3, and a final one corresponding to the "lowest standard" of performance and was assigned a value of 1. Standards for "high" performances, a value of 4, and "low" performances, a value of 2, were not defined. These numbers did appear on the rating scale form

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[2]Guilford, "Rating Scales," pp. 269-270.

and were to be used when behaviors performed were believed to be "high" or "low," i.e., if the performance of a behavior bettered the "middle standard" but did not quite match standards for the "highest standard," a 4 was assigned.

In addition to checking the appropriate 5-1 boxes which corresponded to the 5-1 standards described on the explanation sheet, a space was provided after each item on the rating scale form for the rater to write comments. No attempt was made to incorporate these comments in the formal analysis of the micro-teaching presentations. However, in that these forms were to be returned to provide the pre-service teachers who had presented micro-lessons with a source of feedback, the comments which were written served to provide supplementary feedback and evaluation information.

The advantages of using this type of "standard scale" rating form were:

1. Little time was needed to check the appropriate boxes for each behavior, thus more time was available to observe and compare behaviors with the "standards" of performance.

2. The use of "standards" as criteria of performance avoided the mere assignment of abstract numbers to an individual's trait.[3]

3. A rather permanent "yardstick" was set up. Observers' standards would therefore not shift from day to day.[4]

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[3] Ibid., p. 269. [4] Ibid.

4. The ratings of different groups of judges would be comparable in absolute as well as in relative amounts because the same "yardsticks" were used by all groups.[5]

5. The scale and its use served as learning experiences for the observers.

Disadvantages pointed out by Guilford were that:

1. In practice, two raters' interpretations of behavior performances were rarely exactly alike, even if they rated the same person.

2. The distances between the five levels of performance were probably not equal.

3. Willful overestimation and underestimation of an individual's performance were still possible when the scale is used.

4. The original scales were very difficult to make.[6]

The Raters

Raters used in this study were the pre-service teachers assigned to each of the six treatment groups. These pre-service teachers did not rate all of the micro-lessons, however. Normally, those pre-service teachers who served as micro-teaching students and from eight to twenty-five other pre-service teachers serving as observers rated each micro-lesson. Never was fewer than twelve nor more than thirty raters used for a micro-lesson.

Pre-service teachers enrolled in the elementary science methods course were used as raters for several

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[5] Ibid. [6] Ibid., p. 270.

reasons. First, it was found in studies at Stanford University that secondary school students who served as micro-teaching students had more reliable ratings of the performances of pre-service teachers who presented them micro-lessons than university personnel who were supervising the same micro-lessons.[7]

Secondly, the rating scale served as a symbolic modeling type of learning. After the initial discussion of the behaviors included on the scale and instruction in the use of the scale, it was believed that the procedure of observing and rating these behaviors would also serve to strengthen and reinforce the learning of these behaviors.

Thirdly, it was recognized that it would be difficult for any one pre-service teacher to observe and rate the performance of ten specific behaviors appearing in the span of a five to seven minute micro-lesson. It was therefore believed that the use of several observers would help to overcome this short-coming.

Education of the Raters

Initial explanation of the ten behavioral items of the rating scale and instruction in the use of the instrument was given during the first week of the micro-teaching

[7]Fortune, Cooper, and Allen, "Stanford Summer Micro-Teaching Clinic," p. 390.

laboratory sessions. During these sessions each behavior was specifically defined and demonstrated. Some opportunity was also provided for the trial rating of these demonstrated behaviors.

It was also emphasized at these orientation sessions, as well as many times throughout the eight weeks of micro-teaching, that for purposes of this study, the behaviors demonstrated were the important factors to consider, not the science content of the lessons. Furthermore, considerable stress was placed upon the assumption that the primary concentration should be on those behaviors of involving pupils in the lesson, asking higher order questions, asking questions appropriately, and utilizing various types of responses to pupil comments or answers.

Rater Reliability

Using an application of an analysis of variance procedure appropriate for incomplete sets of ratings suggested by Ebel,[8] a measure of the reliability between pre-service teachers' ratings was determined. Ratings for twenty-seven micro-lessons presented by pre-service teachers in the study during the fourth week of the term

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[8]Robert L. Ebel, "Estimation of the Reliability of Ratings," in Principles of Educational and Psychological Measurement: A Book of Selected Readings, ed. by William A. Mehrens and Robert L. Ebel (Chicago: Rand McNally and Co., 1967), pp. 116-127.

were analyzed. Rater reliability for the four measures of concern on the <u>Micro-Teaching Rating Scale</u> was .48.

<u>Audio-Tape Analysis Instrument</u>

This three-part instrument was devised to evaluate a five minute segment of a pre-service teacher's presentation of a micro-lesson to four elementary school children. Part I was used to evaluate an audio-tape recording of the lesson. Part II was used to rate a transcription of the lesson. Part III was used to give a rough estimate of the elementary school children's learning of the objectives involved in the micro-lesson.

<u>Selection of the Behaviors</u>

The procedures by which the behaviors to be included in this instrument were selected were the same as those used in determining the behaviors to include in the <u>Micro-Teaching Rating Scale</u>. It was the intent to select behaviors that could be used in both instruments so that one set of criterion measures could be used in determining the "effectiveness" of micro-teaching performances.

<u>Construction and Use of the Instrument</u>

<u>Part I</u> was designed to be used by a rater whose job it would be to listen to a tape recording of a micro-lesson and then, with the aid of a stop watch, measure the following:

1. The total amount of pre-service teacher talk time.

2. The total amount of elementary school children's talk time.

3. The total time of silence, activity, or confusion.

4. The length of each pre-service teacher pause after asking a question.

5. The length of each pre-service teacher pause before providing a response to a child's comment or answer.

Even though all tape recordings were more than five minutes in length, measurements were only made of verbal activity during the first five minutes of the actual micro-lesson. A stop watch calibrated in one-hundreths of a minute was used and all measurements were reported to the nearest one-hundreths of a minute.

From the measurements of verbal activity recorded, two types of scores were derived for analysis purposes:

1. A percentage score indicating the per cent of students' verbal involvement compared to the total pre-service teacher-students' talk time.

2. Average pause time scores for the average length of pre-service teacher pauses after asking questions and before providing responses.

Part II of the instrument was designed to provide a rater with a format which could be used in classifying the following bits of information from a transcription of a micro-lesson:

1. The kinds of questions the pre-service teacher asked.

2. The kinds of responses made by the pre-service teacher.

3. The number of questions asked by the teacher which were not responded to by the elementary school children.

From the above classifications, the following types of scores were derived for analysis purposes:

1. A percentage score indicating the percentage of higher order questions asked out of all the questions asked by the pre-service teacher.

2. A percentage score indicating the percentage of neutral responses provided out of all the responses provided by the pre-service teacher.

3. A percentage score indicating the percentage of questions asked by the pre-service teacher which were responded to by the elementary school children.

Part III was designed to provide the pre-service teachers who presented micro-lessons to elementary school children with a means of indicating whether the objectives of the lesson were achieved.

The process measure and the instructions for administering the measure were modifications from the Science: A Process Approach lesson[9] which was taught by the pre-service teachers. This lesson, process measure, and instructions for administering the measure are presented in Appendix F, page 219.

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[9]American Association for the Advancement of Science, Science: A Process Approach, Part D, Lesson v on "Observing Falling Objects." No page.

The Raters

Different sets of raters were used for each part of the instrument.

For Part I three people, all of whom had previous experience using a stop watch were used to make the timed measurements.

For Part II five people, all of whom were educated in the use of this part of the instrument and knowledgeable in the field of teacher education and in the use of questioning and response behaviors, were used to classify types of questions, responses, and indicate the questions to which the elementary school children did not respond.

Raters used for Parts I and II did not know the names of the pre-service teachers whose tape recordings they listened to or transcriptions they read. Neither did they know to which treatment group these pre-service teachers belonged. Tape recordings and transcriptions were randomly assigned to the raters of both parts.

For Part III the process measure taken by the elementary school children was administered by each pre-service teacher to his particular group of four children.

Education of the Raters

Part I: To aid the raters in the making of the timed measurements, the tape recordings of each micro-lesson were supplemented with transcriptions of these same lessons. Each question asked by the pre-service teacher was underlined in black and each pre-service teacher response was underlined in red on the transcripts. These visual markings provided clues to the raters as to when to begin and end the timed episodes. The indications of what were pre-service teacher questions and responses were derived from the ratings supplied from Part II of the instrument.

The following types of guidelines were also provided to each of the raters:

1. Since a cassette-type tape recorder was used by the raters, instruction in the use of the recorder was given.

2. Instruction was given on the correct use, reading and recording of the timed measurements to the nearest one-hundreths of a minute using the stop watch provided.

3. To create a consistent pattern of interpreting verbal activity, the following guidelines were also established:

    a. When two people are talking at the same time, record only the talk time of the one person whose voice dominates.

    b. If neither voice dominates, count the sequence as "confusion."

    c. When three or more people are talking at once, record this as "confusion" time.

    d. Begin timing the pauses after questions as soon as the last word in the question is made by the pre-service teacher and stop the measurement as soon as another word is spoken by the pre-service teacher or a child.

e. Begin timing the pauses before a teacher response as soon as the last word of the child's comment is made and stop the measurement as soon as the first word of the pre-service teacher is made.

4. Finally, it was suggested that it would take three listenings of the tape recordings to make effective measurements; once to record the total student talk time, once to record the total teacher talk time (the total time of silence, activity, and confusion could then be determined), and once to measure the pre-service teacher pause times.

Part II: A complete description of the educational procedure and material used to acquaint the five raters used to analyze this part of the study can be found in Appendix G, page 228.

Part III: A complete description of the process measure and the instructions for administering this measure are presented in Appendix F, page 219.

Rater Reliability

Part I: Determination of the reliability of the three raters used to measure amounts of verbal activity was a matter of calculating the degree of agreement between raters for their measurements. Using an analysis of variance procedure suggested by Ebel,[10] such a calculation was made of a micro-lesson which all three raters rated. From this procedure a reliability of rating value of .84 was found.

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[10]Ebel, "Estimation of the Reliability of Ratings," p. 120.

Part II: Again, using an application of an analysis of variance procedure suggested by Ebel,[11] reliability of ratings measures were determined. Two samples of micro-lessons were used to derive the reliability of ratings value. These samples were compilations of many of the actual micro-lessons presented by the pre-service teachers in the study. The samples were designed in such a way that all of the possible question and response types were included.

Because each of the five raters rated separate micro-lessons, it was necessary, in the use of the analysis of variance procedure, to determine the "between-raters" variance and include this in the over-all analysis of ratings. With the inclusion of this "between-raters" variance the resultant reliability of ratings values were .90 for the second sample lesson and .98 for the third sample lesson.

Part III: Because the scores received on the process measure by the elementary school children were only of incidental importance, no attempt was made to establish reliability of ratings measures among the pre-service teachers who taught the lessons and administered the instrument.

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[11] Ibid.

Semantic Differential Attitude Instrument

The semantic differential was a technique developed by Osgood, Suci, and Tannenbaum[12] to measure the meaning that an individual associates with concepts or concept phrases. Because of the apparent successes in using a particular aspect of the semantic differential as an attitude instrument, because of its application in previous studies as a means of determining pre-service teachers' attitudes resulting from micro-teaching experiences,[13] and because of its ease of administering and scoring, the semantic differential was particularly applicable for this study.

The Instrument

The format of the Semantic Differential Attitude Instrument was identical to the format suggested by Osgood, Suci, and Tannenbaum.[14] The instrument, itself, consisted of a series of seven concept phrases each accompanied by twenty scales which the pre-service teacher was to react to by indicating how he associated the scales with the concept phrase. The same set of twenty scales accompanied each concept phrase.

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[12]C. E. Osgood, G. J. Suci, and P. H. Tannenbaum, The Measurement of Meaning (Urbana: University of Illinois Press, 1957).

[13]Steinbach, "A Comparative Study"; Stang, "The Effect of Micro-Teaching."

[14]Osgood, The Measurement of Meaning.

Concept phrases.--Osgood listed three primary criteria for selecting semantic differential concepts.[15] These were:

1. The investigator should select concepts which were similar to the significate they represented. Since the primary significates of concern in this study were "teaching elementary school science" and "micro-teaching with peers," concept phrases appropriate to these significates were selected.

2. The investigator should try to select concepts that vary in meaning one from the other. To obtain concept variability five distinct aspects of the significate "teaching elementary school science" were identified and included in the instrument. These were "teaching in the elementary school," "science in the elementary school," "myself teaching elementary school science," "student participation in science activities," and "higher order questions in science teaching." In addition, two aspects of the significate "micro-teaching with peers" were included. These were: "presenting a science lesson to peers for the practice of teaching elementary school science," and "small groups (micro-teaching laboratory sessions) in the elementary science methods course."

3. The investigator should use "good judgment" when selecting concepts. The "good judgment" criteria

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[15] Ibid., pp. 77-78.

for concepts was the recommendations from research on micro-teaching which used a semantic differential technique and recommendations from research relating to attitude development.

Scales.--The scales consisted of twenty bipolar pairs of adjective words which were chosen from a large number of such adjective pairs because of their proven value as indicators of the "evaluative" aspect of meaning. The specific scales which were chosen were also selected because of their apparent relevancy to the concepts being judged.[16]

The scales or bipolar adjectives were placed vertically under each concept phrase. A continuous line segmented into seven equal intervals by sets of colon marks separated each word of the adjective pairs. An example of this format was:

good ____:____:____:____:____:____:____ bad

The adjective pairs were such that each word had a meaning of opposite value from the other. Thus it was possible for a pre-service teacher to react to a concept phrase by indicating both a direction of attitude (either to one pole or the other; a score falling at the origin or center of the scale was taken as an index of neutral

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[16] Ibid., pp. 78-80.

or no association) and an intensity of attitude (indicated by how far away from center the person went) for each pair of adjective words.

The assumption that the "evaluative" type scales selected from Osgood's lists for use in this study were appropriate indicators of attitude was made by Osgood with these words:

> Most authorities are agreed that attitudes are learned and implicit--they are inferred states of the organism that are presumably acquired in much the same manner that other such internal learned activity is acquired. Further, they are predispositions to respond, but are distinguished from other such states of readiness in that they predispose toward an _evaluative_ response. Thus, attitudes are referred to as "tendencies of approach or avoidance," or as "favorable or unfavorable," and so on. This notion is related to another shared view--that attitudes can be ascribed to some basic bipolar continuum with a neutral or zero reference point, implying that they have both direction and intensity and providing a basis for the quantitative indexing of attitudes. Or, to use a somewhat different nomenclature, attitudes are implicit processes having reciprocally antangonistic properties and varying in intensity.[17]

Format.--As indicated, twenty pairs of adjective word pairs appeared vertically under each concept phrase. Only one concept phrase appeared on a page. To avoid problems of central tendency and anchoring, the scales were randomized in their direction, i.e., some pairings began with the unfavorable word.

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[17] _Ibid_.

<u>Reliability of the Semantic Differential as an Attitude Instrument</u>

As part of the early factor analysis studies conducted by Osgood, reliability coefficients were derived. In one study one-hundred subjects reacted to twenty concepts, each concept appearing twice. Test and retest scores were correlated across the one-hundred subjects and forty items and a reliability coefficient of .85 was attained.[18]

Tannenbaum found the test-retest reliability of six of the "evaluative" scales to range from .87 to .93.[19] Additional reliability data, confirming these results were also obtained in a comparison study with Thurston scales specifically designed to scale the same attitude objects.[20]

<u>Validity of the Semantic Differential as an Attitude Instrument</u>

Osgood stated that "The evaluative dimension of the semantic differential displays reasonable face validity as a measure of attitude."[21] This statement was supported by Osgood's highly significant correlations between semantic differential evaluative scores and scores

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[18] <u>Ibid</u>., pp. 127-127.

[19] <u>Ibid</u>., p. 192.

[20] <u>Ibid</u>., pp. 192-193.

[21] <u>Ibid</u>.

on both the Thurston (p .01) and the Guttman (p .01) scales.[22]

In another study conducted by Manis, five undergraduate "communicators" wrote two short passages on their views toward college life and rated their passages on a nine-point semantic differential. The rating results were then compared with ratings given to the passages by thirty undergraduate "recipients," and Manis concluded that the evaluative scales can be profitably used in assessing attitudes.[23]

Finally, Walker constructed a laboratory analogue for social attitude learning and used it to assess the attitudinal validity of an evaluative semantic differential's capacity to predict behavior. The behavioral validity of the evaluative semantic differential was partially confirmed.[24]

Administration and Scoring of the "Semantic Differential Attitude Instrument"

The instrument was administered twice to the pre-service teachers in the study. As a pre-test the

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[22] Ibid.

[23] M. Manis, "Assessing Communication with the Semantic Differential," American Journal of Psychology, LXXII (1959), 111-113.

[24] Lawrence Walker, "A Concept Formation Analogue of Attitude Development," Dissertation Abstracts, XXII (1962), 2482-2483.

instrument was administered before the first meeting of the elementary science methods course. Ten weeks later the same instrument was administered during the last class meeting as a post-test.

For the pre-test administration it was found necessary to define the concept phrases "higher order questions in science teaching" and "presenting practice lessons to peers" in that the pre-service teachers had no way of knowing how these phrases were being used. This was done, as much as possible, in a non-evaluative manner. To insure consistency, the same definitions were given of these two concept phrases prior to the post-test administration of the instrument as well.

Scoring of the instrument was a matter of first assigning numbers 1 through 7 to each interval between the pairs of adjective words as follows:

good <u> 7 : 6 : 5 : 4 : 3 : 2 : 1 </u> bad

If an individual checked the adjective pair "good-bad" between the first and second sets of colons at the left, a 6 was assigned. Other intervals were assigned numbers as indicated above. For purposes of scoring consistency, the unfavorable poles were always assigned the score 1 and the favorable poles the score 7, regardless of the presentation of the scales in graphic form.

Reliability of the Instrument for this Study

After pre-test administration of the *Semantic Differential Attitude Instrument* a procedure developed by Hoyt[25] for calculating internal consistency reliability coefficients was used to determine the reliability of each of the seven concept phrases as well as for the instrument as a whole. The results of these calculations are given in Table 4.1.

TABLE 4.1.--Internal consistency reliability coefficients for the seven concept phrases and total *Semantic Differential Attitude Instrument*.

Measure	Reliability Coefficient
1. Teaching in the Elementary School	.91
2. Science in the Elementary School	.95
3. Myself Teaching Elementary School Science	.94
4. Student Participation in Science Activities	.90
5. Higher Order Questions in Science Teaching	.87
6. Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science	.94
7. Small Groups in the Science Methods Course	.94
8. Total *Semantic Differential Attitude Instrument*	.96

[25] C. J. Hoyt, "Test Reliability Estimated by Analysis of Variance," *Psychometrika*, VI (1941), 153-160.

Summary

To provide a means of studying the specific teaching behaviors and attitudes of concern in this study three instruments were developed.

A Micro-Teaching Rating Scale was developed to rate the performances of pre-service teachers while presenting micro-lessons to their peers. Pre-service teachers who were part of the micro-teaching laboratory groups served as the observer-raters of these micro-lessons. The mean rater reliability for the four measures of the instrument was .48.

A three-part Audio-Tape Analysis Instrument was developed to evaluate pre-service teachers' performances while presenting micro-lessons to elementary school children. Part I allowed raters to time verbal activities from an audio-tape recording of the lesson. Rater reliability for this part was .84. Part II allowed raters to classify types of pre-service teacher's questions and responses from a transcription of the micro-lesson. Rater reliability for this part was .98. Part III was designed to provide a rough estimate of the elementary school childrens' mastery of the objectives of the lesson. This part was administered by the pre-service teachers who taught the micro-lesson.

A Semantic Differential Attitude Instrument was designed using "evaluative" scales suggested by Osgood.

The instrument was devised to provide pre- and post-test indications of pre-service teachers' attitudes towards: (1) teaching elementary school science, and (2) the use of micro-teaching with peers as a means of learning behaviors associated with inquiry science teaching. Reliability ratings for the concept phrases used in the instrument and for the instrument as a whole ranged from .87 to .96.

CHAPTER V

ANALYSIS OF RESULTS

This chapter presents the data collected, the analy- of the data, and the results based on the analysis. For organizational purposes the chapter is divided into sections corresponding to the pre-service teacher's (1) performance in presenting a micro-lesson to peers, (2) performance in presenting a micro-lesson to elementary school children, and (3) attitude toward specific aspects of teaching elementary school science and the use of micro-teaching with peers. The hypotheses, as stated in Chapter III, are again included in the sections which relate to the relevant analysis procedures.

Micro-Lessons with Peers

The pre-service teachers in the study presented one or two micro-lessons using either four, eight, or twelve to sixteen peers as pupils for their lessons. The pre-service teachers' performances were rated by other members of the micro-teaching laboratory group using the Micro-Teaching Rating Scale (see Appendix A, page 194). For purposes of this study, only the four measures dealing with the pre-service teacher's ability to involve students in the lesson, ask higher order questions, ask questions in a proper manner, and provide a variety of feedback responses to student comments and answers were analyzed. The mean scores on each of the four measures for the six treatment groups are shown in Table 5.1. For the groups that presented two lessons only the mean scores for the second lesson were used in the analysis of data.

Using a repeated measures, two-way analysis of variance procedure given by Winer,[1] the F-ratios for peer-groups, lesson-groups, measures, and the interactions between these main effects were calculated in order to test hypotheses one, two, three, and four. Data pertaining to the testing of these hypotheses are given in Table 5.2.

Examination of this data reveals that for lesson-group treatment, "A," there was no significant difference at the .05 level of confidence between groups presenting one lesson or two lessons to their peers. Thus hypothesis one was not refuted. This hypothesis stated that there will be no differences in the presentations of micro-lessons to peers in an elementary science methods micro-teaching laboratory as indicated by mean of the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the

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[1]B. J. Winer, Statistical Principles in Experimental Design (New York: McGraw-Hill Book Co., 1962), p. 105.

TABLE 5.1.--Mean scores of pre-service teachers' performances on four measures of the Micro-Teaching Rating Scale according to type of treatment.

Measure	Treatment Group*						Total Measure Mean
	4P/1L	4P/2L	8P/1L	8P/2L	12-16P/1L	12-16P/2L	
1. Involvement of students	4.115**	4.336	4.320	4.303	4.145	4.196	4.236
2. Teacher's Questions	3.968	4.122	4.126	4.138	4.100	4.217	4.112
3. Questioning Behavior	4.020	4.148	4.018	4.010	4.224	4.207	4.105
4. Reinforcement	3.938	4.068	3.863	4.099	4.141	4.205	4.052
Total Group Mean	4.010	4.168	4.082	4.138	4.152	4.206	

*Treatment groups are represented by a combination of "P" and "L" variables. "P" refers to the size of the peer micro-class, i.e., 4P = four peers. "L" refers to the number of micro-lessons taught, i.e., 1L = one lesson taught.

**As interpreted, this cell reads "The mean score on the 'Involvement of Peers' measure for the group which presented one lesson to four peers was 4.115." All scores are based on a five point scale with five being high.

TABLE 5.2.--Repeated measures, two-way analysis of variance for four measures of the Micro-Teaching Rating Scale relative to testing differences and interactions between lesson-groups, peer-groups, and measures in the pre-service teachers' presentations of micro-lessons to peers.

Source of Variation*	SS	dF	MS	F-ratio	P value
Between Subjects					
A	0.478	1	0.477934	0.76	>.25
B	0.357	2	0.178335	0.28	>.25
AB Interaction	0.143	2	0.071435	0.11	>.25
Error	34.135	54	0.632121		
Within Subjects					
C	1.089	3	0.363061	4.98	<.01
AC Interaction	0.090	3	0.029924	0.41	>.25
BC Interaction	0.847	6	0.141108	1.94	<.10, >.05
ABC Interaction	0.203	6	0.033828		
Error	11.808	162	0.072888		

*"A" refers to lesson-group treatment, "B" refers to peer-group treatment, and "C" refers to the measures.

Micro-Teaching Rating Scale between groups presenting one lesson and groups presenting two lessons when the second lesson of the two-lesson groups are compared to the one lesson of the one-lesson groups.

The data next revealed that for peer-group treatment, "B," there was no significant difference at the .05 level of confidence between groups presenting lesson(s) to four, eight, or twelve to sixteen peers. Thus, hypothesis two was not rejected. This hypothesis stated that there will be no differences between peer-groups of four, eight, and twelve to sixteen in the presentations of micro-lessons to peers in an elementary science methods micro-teaching laboratory, as indicated by the mean of the "Involvement of Stduents in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

The data also indicated that the differences between measures, "C," as determined by the combined scores for all subjects for each of the measures, was significant at the .05 level of confidence and could have occurred by change one time in one hundred. Therefore, hypothesis three was rejected. It stated that there will be no differences between the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning

Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

Finally, the data indicated that for interaction effects, "AB," "AC," and "BC," there were no significant differences at the .05 level of confidence. Thus hypothesis four was not refuted. It stated that there will be no interactions between peer-groups, lesson-groups, and measures, where the measures used are the "Involvement of Students in Learning Activities," "Teacher's Questions," "Questioning Behavior of the Teacher," and "Reinforcement of Pupil Responses" measures of the Micro-Teaching Rating Scale.

Micro-Lessons with Elementary School Children

After the pre-service teachers in the study presented their micro-lessons to peers in a university setting, each taught a micro-lesson to four second, third, or fourth grade elementary school children in an elementary school setting. The same lesson plan was used by all pre-service teachers. Each lesson was audio-tape recorded and later transcribed. Procedures identified in the Audio-Tape Analysis Instrument (see Appendix C, page 200) were used to derive measures of pre-service teacher performance. The mean scores for each of seven performance measures for each treatment group were analyzed separately. These means are shown in Table 5.3.

TABLE 5.3.--Mean scores of pre-service teachers' performances on the seven measures of the *Audio-Tape Analysis Instrument* according to type of treatment.

Measure**	Treatment Group*					
	4P/ 1L	4P/ 2L	8P/ 1L	8P/ 2L	12-16P/ 1L	12-16P/ 2L
1. Student Verbal Invol.	.326	.265	.341	.278	.319	.290
2. Wait-Time After Quest.	.151	.158	.141	.170	.150	.166
3. Wait-Time Before Res.	.090	.115	.124	.095	.105	.131
4. Higher Order Questions	.465	.458	.446	.443	.434	.478
5. Neutral Responses	.323	.307	.290	.363	.248	.772
6. Questions with Resps.	.802	.776	.848	.777	.763	.772
7. Children's Performance	.930	.960	.880	.840	.940	.920

*Treatment groups are represented by a combination of "P" and "L" variables. "P" refers to the size of the micro-class, i.e., 4P = four peers in the micro-class. "L" refers to the number of micro-lessons taught, i.e., 1L = one lesson taught.

**Key to measure abbreviations and kinds of measure scores:

1. Student Verbal Involvement - per cent of student talk time from total teacher talk and student talk time.
2. Wait-Time After Questions - per-service teacher's average pause time after asking a question recorded in tenths of a minute.
3. Wait-Time Before Responses - pre-service teacher's average pause time before responding to a child as recorded in tenths of a minute.
4. Higher Order Questions - per cent of higher order questions asked by the pre-service teacher compared to total number of questions asked.
5. Neutral Responses - per cent of neutral pre-service teacher responses out of all responses given to the children.
6. Questions With Responses - per cent of questions that were responded to by children from all the questions asked by the pre-service teacher.
7. Children's Performance - per cent of corrent responses on the process measure taken by the children over the micro-lesson.

Using a two-way analysis of variance procedure suggested by Hays,[2] F-ratios were calculated for peer-groups, lesson-groups, and the interactions between peer-groups and lesson-groups in order to test hypotheses five, six, and seven. Data pertaining to the testing of these hypotheses are given in Table 5.4.

Examination of the data presented in Table 5.4 reveals that for lesson-group treatments, the "A's," no significant differences at the .05 level of confidence existed on any of the seven measures of the Audio-Tape Analysis Instrument. Thus, hypothesis five was not rejected. It stated there will be no differences between one-lesson and two-lesson groups in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the Audio-Tape Analysis Instrument and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

The data from Table 5.4 also revealed that for peer-group treatments, the "B's," no significant differences at the .05 level of confidence existed on any of the seven measures. Thus, hypothesis six was not rejected. Hypothesis six stated that there will be no differences between peer-groups of four, eight, and twelve to sixteen

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[2]William L. Hays, Statistics for Psychologists (New York: Holt, Rinehart and Winston, 1963), p. 387.

TABLE 5.4.--Two-way analysis of variance for each of the seven measures of the Audio-Tape Analysis Instrument relative to testing differences and interactions between lesson-groups and peer-groups in the pre-service teacher's presentations of micro-lessons to elementary school children.

Source of Variance*	SS	df	MS	F-ratio	P value
	Measure 1:	Student Verbal Involvement			
Between Subjects					
A	.039	1	.0390	2.3320	.1326
B	.002	2	.0010	.0602	.9417
Interaction	.004	2	.0018	.1088	.8972
Error	.886	54	.0166		
	Measure 2:	Wait-Time After Questions			
Between Subjects					
A	.005	1	.0045	1.7213	.1951
B	.000	2	.0001	.0248	.9755
Interaction	.001	2	.0006	.2336	.7925
Error	.216	54	.0040		
	Measure 3:	Wait-Time Before Responding			
Between Subjects					
A	.001	1	.0008	.1757	.6768
B	.002	2	.0012	.2625	.7701
Interaction	.010	2	.0050	1.0787	.3473
Error	.248	54	.0046		
	Measure 4:	Higher Order Questions			
Between Subjects					
A	.002	1	.0019	.0625	.8036
B	.003	2	.0015	.0488	.9525
Interaction	.008	2	.0040	.1304	.8780
Error	1.658	54	.0307		
	Measure 5:	Neutral Responses			
Between Subjects					
A	.038	1	.0375	1.1763	.2830
B	.011	2	.0053	.1648	.8485
Interaction	.034	2	.0168	.5281	.5928
Error	1.739	54	.0322		
	Measure 6:	Questions with Responses			
Between Subjects					
A	.013	1	.0129	.8687	.3555
B	.020	2	.0101	.6819	.5100
Interaction	.016	2	.0080	.5412	.5852
Error	.799	54	.0148		
	Measure 7:	Children's Performance			
Between Subjects					
A	.000	1	.0000	.0747	.7858
B	.001	2	.0004	2.0488	.1388
Interaction	.000	2	.0001	.3235	.7251
Error	.011	54	.0002		

*"A" refers to lesson-group treatment, "B" refers to peer-group treatment, and "Interaction" refers to the interactions between lesson and peer-group treatments.

in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the <u>Audio-Tape Analysis Instrument</u> and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

Finally, the data revealed that there were no significant interactions, the "Interactions," at the .05 level of confidence between lesson-groups and peer-groups on the seven measures. Thus, hypothesis seven was also not rejected. Hypothesis seven stated that there will be no interactions between peer-groups and lesson-groups in the presentations of micro-lessons to four elementary school children in an elementary school setting, as indicated by each of the six measures of the <u>Audio-Tape Analysis Instrument</u> and the mean of the childrens' scores on the process measure administered to the children following the micro-lesson.

Pre-Service Teacher Attitude

Prior to the beginning of the first class meeting, the students in the study were administered a seven part <u>Semantic Differential Attitude Instrument</u> (see Appendix D, page 205) which sought to determine their attitudes towards teaching elementary school science and the possibility of presenting science lessons to their peers for the practice of teaching elementary school science. After the pre-service teachers taught their final micro-lesson to elementary school children, the attitude instrument was again administered. Pre- and post-test data for the total instrument as well as for the seven parts of the instrument were analyzed. The mean scores for each part of the instrument as well as for the total instrument for the various treatment groups on both pre- and post-tests are shown in Table 5.5.

Analysis of Total Mean Scores

An analysis of covariance procedure suggested by Winer[3] was used to derive the F-ratios for lesson-group treatments, peer-group treatments, and the interactions between lesson and peer-groups to test hypotheses eight, nine, and ten. Data pertaining to the testing of these hypotheses are given in Table 5.6.

Inspection of the two-way analysis of covariance data presented in Table 5.6 reveals that for lesson-group treatments, "A," there was no significant difference at the .05 level of confidence between total mean scores. Thus hypothesis eight was not rejected. It stated that there will be no differences between one-lesson and two-lesson groups in attitudes, as measured by the total group

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[3]Winer, Statistical Principles, p. 578.

TABLE 5.5.--Pre-test and post-test mean scores for each of the seven concept phrases and for the total Semantic Differential Attitude Instrument according to the type of treatment.

Measure**	Treatment Group*					
	4P/1L	4P/2L	8P/1L	8P/2L	12-16P/1L	12-16P/2L
			Pre-Test			
Tchng in El Sch	120.20+	120.40	123.00	124.80	120.60	115.90
Sci in El Sch	116.20	110.40	116.90	119.00	112.10	102.70
Myself Tch Sci	123.80	116.60	116.50	111.30	106.60	116.40
St Part in Sci	122.00	122.20	123.00	123.30	120.50	125.80
HO Quest in Sci	115.00	123.10	121.90	119.40	120.90	121.20
Pre Less to Peers	95.70	104.30	97.20	99.90	102.90	101.50
Sm Grps in Cour	109.10	113.60	105.90	111.70	117.30	107.30
Total++	802.00	809.10	806.60	809.30	800.90	793.20
			Post-Test			
Tchng in El Sch	123.10	126.70	127.90	125.20	120.40	122.30
Sci in El Sch	120.60	119.70	127.10	118.40	120.30	122.90
Myself Tch Sci	125.70	126.90	128.80	122.60	120.40	126.70
St Part in Sci	127.90	124.80	131.80	125.00	123.70	127.50
HO Quest in Sci	122.60	123.10	124.90	123.50	122.10	114.20
Pre Less to Peers	102.50	109.60	125.20	96.00	90.30	113.10
Sm Grps in Cour	110.30	114.50	124.40	106.40	106.70	108.80
Total	834.20	847.00	889.40	817.10	803.90	835.50

*Treatment groups are represented by a combination of "P" and "L" variables. "P" refers to the size of the peer micro-class, i.e., 4P = four peers in the micro-class. "L" refers to the number of micro-lessons taught, i.e., 1L = one lesson taught.

**The concept phrase measures are abbreviations for the following:
Tchng in El Sch = Teaching in the Elementary School
Sci in El Sch = Science in the Elementary School
Myself Tch Sci = Myself Teaching Science in the Elementary School
St Part in Sci = Student Participation in Science Activities
HO Quest in Sci = Higher Order Questions in Science Teaching
Pre Less to Peers = Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science
Sm Grps in Cour = Small Groups in the Science Methods Course

+As interpreted, this cell reads "The mean score on the 'Teaching in the Elementary School' phrase for the treatment group which presented one lesson to four peers was 120.20." All scores are mean scores across all twenty adjective-pair scales with 140 being the highest possible score.

++This represents the total group mean score across all seven concept phrases with 980 being the highest possible score.

TABLE 5.6.--Two-way analysis of covariance for total scores on the Semantic Differential Attitude Instrument relative to testing differences and interactions between lesson-groups and peer-groups in the pre-service teacher's attitudes.

Source of Variation*	SS	df	MS	F-ratio	P value
Between Subjects					
A	1465.525	1	1468.5253	.3145	.5773
B	7276.440	2	3638.2198	.7792	.5640
Interaction	32767.403	2	16383.7016	3.5090	.0371
Error	247466.180	53			

*"A" refers to lesson-groups, "B" refers to peer-groups, and "Interaction" refers to the interactions between lesson- and peer-group treatments.

mean scores of the Semantic Differential Attitude Instrument.

Examination of the Table 5.6 data reveals also that for peer-group treatments, "B," no significant difference exists at the .05 level of confidence between total mean scores. Thus, hypothesis nine was not refuted. It stated that there will be no differences between peer-groups of four, eight, and twelve to sixteen in attitudes, as measured by the total group mean scores of the Semantic Differential Attitude Instrument.

Finally, the data presented in Table 5.6 indicated the interaction effect between lesson-groups and peer-groups was significant at the .05 level of confidence and could have occurred by change less than four times out of one hundred. Thus, hypothesis ten was rejected. It stated that there will be no interactions between lesson-groups and peer-groups in attitudes, as measured by the total group mean scores of the Semantic Differential Attitude Instrument.

On the basis of the data presented in Table 5.6 it was inferred that although no significant differences existed in attitudes among pre-service teachers who had presented one or two micro-lessons or who had presented lesson(s) to groups of four, eight, or twelve to sixteen peers, a difference occurred which was the result of some particular combination of number of lessons taught and number of peers in the micro-teaching class. A geometric representation of the total group means, given in Figure 5.1, was compiled to detect if there were combinations of lesson and peer treatments which could have accounted for the significant interaction effect. Figure 5.1 represents the group mean profiles corresponding to the simple effects of number of lessons taught for each of the three peer size groups.

It was noticed in Figure 5.1 that the profile for peer size groups of eight appeared to have a slope which was different from the slopes of the other two groups. The test for the presence of interaction was equilavent to a test on the difference in the slopes of the profiles of these simple effects. However, to statistically

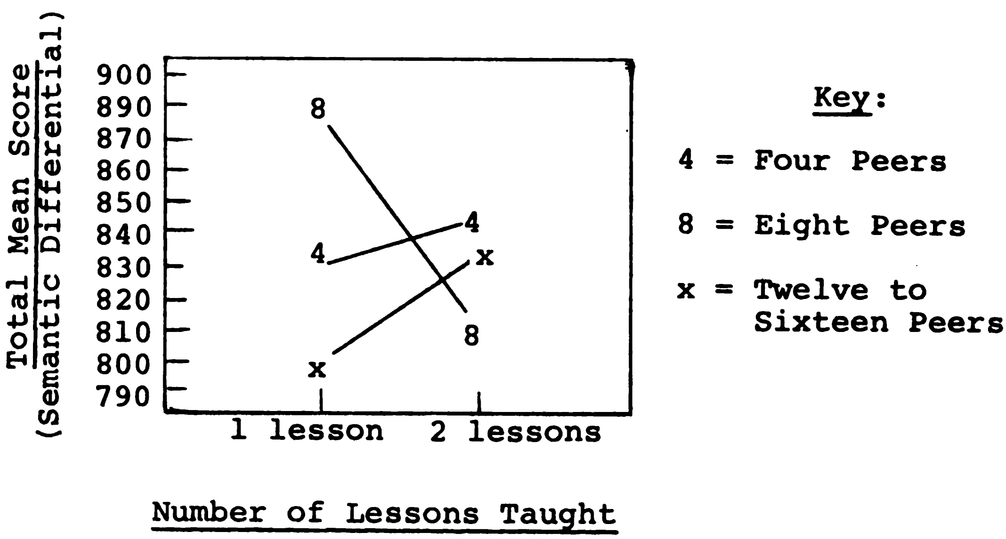

Figure 5.1.--Profile of mean scores on the total Semantic Differential Attitude Instrument for treatment groups corresponding to the effects of the number of lessons for each of the peer size groups.

determine which specific combinations of groups contributed to the significant interaction noted in Table 5.6, it was necessary to examine the magnitude of differences in mean scores between each pair of treatment groups. Data pertaining to the differences in mean scores between treatment groups are presented in Table 5.7.

From the data presented in Table 5.7 it was possible to not only compare each pair of group means but to combine any number of group means and compare them with any other combinations of group means. However, for purposes of this study only a few of the comparisons between pairs of group means were meaningful. For example,

TABLE 5.7.--Differences between treatment groups' post-test mean scores for the total Semantic Differential Attitude Instrument.

Group		Treatment Group*				
		4P/2L	8P/1L	8P/2L	12-16P/1L	12-16P/2L
	Mean**	847.0	889.4	817.1	803.9	835.5
4P/1L	834.7	-12.3+	-54.7	17.6	30.8	-0.8
4P/2L	847.0		-42.4	26.9	43.1	11.5
8P/1L	889.4			72.3	85.5	53.9
8P/2L	817.1				13.2	-18.4
12-16P/1L	803.9					-31.6

*Treatment groups are represented by a combination of "P" and "L" variables. "P" refers to the size of the peer micro-class, i.e., 4P = four peers. "L" refers to the number of micro-lessons taught, i.e., 1L = one lesson taught.

**Mean scores are taken from Table 5.5.

+The differences in a cell is the mean represented by a column subtracted from the mean represented by the row; thus, 834.7 - 847.0 = -12.3.

discovery of the fact that the differences in mean scores between groups 8P/1L and 12-16P/1L, 8P/1L and 8P/2L, and 8P/1L and 4P/1L were significant, could have had particular meaning in this study. Using the Scheffé technique for post hoc comparisons described by Hays,[4] however, it was discovered that none of the differences between any pair of group means were significant enough

[4]Hays, Statistics for Psychologists, p. 484.

(.05 level) to account for the rejection of the general hypothesis of no effects due to the interaction of lesson-groups and peer-groups when the criterion were the pre-service teachers' attitudes as measured by the total mean scores of the Semantic Differential Attitude Instrument.

From these results it was inferred that the significant interaction between lesson and peer-treatments was due to some combination(s) of group means other than the pair-wise comparisons.

Analysis of Mean Scores for Each Concept Phrase

A two-way analysis of covariance procedure suggested by Winer[5] was used to derive the F-ratios for lesson-groups, peer-groups, and the interactions of lesson-groups and peer-groups in order to test hypotheses eleven, twelve, and thirteen. Data pertaining to the testing of these hypotheses are given in Table 5.8.

Examination of the two-way analysis of covariance data presented in Table 5.8 disclosed that for lesson-group treatments, the "A's," no significant differences at the .05 level of confidence existed on any of the seven concept phrases of the Semantic Differential Attitude Instrument. Thus, hypothesis eleven was not rejected. It stated that there will be no differences between one-lesson and two-lesson groups in attitudes, as measured by

[5]Winer, Statistical Principles, p. 578.

TABLE 5.8.--Two-way analysis of covariance for each of the seven concept phrases of the Semantic Differential Attitude Instrument relative to testing differences and interactions between lesson-groups and peer-groups in the pre-service teacher's attitudes.

Source of Variance*	SS	dF	MS	F-ratio	P value
Concept Phrase 1: Teaching in the Elementary School					
Between Subjects					
A	28.411	1	28.4113	.2844	.5961
B	80.504	2	40.2518	.4029	.6705
Interaction	184.966	2	92.4831	.9256	.4026
Error	5305.639	53	100.1064		
Concept Phrase 2: Science in the Elementary School					
Between Subjects					
A	2.743	1	2.7432	.0173	.8960
B	182.013	2	91.0065	.5929	.5674
Interaction	684.621	2	342.3103	2.1549	.1260
Error	81351.735	53	1534.9384		
Concept Phrase 3: Myself Teaching Science in the Elementary School					
Between Subjects					
A	8.777	1	8.7770	.0802	.7781
B	33.725	2	16.8625	.1541	.8576
Interaction	189.832	2	94.9158	.8676	.4259
Error	5799.662	53	109.4257		
Concept Phrase 4: Student Participation in Science Activities					
Between Subjects					
A	147.185	1	147.1847	.6913	.4095
B	78.429	2	39.2147	.1842	.8324
Interaction	148.182	2	74.0908	.3480	.7077
Error	11283.186	53	212.8920		
Concept Phrase 5: Higher Order Questions in Science Teaching					
Between Subjects					
A	281.725	1	281.7246	.9314	.3389
B	518.285	2	259.1426	.8568	.4304
Interaction	187.275	2	93.6376	.3096	.7351
Error	160300.625	53	3021.5401		
Concept Phrase 6: Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science					
Between Subjects					
A	30.814	1	30.8138	.0492	.8254
B	1148.095	2	574.0476	.9159	.4064
Interaction	7434.749	2	3717.3745	5.9312	.0048
Error	332181.708	53	6267.5794		
Concept Phrase 7: Small Groups in the Science Methods Course					
Between Subjects					
A	229.024	1	229.0237	.3859	.5372
B	629.422	2	314.7108	.5303	.5915
Interaction	1565.420	2	782.7102	1.3190	.2761
Error	314522.761	53	5934.5804		

*"A" refers to lesson-group treatment, "B" refers to peer-group treatment, and "Interaction" refers to the interactions between lesson- and peer-group treatments.

group mean scores for each of the seven concept phrases of the Semantic Differential Attitude Instrument.

Inspection of data in Table 5.8 also revealed that for peer-group treatments, the "B's," no significatn differences at the .05 level of confidence existed on any of the seven concept phrases. Thus, hypothesis twelve was also not rejected. It stated that there will be no differences between peer-groups of four, eight, and twelve to sixteen in attitudes, as measured by group mean scores for each of the seven concept phrases of the Semantic Differential Attitude Instrument.

Finally, with the exception of the concept phrase "Presenting a Science Lesson to Peers to the Practice of Teaching Elementary School Science," the data revealed that there were no significant interactions, the "Interactions," at the .05 level of confidence between lesson-groups and peer-groups. Thus, with the exception of sub-hypothesis 13.6, hypothesis thirteen was not refuted. Hypothesis thirteen stated that there will be no interactions between peer-groups and lesson-groups in attitudes, as measured by group mean scores for each of the seven concept phrases of the Semantic Differential Attitude Instrument. Sub-hypothesis 13.6 was rejected. It stated that there will be no interaction in attitude toward "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science."

To determine if the significant interaction noted above could be accounted for by differences in specific pairs of group means for the concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science," a profile, given in Figure 5.2, corresponding to the simple effects of number of lessons taught for each of the three peer size groups was constructed.

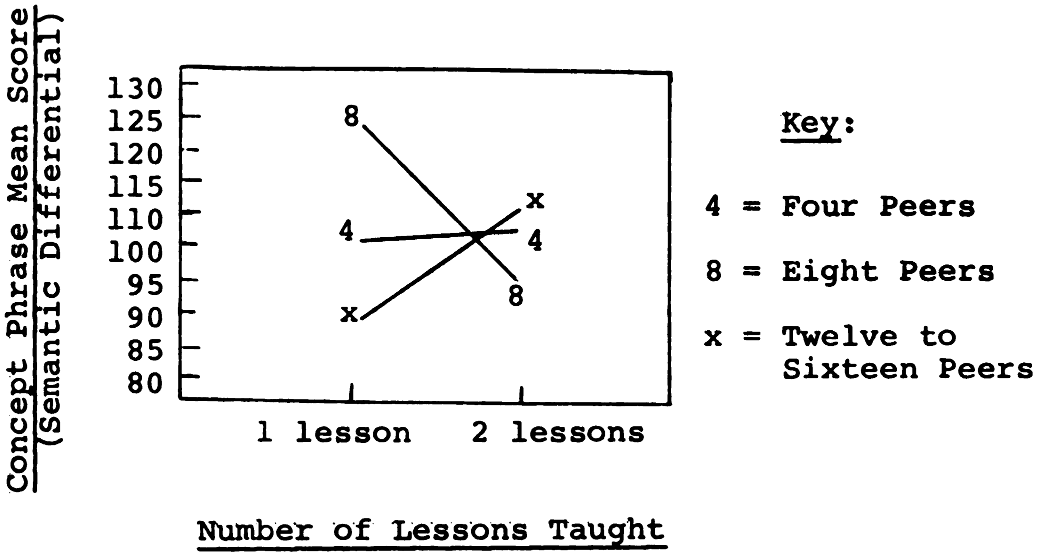

Figure 5.2.--Profile of mean scores on the concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science" for treatment groups corresponding to the effects of peer-size micro-teaching classes for those presenting one or two micro-lessons.

It was noted that the profile for peer-size groups of eight in Figure 5.2 appeared to have a slope which was different from the slopes of the other two peer-size groups. In order to statistically determine which specific combinations of groups contributed to the significant interaction, Table 5.9 was then constructed to indicate the magnitude of differences in group means for this specific concept phrase.

TABLE 5.9.--Differences between treatment groups on post-test mean scores for the concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science."

Group		Treatment Group*				
		4P/2L	8P/1L	8P/2L	12-16P/1L	12-16P/2L
	Mean**	109.6	125.2	96.0	90.3	113.1
4P/1L	102.5	-7.1+	-22.7	6.5	12.2	10.6
4P/2L	109.6		-15.6	13.6	19.3	-3.5
8P/1L	125.2			29.2	34.9	12.1
8P/2L	96.0				5.7	-17.1
12-16P/1L	90.3					-22.8

*Treatment groups are represented by a combination of "P" and "L" variables. "P" refers to the size of the peer micro-class, i.e., 4P = four peers. "L" refers to the number of micro-lessons taught, i.e., 1L = one lesson taught.

**Mean scores are taken from Table 5.5.

+The differences in a cell is the mean represented by a column subtracted from the mean represented by the row; thus 102.5 - 109.6 = -7.1.

The Scheffé technique of post hoc comparisons described by Hays[6] was used to determine if any of the pair-wise comparisons between treatment group means were significant enough (.05 level) to account for the over-all significance noted for the phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science." It was found that none of the differences in mean scores were significant. Thus it was inferred that the significant interaction between lesson- and peer-treatments was due to some combination(s) of group means other than the pair-wise comparisons.

Summary

Table 5.10 which follows contains a summary of abbreviated versions of the hypotheses for each of the three phases of the study including the statistics used and the results found.

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[6] Hays, Statistics for Psychologists, p. 484.

TABLE 5.10.--Summary of results.

Hypothesis	Results
Micro-Lessons with Peers	
H_{01}: There will be no differences between lesson-group treatments in selecting teaching behaviors while presenting micro-lessons to peers.	The null hypothesis was not rejected using a repeated measures, two-way analysis of variance procedure.
H_{02}: There will be no differences between peer-group treatments in selected teaching behaviors while presenting micro-lessons to peers.	The null hypothesis was not rejected using a repeated measures, two-way analysis of variance procedure.
H_{03}: There will be no differences between measures of the Micro-Teaching Rating Scale.	The measures were found to differ significantly using a repeated measures, two-way analysis of variance procedure.
H_{04}: There will be no interactions between peer-groups, lesson-groups, and measures in selected teaching behaviors while presenting micro-lessons to peers.	The null hypothesis was not rejected using a repeated measures, two-way analysis of variance procedure.
Micro-Lessons with Elementary School Children	
H_{05}: There will be no differences between lesson-group treatments in selected teaching behaviors while presenting micro-lessons to elementary school children.	The null hypothesis was not rejected using a two-way analysis of variance procedure.
H_{06}: There will be no differences between lesson-group treatments in selected teaching behaviors while presenting micro-lessons to elementary school children.	The null hypothesis was not rejected using a two-way analysis of variance procedure.
H_{07}: There will be no interactions between peer-groups and lesson-groups in selected teaching behaviors while presenting micro-lessons to elementary school children.	The null hypothesis was not rejected using a two-way analysis of variance procedure.
Pre-Service Teacher Attitude	
H_{08}: There will be no differences between lesson-group treatments in attitudes for the total Semantic Differential Attitude Instrument.	The null hypothesis was not rejected using a two-way analysis of covariance procedure.

Hypothesis		Results
H_{09}:	There will be no differences between peer-group treatments in attitudes for the total Semantic Differential Attitude Instrument.	The null hypothesis was not rejected using a two-way analysis of covariance procedure.
H_{010}:	There will be no interactions between lesson-groups and peer-groups in attitudes for the total Semantic Differential Attitude Instrument.	A significant interaction effect was found using a two-way analysis of covariance procedure. Post hoc comparisons using a Scheffé technique failed to indicate that this difference was between any pair of treatment groups.
H_{011}:	There will be no differences between lesson-group treatments in attitudes for each of the concept phrases of the Semantic Differential Attitude Instrument.	The null hypothesis was not rejected using a two-way analysis of covariance procedure.
H_{012}:	There will be no differences between peer-group treatments in attitudes for each of the concept phrases of the Semantic Differential Attitude Instrument.	The null hypothesis was not rejected using a two-way analysis of covariance procedure.
H_{013}:	There will be no interactions between lesson-group and peer-group treatments in attitudes for each of the concept phrases of the Semantic Differential Attitude Instrument.	The null hypothesis was not rejected using a two-way analysis of covariance procedure for six of the seven concept phrases. A significant interaction was found for the phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science." Post hoc comparisons using a Scheffé technique failed to indicate that this difference was between any pair of treatment groups.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter presents a brief review of the study, including background information leading to the need for the study, purposes and design of the study, treatments, and hypotheses tested. The conclusions contained within this chapter are based upon the data presented in Chapter V. Discussion of the possible reasons for the results of the study and possible inferences which can be drawn are also included. Finally, implications for teacher preparation institutions wishing to use micro-teaching and recommentations for further research are included.

Summary

Many of the current practices and approaches to the teaching of elementary school science have been derived from earlier philosophies of elementary science education. Examples of this were the beliefs that children should be directly involved in learning experiences and that elementary school science should be interdisciplinary in nature. Another example was the belief that both the processes and products of scientific investigation were important aspects of elementary school science.

The objectives of present elementary school science education reiterated the fact that the practices and philosophies mentioned above were indeed predominant in science programs in many of today's elementary schools. Furthermore, research indicated that many of these objectives had changed very little since the time of the National Education Association study in 1926.

Although the objectives have changed little since 1926, the means of implementing these objectives have changed greatly. Much of present elementary school science, for example, has been characterized by (1) inquiry learning and inquiry teaching, (2) an emphasis on direct student involvement in learning activities, (3) a stronger and earlier emphasis on science content, and (4) an equal emphasis on the process objectives of elementary school science.

As a result of this "new" character of elementary school science the roles of both the learner and the teacher have changed drastically. A greater knowledge of content has been required of the elementary teacher of science. In addition, skills appropriate for inquiry teaching have been suggested for teachers to acquire to effectively meet the goals and objectives set forth in many of the new science programs.

Evidence suggested, however, that many elementary school teachers had not understood inquiry learning and its connection with the objectives of elementary school science. Furthermore, it was found that many teachers had little skill in teaching science using an inquiry approach. Blame for the elementary school teacher's inadequacies in teaching elementary school science has often been placed with teacher preparation institutions. Analysis of teacher preparation programs indicated that one of the prime reasons for the lack of success in preparing teachers had been due to the limited opportunities for pre-service teachers to transfer and implement what they learned in science methods and content courses into real teaching experiences.

As a method of providing pre-service teachers with opportunities to develop and practice the skills of science teaching in science content and methods courses, micro-teaching has been a relative newcomer in the field of teacher education. However, it has been shown that when pre-service teachers were given opportunities to teach short duration lessons to small groups of pupils in order to become familiar with an develop certain teaching skills, these pre-service teachers made improvements in their ability to teach science. This type of growth was even found in cases where pre-service teachers using micro-teaching in university settings were compared to student teachers in elementary school settings.

The use of micro-teaching in teacher preparation institutions with large pre-service teacher enrollments has had some logistical disadvantages, however. It has been a problem, for instance, to find pupils for micro-lessons. It has also been difficult to secure enough instructional personnel to supervise the micro-lessons. Furthermore, it has been logistically frustrating to find sufficient time to have each pre-service teacher present more than one micro-lesson during a ten week period, especially if these lessons were to be taught during scheduled class time.

As a result of these limiting factors the micro-teaching technique has not been widely used in teacher preparation institutions with large pre-service teacher enrollments. Under the assumptions, however, that "real" teaching experiences were necessary to better prepare elementary teachers of science, and that micro-teaching was an effective and efficient technique for fulfilling this function, it was believed necessary to find ways of adapting the micro-teaching design to fit the needs of teacher preparation institutions with large enrollments.

With this goal in mind it was the specific purpose of this study to discover if viable alternatives to the traditional micro-teaching format could be designed. Two variables, number of lessons taught and number of pupils in the micro-teaching classes, were manipulated to compare the effects of treatments on the acquisition of teaching behaviors and attitudes. Two hundred forty pre-service teachers enrolled in an elementary science methods course during the winter term at Michigan State University were randomly assigned to one of six treatment groups. From these six groups a total of sixty pre-service teachers, ten from each group, were randomly selected to serve as the subjects for this study.

The science methods course consisted of lectures and outside assignments on various topics in elementary science education, autotutorial sessions designed to acquaint the pre-service teachers with the content and processes of some of the new elementary science experimental programs, and micro-teaching laboratory sessions. During all these phases of the course several forms of instruction employing live, video-taped, and symbolic models were used to indicate the types of behaviors and the pre-service teachers were to emulate during their micro-teaching sessions.

In the micro-teaching laboratory sessions which met once a week for eight weeks, the pre-service teachers in the study taught one or two micro-lessons to groups of four, eight, or twelve to sixteen peers. The arrangement of the treatment groups was as shown in Figure 6.1.

Group	Treatment
4P/1L	Teach one micro-lesson to four peers
4P/2L	Teach two micro-lessons to four peers
8P/1L	Teach one micro-lesson to eight peers
8P/2L	Teach two micro-lessons to eight peers
12-16P/1L	Teach one micro-lesson to twelve to sixteen peers
12-16P/2L	Teach two micro-lessons to twelve to sixteen peers

Figure 6.1.--Arrangement of micro-teaching laboratory groups by treatment.

Feedback and evaluation following the presentations of micro-lessons to their peers was provided the pre-service teachers via a Micro-Teaching Rating Scale. This scale was filled out by peers participating as pupils or observers of the micro-lessons. Later, these same forms were used to analyze differences in teaching behavior between treatment groups.

Following the micro-lessons with peers all the pre-service teachers in the study presented a micro-lesson, using the same lesson plan, to different groups of four elementary school children in an elementary school setting. These lessons were audio-tape recorded and an Audio-Tape Analysis Instrument was used to analyze teachers' behaviors. These behaviors were similar to those which were emphasized and analyzed in the presentations of micro-lessons using peers as micro-teaching students.

To determine the pre-service teachers' attitudes towards concept phrases relating to the teaching of elementary school science and the micro-teaching experiences a Semantic Differential Attitude Instrument was used. The instrument was administered before the first class meeting and on the last day of class.

Based on the purposes of the study it was hypothesized that there would be no differences in the pre-service teachers' performances between lesson and peer-group treatments and no treatment interactions on the selected behaviors of the Micro-Teaching Rating Scale and the Audio-Tape Analysis Instrument when teaching micro-lessons to peers or to elementary school children. It was also hypothesized that there would be no differences between treatment groups and no treatment interactions in the pre-service teachers' attitudes towards the teaching of elementary school science and the experiences of presenting micro-lessons to peers as measured by the Semantic Differential Attitude Instrument.

Conclusions

In view of the testing of the hypotheses held for this study, the following conclusions were drawn:

1. There were no significant differences between lesson-treatment groups in presentations of

micro-lessons to peers when the four measures of the Micro-Teaching Rating Scale were the criterion of performance.

2. There were no significant differences in peer-treatment groups in presentations of micro-lessons to peers when the four measures of the Micro-Teaching Rating Scale were the criterion of performance.

3. There were significant differences in the four measures of the Micro-Teaching Rating Scale as indicated by the performances of all treatment groups on these measures.

4. There were no significant interactions between lesson-groups, peer-groups, and measures in the presentations of micro-lessons to peers when the four measures of the Micro-Teaching Rating Scale were the criterion of performance.

5. There were no significant differences between lesson-treatment groups and peer-treatment groups and no significant interactions between these two treatments in the presentations of micro-lessons to elementary school children when the seven measures of the Audio-Tape Analysis Instrument were the criterion of performance.

6. There were no significant differences between lesson-treatment groups and peer-treatment groups in the pre-service teachers' attitudes as measured by the total group mean scores of the Semantic Differential Attitude Instrument.

7. There were significant interactions between lesson-groups and peer-groups in the pre-service teachers' attitudes as measured by the total group mean scores on the Semantic Differential Attitude Instrument. Post hoc analysis indicated that this difference was not attributable to differences which were significant between any pair of treatment groups.

8. There were no significant differences between lesson groups and peer-treatment groups in the pre-service teachers' attitudes as measured by each of the seven concept phrases of the Semantic Differential Attitude Instrument.

9. With the exception of the concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science," there were no significant interactions between lesson-groups and peer-groups in the pre-service teachers' attitudes as measured by each of the seven concept phrases of the Semantic Differential Attitude Instrument.

10. For the concept phrase, "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science," there were significant interactions between lesson-groups and peer-groups. Post hoc analysis indicated that this difference was not attributable to differences which were significant between any pair of treatment groups.

Discussion

Number of Students in the Micro-Teaching Class

Since the formal development of micro-teaching at Stanford University, it has been widely suggested and assumed that optimal learning of specific teaching behaviors occurs in micro-teaching when the micro-class size ranges from two to five pupils. The rationale for this has been that with small numbers of pupils the teacher does not have to be concerned with control and classroom management problems which would detract from concentration on the development of instructional skills. Another rationale has been that a small number of pupils could be gathered in close proximity with one another and the teacher, thus making it easier for the teacher to direct and focus instruction and activity in a limited amount of physical space.

Results of this study, however, failed to support the assumption that micro-teaching with small numbers of pupils in the micro-classes (four) were more appropriate for the learning of teaching behaviors than when larger micro-classes (eight or twelve to sixteen pupils) were used. Although this study has not proven equality among the treatments of presenting micro-lessons to four, eight, or twelve to sixteen peers, one of the inferences that could be drawn from the results was that the size of the micro-teaching class had no effect on the learning of specific teaching behaviors.

There were several possible factors in this study, however, which could have contributed to results which failed to support the superiority of small micro-teaching classes over larger micro-teaching classes. Thus, caution is needed in making the inference of no differences due to four, eight, and twelve to sixteen peers-class treatments and in attempting to generalize the results of this study to other micro-teaching situations.

The first factor which could have nullified any potential differences between pupil-size treatments was the fact that peers were used as the micro-teaching students. It, therefore, might have been expected that control and classroom management problems would be less frequent than if elementary school children had been used.

Secondly, it was possible that modeling instruction was insufficient to bring about changes in behavior. Thus, if there were potential differences in treatments, they might not have appeared because of the lack of direction for initiating change.

Thirdly, potential differences between treatments might not have developed because of the lack of time for the pre-service teachers in the treatment groups to present more than one or two micro-lessons.

A fourth reason for caution in relation to the conclusions of the study was that the instruments used to measure teaching behavior might not have been adequate. The "standards of behavior" criteria and examples of behavior provided with the Micro-Teaching Rating Scale might not have been precisely and clearly enough defined to allow raters to identify behaviors during micro-lessons or to discriminate between levels of performance. The same might have been true with the definitions and examples provided with the Audio-Tape Analysis Instrument.

A final reason was that the raters used to evaluate teaching performances might not have correctly evaluated the pre-service teachers' behaviors. The pre-service teachers used to rate their peers might not have always measured what they were supposed to measure. It was possible that peer raters were influenced by such things as the pre-service teacher's physical presence, popularity, and gregariousness. The same might have been true with the raters used to evaluate the micro-lessons presented to elementary school children using the Audio-Tape Analysis Instrument.

There was some evidence to suggest that the Micro-Teaching Rating Scale, the peers used as raters using the Micro-Teaching Rating Scale, or a combination of these might definitely have contributed to the relatively low reliability ratings of pre-service teachers' performances while presenting micro-lessons to their peers. However, such was not the case in the use of the Audio-Tape Analysis Instrument used to rate pre-service teachers' behaviors while presenting micro-lessons to elementary school children. Thus, the fourth and final factors mentioned above were probably more applicable to the Micro-Teaching Rating Scale and the peers used as raters than to the Audio-Tape Analysis Instrument and the raters trained to use this instrument.

Number of Micro-Lessons Presented

In addition to the procedure of presenting micro-lessons to small groups of pupils, it has also been suggested and assumed by various sources that optimal learning of specific teaching behaviors occurs in micro-teaching when an opportunity is provided the pre-service teacher to reteach a lesson once the original lesson has been taught, evaluated, and feedback provided. Other sources suggested that if reteaching was found to be impractical or unnecessary then at least opportunities be given for the presentations of other micro-lessons. The obvious rationale for the "reteach" concept was that after appropriate feedback and evaluation of an original micro-lesson, the pre-service teacher could immediately attempt to improve upon his first performance.

Again, the evidence of this study failed to support the assumption that a teach-reteach pattern, or at least the presentation of two micro-lessons, was more appropriate in bringing about changes in teaching behavior than the teaching of just one micro-lesson.

As before, no proof was provided that the treatments of presenting one micro-lesson or two micro-lessons equally affected the learning of teaching behaviors by the pre-service teachers in these treatment groups. Possible factors which could have contributed to the results of this phase of the study were as follows:

1. Those groups which presented two lessons had the option of reteaching the same lesson or preparing and teaching an entirely different lesson. Thus, this study was not attempting to compare the "teach-reteach" format with a "single teach" format. It was quite likely, however, that for those presenting two lessons, attempts

were made to improve upon skills which were rated low by their peers on the first lesson.

2. It was possible that modeling instruction was insufficient to bring about changes in behavior. Thus, if there were potential differences in treatments, they might not have appeared because of the lack of direction for initiating change.

3. It was possible that feedback and evaluation provided in the form of the rating scale, written comments, and oral communication during the peer micro-teaching phase of the study was not adequate to allow differences between treatment groups to show.

4. The instruments and raters used might not have adequately evaluated the pre-service teachers' performances while presenting micro-lessons to peers and to elementary school children.

Pre-Service Teachers' Attitudes

The fact that very few significant differences occurred between treatment groups could have meant that the treatments were equal in their ability to effect attitude change. This could only be inferred from the results because no proof was actually provided to support this assumption. The same factors which might have contributed to the lack of differences in treatments when teaching behaviors were considered might also have operated to limit the amount of differences in attitude development among treatment groups.

Not all of the differences in attitude scores were nonsignificant between treatment groups, however. Significant interaction effects between lesson-group treatment and peer-group treatment were found with the total group mean scores on the attitude instrument and with the specific concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science." Although post hoc analysis revealed that this difference could not be accounted for by significant differences between any pair of treatment groups, the profiles of the group mean scores for the total attitude instrument as well as for the concept phrase "Presenting a Science Lesson to Peers for the Practice of Teaching Elementary School Science" revealed that the particular treatment combination of presenting one micro-lesson to eight peers elicited higher pre-service teacher attitudes than any other combination of lesson and peer treatments.

One possible explanation for this was that this particular group of ten pre-service teachers formed a kind of group spirit as the term progressed. Evidence for this was in the form of the investigators' observations of these subjects working and talking together both in and out of class. As a result, this particular group might have been able to perpetuate a positive attitude towards the micro-teaching experiences with peers which was not solely due to the type of treatment they received.

That such a factor could have been at work in all the treatment groups might also have accounted for the fact that there were no significant differences between treatment groups on other portions of the attitude instrument.

Implications for Teacher Preparation Institutions

Although equality of treatments was not proven and although caution was needed in drawing inferences from the conclusions of this study, the results indicated that perhaps there was more than one micro-teaching paradigm which could be employed by teacher preparation institutions attempting to use the micro-teaching technique with large groups of pre-service teachers, limited supervisory personnel, and limited time allotments. The traditional micro-teaching paradigm along with the six possible paradigms suggested by the results of this study have been presented in Figure 6.2. Each of the six alternative paradigms represented a type of treatment used in this study. Variation occurred only in the number of peers used as micro-teaching students and number of micro-lessons presented.

If it had been found that these particular paradigms were equal in the effects on behavior and attitude

1. **Stanford Micro-Teaching Paradigm***

INSTRUCTION		TEACHING	CRITIQUE			RETEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 2-5 Pupils 5-7 Minutes	Evaluation	Feedback	planning →	Micro-Lesson 2-5 Pupils 507 Minutes	Evaluation	Feedback

2. **Teach with Four Peers--Treatment Group 4P/1L**

INSTRUCTION		TEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 4 Peers 5-7 Minutes	Evaluation	Feedback

3. **Teach-Reteach with Four Peers--Treatment Group 4P/2L**

INSTRUCTION		TEACHING	CRITIQUE			RETEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 4 Peers 5-7 Minutes	Evaluation	Feedback	planning →	Micro-Lesson 4 Peers 5-7 Minutes	Evaluation	Feedback

4. **Teach with Eight Peers--Treatment Group 8P/1L**

INSTRUCTION		TEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 8 Peers 5-7 Minutes	Evaluation	Feedback

5. **Teach-Reteach with Eight Peers--Treatment Group 8P/2L**

INSTRUCTION		TEACHING	CRITIQUE			RETEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 8 Peers 5-7 Minutes	Evaluation	Feedback	planning →	Micro-Lesson 8 Peers 5-7 Minutes	Evaluation	Feedback

6. **Teach with Twelve to Sixteen Peers--Treatment Group 12-16P/1L**

INSTRUCTION		TEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 12-6 Peers 5-7 Minutes	Evaluation	Feedback

7. **Teach-Reteach with Twelve to Sixteen Peers--Treatment Group 12-16 P/2L**

INSTRUCTION		TEACHING	CRITIQUE			RETEACHING	CRITIQUE	
Modeling of Behaviors	planning →	Micro-Lesson 12-16 Peers 5-7 Minutes	Evaluation	Feedback	planning →	Micro-Lesson 12-16 Peers 5-7 Minutes	Evaluation	Feedback

*This paradigm is an interpretation of Allen and Ryans's description of the structure of the micro-teaching design: Dwight Allen and Kevin Ryan, Microteaching (Reading, Mass.: Addison-Wesley Publishing Co., 1969), pp. 36-47.

Figure 6.2.--Seven micro-teaching paradigms.

development, any one of these paradigms would be appropriate for use in teacher preparation programs. The particular limitations of a teacher preparation institution, however, would dictate which of the formats would be most appropriate. For instance, where large numbers of pre-service teachers and few supervisory personnel were limiting factors, the use of Paradigm Six or Seven would allow one supervisor to observe and supervise micro-lessons which would involve several of the pre-service teachers in the class at one time. Where large numbers of pre-service teachers and time were limiting factors, the use of Paradigms Two, Four, and Six would better permit the scheduling of one micro-lesson per pre-service teacher during a term rather than two micro-lessons during a term.

Recommendations for Further Research

While the results of this study are inconclusive, the following questions emanating from this study are recommended for further research on the use of micro-teaching in the preparation of pre-service teachers:

1. As yet, there is still no conclusive evidence to indicate the optimal number of pupils that should be used in micro-teaching. Is micro-teaching with four pupils as effective in the learning of teaching behaviors and attitudes as micro-teaching with eight or sixteen

pupils? If so, would similar results be found if micro-teaching groups as large as twenty, twenty-five, or thirty pupils were used?

2. Given a specific number of teaching behaviors to be learned, there is also still no conclusive evidence to suggest the optimal number of micro-lessons that should be taught to learn these behaviors. Would individual pre-service teacher differences negate the need for searching for the optimal number of micro-lessons that should be taught or is there a common growth pattern in the learning of teaching behaviors that might suggest an appropriate number of micro-teaching experiences?

3. Is "reteaching" of the same lesson necessary? Might equal growth occur if a different lesson were taught but with emphasis on the same behaviors?

4. Is the use of peers equal to the use of elementary school children as micro-teaching students in the acquisition of appropriate behaviors and attitudes by pre-service teachers?

5. How do pre-service teachers who have taught "practice" micro-lessons to peers compare in behaviors and attitudes to pre-service teachers who have taught "practice" micro-lessons to elementary school children when both groups teach micro-lessons to elementary school children in environments different from either "practice" environment?

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APPENDICES

APPENDIX A

MICRO--TEACHING RATING SCALE

MICRO-TEACHING RATING SCALE

Micro-Teacher ______________________________ Group __________

Grade Level __________ Topic ______________________________

INSTRUCTIONS: 1) Check the appropriate box for each item using the Micro-Teaching Rating Scale (Item Explanations) sheet as a guide. 2) Include comments if there are any specific things you want to call to the attention to the micro-teacher.

	5	4	3	2	1	
1. INTRODUCTION TO THE LESSON Comments: ____________						1.
2. TEACHER'S EXPLANATIONS AND/OR DEMONSTRATIONS Comments: ____________						2.
3. INVOLVEMENT OF STUDENTS IN LEARNING ACTIVITIES Comments: ____________						3.
4. TEACHER'S QUESTIONS Comments: ____________						4.
5. QUESTIONING BEHAVIOR OF THE TEACHER Comments: ____________						5.
6. REINFORCEMENT OF PUPIL RESPONSES Comments: ____________						6.
7. INSTRUCTIONAL CLOSURE Comments: ____________						7.
8. TEACHER'S CHARACTERISTICS Comments: ____________						8.
9. PREPARATION FOR THE LESSON Comments: ____________						9.
	5	4	3	2	1	

	5	4	3	2	1	
10. OVER-ALL EVALUATION						10.

Comments: ______________________________

____

____

APPENDIX B

MICRO-TEACHING RATING SCALE

(ITEM EXPLANATION)

MICRO-TEACHING RATING SCALE

(ITEM EXPLANATIONS)

1. Introduction to the Lesson.
   - 5 = Very informative (goals or objectives for instruction clearly indicated) and/or stimulating (an interest in going ahead with the lesson was created).
   - 3 = Somewhat informative and/or stimulating.
   - 1 = Little indication given of direction to the lesson (goals or objectives not indicated) and/or little motivation or interest created for completing the lesson.

2. Teacher's Explanations and/or Demonstrations during the Lesson.
   - 5 = Concepts clearly established. Examples given, materials used and teacher demonstrations appropriate for the topic and grade level.
   - 3 = Shows some clarity in explaining and/or demonstrating concepts. Some examples and materials were not appropriate for topic and grade level.
   - 1 = Concepts not clearly explained or demonstrated. Examples and materials inappropriate.

3. Involvement of Students in Learning Activities.
   - 5 = Students given the opportunity to become actively involved in the lesson (both verbally and physically). Student activities were appropriate for the topic and grade level.
   - 3 = Some opportunities given for students to become involved either verbally or physically. Activities were somewhat meaningful.
   - 1 = Little opportunity given students to participate. Activities inappropriate.

4. Teacher's Questions.
   - 5 = A wide variety of questions asked including probing, divergent (open-ended) and higher order (not recall) types. These were clearly stated.
   - 3 = Some variety of question types, however, only a few probing, divergent and higher order types. Not all questions were clearly stated.
   - 1 = No questions asked or only of immediate recall or one-word answer types. Questions so vague or general that it was impossible to answer them.

5. Questioning Behavior of the Teacher.
   5 = Answers were not given away in the question or by the way it was asked. Teacher able to wait long enough for students to respond.
   3 = Some answers given away by the question itself or by the way it was asked. Teacher not always able to wait long enough for students to respond.
   1 = Answers given away by the question or the way it was asked. Teacher answered own questions or did not wait for students to respond before going on.

6. Reinforcement of Pupil Responses.
   5 = Effective use made of positive reinforcers to encourage and provide feedback, negative reinforcers to indicate misdirection and redirection and neutral (withheld) reinforcers to encourage pupils to continue investigating or challenge their own thoughts.
   3 = Some feedback provided in the form of positive, negative and neutral reinforcers.
   1 = Little or no reinforcement of pupil responses.

7. Instructional Closure.
   5 = Lesson summarized in such a way that the major purposes and principles were linked with past knowledge and future undertakings. Gave you feelings of achievement.
   3 = Familiar and new material somewhat linked together. Moderate feelings of achievement.
   1 = Little linkage of past knowledge and new material. Feelings of accomplishing nothing.

8. Teacher's Characteristics.
   5 = Voice, appearance and mannerisms add much to the presentation. Shows much enthusiasm, self-assurance and flexibility in presenting the lesson.
   3 = Personal characteristics do not detract much from the presentation. Appears to be reasonably enthusiastic, self-assured and flexible in presenting the lesson.
   1 = Personal characteristics detract much from the presentation. Seems to teach without much enthusiasm, self-assurance and flexibility.

9. Preparation for the Lesson.
   5 = Shows definite evidence of careful preparation. Quite familiar with content and materials. Enough materials which were in working order. Well organized.
   3 = Shows some preparation. Lacks thoroughness and complete understanding of concepts and use of materials.

1 = Not well prepared; knowledge inaccurate at times; materials not ready or pretested.

10. Over-All Evaluation (Not necessarily the average of the above items--other things may be considered).
5 = Outstanding Presentation
4 = Above Average Presentation
3 = Average Presentation
2 = Below Average Presentation
1 = Poor Presentation

APPENDIX C

AUDIO-TAPE ANALYSIS INSTRUMENT

Student Identification #______

AUDIO-TAPE ANALYSIS INSTRUMENT
PART I

I. Teacher Talk/Student Talk Ratio
Amount of Teacher Talk _____ seconds   % of Student
Amount of Student Talk _____ seconds   Talk ________
Amount of Silence, Activity and/or Confusion
_____ seconds

II. Teacher Pause Times - Averages
Wait Time After Questions

Question

1___	2___	3___	4___	5___	6___	7___	8___	9___
10___	11___	12___	13___	14___	15___	16___	17___	18___
19___	20___	21___	22___	23___	24___	25___	26___	27___
28___	29___	30___	31___	32___	33___	34___	35___	36___
37___	38___	39___	40___	41___	42___	43___	44___	45___
46___	47___	48___	49___	50___	51___	52___	53___	54___
55___	56___	57___	58___	59___	60___	61___	62___	63___
64___	65___	66___	67___	68___	69___	70___		

Average Wait Time = ________

Wait Time Before Responses

Response

1___	2___	3___	4___	5___	6___	7___	8___	9___
10___	11___	12___	13___	14___	15___	16___	17___	18___
19___	20___	21___	22___	23___	24___	25___	26___	27___
28___	29___	30___	31___	32___	33___	34___	35___	36___
37___	38___	39___	40___	41___	42___	43___	44___	45___
46___	47___	48___	49___	50___	51___	52___	53___	54___
55___	56___	57___	58___	59___	60___	61___	62___	63___
64___	65___	66___	67___	68___	69___	70___		

Average Wait Time = ________

EVALUATOR ____________________ STUDENT ____________________

AUDIO-TAPE ANALYSIS INSTRUMENT--PART II

EVALUATION FORM

KEYS:

Lower Order Question = L   Neutral Response = N   No Opportunity for response = X

Higher Order Question = H

Other Types = 0

QE	Q	R	QE	Q	R	QE	Q	R	QE	Q	R
1			16			31			46		
2			17			32			47		
3			18			33			48		
4			19			34			49		
5			20			35			50		
6			21			36			51		
7			22			37			52		
8			23			38			53		
9			24			39			54		
10			25			40			55		
11			26			41			56		
12			27			42			57		
13			28			43			58		
14			29			44			59		
15			30			45			60		

TOTAL # QUESTIONS ______ % H.O. ______ %L.O. ______

AUDIO-TAPE ANALYSIS INSTRUMENT--PART III

PUPIL EVALUATION MEASURE
Directions and Questions

1. Pick the child who is sitting nearest to your left and say,

"Watch what I am doing very closely. I am going to drop the handball (the red rubber ball) and the golf ball at the same time. I want you to tell me which hits the floor first."

Release both balls from the same height at the same time. (Repeat if necessary.)

"Which ball hit the floor first?"

Put a check in the acceptable space if he says that they both hit the floor at the same time.

Answer acceptable______ Answer unacceptable______

2. Pick the next child at the table who would be sitting to the first child's left and say:

"I am now going to drop the handball and the wade of cotton at the same time. I want you to tell me which hits the floor first."

Release both from the same height and at the same time. (Repeat if necessary.) Ask:

"Which hit the floor first?"

Put a check in the acceptable space if he says that the ball hit first.

Answer acceptable______ Answer unacceptable______

3. Use the same child and ask:

"What caused the ball to hit the floor before the wade of cotton?"

Put one check in the acceptable space if he ways, using his own words, that the cotton wade has more surface area and is therefore more affected by air resistance.

Answer acceptable______ Answer unacceptable______

4. Move to the next child at the table and give him two identical pieces of aluminum foil. (These should be unfolded.) Say:

"Do something to each of these pieces of aluminum foil, or to one piece, so that one will fall to the floor faster than the other."

Put one check in the acceptable space if he crumples one piece and not the other, or if he crumples one piece more than the other.

Answer acceptable______ Answer unacceptable______

5. If the previous child did not complete the task properly, you do so at this time. Then move to the last child and say:

"Point to the piece you think will fall faster because of what the previous child (or you) have done to it. Why should what he (or you) have done to it make it fall faster?"

Put one check in the acceptable space if the child says, in his own words, that what the other child (or you) has done is to reduce the surface area, thereby reducing air resistance.

Answer acceptable______ Answer unacceptable______

Note: For items 3 and 5 the child may not use such words as "surface area," or "air resistance," in his answers. If the child is at all able to communicate the right answer count it as acceptable.

Your Name__________________________ Group_____________

APPENDIX D

SEMANTIC DIFFERENTIAL ATTITUDE INSTRUMENT

SEMANTIC DIFFERENTIAL ATTITUDE INSTRUMENT

THIS IS NOT A TEST AND WILL NOT BE USED IN ANY WAY TO DETERMINE A GRADE FOR THIS COURSE

Name ______________________________

Student No. __________ Group ___

INSTRUCTIONS

The purpose of this instrument is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales. In completing this instrument, please make your judgments on the basis of what these things mean to you. At the top of each page in this booklet you will find a different phrase to be judged and beneath it a set of scales. You are to rate the phrase on each of these scales in order.

Here is how you are to use these scales:

If you feel that the phrase at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

fair __X__:_____:_____:_____:_____:_____:_____ unfair

or

fair _____:_____:_____:_____:_____:_____:__X__ unfair

If you feel that the phrase is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

strong _____:__X__:_____:_____:_____:_____:_____ weak

or

strong _____:_____:_____:_____:_____:__X__:_____ weak

If the phrase seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

active _____:_____:__X__:_____:_____:_____:_____ passive

or

active _____:_____:_____:_____:__X__:_____:_____ passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging. If you consider the phrase to be neutral on the scale, both sides of the scale equally associated with the phrase, or if the scale is completely irrelevant, unrelated to the phrase, then you should place your check-mark in the middle space:

safe _____:_____:_____:__X__:_____:_____:_____ dangerous

INSTRUCTIONS (Continued)

IMPORTANT: (1) Place your check-marks in the middle of spaces, not on the boundries:

THIS NOT THIS

______:______:__X__:______:______X______:______

(2) Be sure you check every scale for every phrase—do not omit any.

(3) Never put more than one check-mark on a single scale.

Sometimes you may feel as though you've had the same item before on the instrument. This will not be the case, so do not look back and forth through the items. Do not try to remember how you checked similar items earlier in the instrument. Make each item a separate and independent judgment. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impressions.

TEACHING IN THE ELEMENTARY SCHOOL

pleasant	____	____	____	____	____	____	____	unpleasant
bad	____	____	____	____	____	____	____	good
negative	____	____	____	____	____	____	____	positive
progressive	____	____	____	____	____	____	____	traditional
interesting	____	____	____	____	____	____	____	boring
successful	____	____	____	____	____	____	____	unsuccessful
untimely	____	____	____	____	____	____	____	timely
complete	____	____	____	____	____	____	____	incomplete
unfair	____	____	____	____	____	____	____	fair
meaningless	____	____	____	____	____	____	____	meaningful
harmonious	____	____	____	____	____	____	____	dissonant
wise	____	____	____	____	____	____	____	foolish
permissive	____	____	____	____	____	____	____	restrictive
pessimistic	____	____	____	____	____	____	____	optimistic
reputable	____	____	____	____	____	____	____	disreputable
worthless	____	____	____	____	____	____	____	valuable
awful	____	____	____	____	____	____	____	nice
important	____	____	____	____	____	____	____	unimportant
painful	____	____	____	____	____	____	____	pleasurable
dishonest	____	____	____	____	____	____	____	honest

SCIENCE IN THE ELEMENTARY SCHOOL

pleasant								unpleasant
bad								good
negative								positive
progressive								traditional
interesting								boring
successful								unsuccessful
untimely								timely
complete								incomplete
unfair								fair
meaningless								meaningful
harmonious								dissonant
wise								foolish
permissive								restrictive
pessimistic								optimistic
reputable								disreputable
worthless								valuable
awful								nice
important								unimportant
painful								pleasurable
dishonest								honest

MYSELF TEACHING SCIENCE IN THE ELEMENTARY SCHOOL

pleasant	___	___	___	___	___	___	___	unpleasant
bad	___	___	___	___	___	___	___	good
negative	___	___	___	___	___	___	___	positive
progressive	___	___	___	___	___	___	___	traditional
interesting	___	___	___	___	___	___	___	boring
successful	___	___	___	___	___	___	___	unsuccessful
untimely	___	___	___	___	___	___	___	timely
complete	___	___	___	___	___	___	___	incomplete
unfair	___	___	___	___	___	___	___	fair
meaningless	___	___	___	___	___	___	___	meaningful
harmonious	___	___	___	___	___	___	___	dissonant
wise	___	___	___	___	___	___	___	foolish
permissive	___	___	___	___	___	___	___	restrictive
pessimistic	___	___	___	___	___	___	___	optimistic
reputable	___	___	___	___	___	___	___	disreputable
worthless	___	___	___	___	___	___	___	valuable
awful	___	___	___	___	___	___	___	nice
important	___	___	___	___	___	___	___	unimportant
painful	___	___	___	___	___	___	___	pleasurable
dishonest	___	___	___	___	___	___	___	honest

STUDENT PARTICIPATION IN SCIENCE ACTIVITIES

pleasant	_____:_____:_____:_____:_____:_____:_____	unpleasant
bad	_____:_____:_____:_____:_____:_____:_____	good
negative	_____:_____:_____:_____:_____:_____:_____	positive
progressive	_____:_____:_____:_____:_____:_____:_____	traditional
interesting	_____:_____:_____:_____:_____:_____:_____	boring
successful	_____:_____:_____:_____:_____:_____:_____	unsuccessful
untimely	_____:_____:_____:_____:_____:_____:_____	timely
complete	_____:_____:_____:_____:_____:_____:_____	incomplete
unfair	_____:_____:_____:_____:_____:_____:_____	fair
meaningless	_____:_____:_____:_____:_____:_____:_____	meaningful
harmonious	_____:_____:_____:_____:_____:_____:_____	dissonant
wise	_____:_____:_____:_____:_____:_____:_____	foolish
permissive	_____:_____:_____:_____:_____:_____:_____	restrictive
pessimistic	_____:_____:_____:_____:_____:_____:_____	optimistic
reputable	_____:_____:_____:_____:_____:_____:_____	disreputable
worthless	_____:_____:_____:_____:_____:_____:_____	valuable
awful	_____:_____:_____:_____:_____:_____:_____	nice
important	_____:_____:_____:_____:_____:_____:_____	unimportant
painful	_____:_____:_____:_____:_____:_____:_____	pleasurable
dishonest	_____:_____:_____:_____:_____:_____:_____	honest

pleasant	____:____:____:____:____:____:____	unpleasant
bad	____:____:____:____:____:____:____	good
negative	____:____:____:____:____:____:____	positive
progressive	____:____:____:____:____:____:____	traditional
interesting	____:____:____:____:____:____:____	boring
successful	____:____:____:____:____:____:____	unsuccessful
untimely	____:____:____:____:____:____:____	timely
complete	____:____:____:____:____:____:____	incomplete
unfair	____:____:____:____:____:____:____	fair
meaningless	____:____:____:____:____:____:____	meaningful
harmonious	____:____:____:____:____:____:____	dissonant
wise	____:____:____:____:____:____:____	foolish
permissive	____:____:____:____:____:____:____	restrictive
pessimistic	____:____:____:____:____:____:____	optimistic
reputable	____:____:____:____:____:____:____	disreputable
worthless	____:____:____:____:____:____:____	valuable
awful	____:____:____:____:____:____:____	nice
important	____:____:____:____:____:____:____	unimportant
painful	____:____:____:____:____:____:____	pleasurable
dishonest	____:____:____:____:____:____:____	honest

PRESENTING A SCIENCE LESSON TO PEERS
FOR THE PRACTICE OF TEACHING ELEMENTARY SCHOOL SCIENCE

pleasant	_____:_____:_____:_____:_____:_____:_____	unpleasant
bad	_____:_____:_____:_____:_____:_____:_____	good
negative	_____:_____:_____:_____:_____:_____:_____	positive
progressive	_____:_____:_____:_____:_____:_____:_____	traditional
interesting	_____:_____:_____:_____:_____:_____:_____	boring
successful	_____:_____:_____:_____:_____:_____:_____	unsuccessful
untimely	_____:_____:_____:_____:_____:_____:_____	timely
complete	_____:_____:_____:_____:_____:_____:_____	incomplete
unfair	_____:_____:_____:_____:_____:_____:_____	fair
meaningless	_____:_____:_____:_____:_____:_____:_____	meaningful
harmonious	_____:_____:_____:_____:_____:_____:_____	dissonant
wise	_____:_____:_____:_____:_____:_____:_____	foolish
permissive	_____:_____:_____:_____:_____:_____:_____	restrictive
pessimistic	_____:_____:_____:_____:_____:_____:_____	optimistic
reputable	_____:_____:_____:_____:_____:_____:_____	disreputable
worthless	_____:_____:_____:_____:_____:_____:_____	valuable
awful	_____:_____:_____:_____:_____:_____:_____	nice
important	_____:_____:_____:_____:_____:_____:_____	unimportant
painful	_____:_____:_____:_____:_____:_____:_____	pleasurable
dishonest	_____:_____:_____:_____:_____:_____:_____	honest

SMALL GROUPS IN THE SCIENCE METHODS COURSE

pleasant	_____:_____:_____:_____:_____:_____:_____	unpleasant
bad	_____:_____:_____:_____:_____:_____:_____	good
negative	_____:_____:_____:_____:_____:_____:_____	positive
progressive	_____:_____:_____:_____:_____:_____:_____	traditional
interesting	_____:_____:_____:_____:_____:_____:_____	boring
successful	_____:_____:_____:_____:_____:_____:_____	unsuccessful
untimely	_____:_____:_____:_____:_____:_____:_____	timely
complete	_____:_____:_____:_____:_____:_____:_____	incomplete
unfair	_____:_____:_____:_____:_____:_____:_____	fair
meaningless	_____:_____:_____:_____:_____:_____:_____	meaningful
harmonious	_____:_____:_____:_____:_____:_____:_____	dissonant
wise	_____:_____:_____:_____:_____:_____:_____	foolish
permissive	_____:_____:_____:_____:_____:_____:_____	restrictive
pessimistic	_____:_____:_____:_____:_____:_____:_____	optimistic
reputable	_____:_____:_____:_____:_____:_____:_____	disreputable
worthless	_____:_____:_____:_____:_____:_____:_____	valuable
awful	_____:_____:_____:_____:_____:_____:_____	nice
important	_____:_____:_____:_____:_____:_____:_____	unimportant
painful	_____:_____:_____:_____:_____:_____:_____	pleasurable
dishonest	_____:_____:_____:_____:_____:_____:_____	honest

APPENDIX E

MICRO-TEACHING INFORMATION SHEET

INFORMATION for students involved in the experimental phase of the science methods course.

Before beginning I wish to thank each of you again for your participation in this study. I'm sure you will find the experiences beneficial in developing your skills as a teacher. At the same time you will be contributing a great deal to our knowledge of how best to provide prospective teachers like yourselves with meaningful teaching experiences prior to the time of student teaching.

1. The attached sheet indicates:

   a. the day(s) you will present your lesson(s) to your peers.
   b. the day you will present a lesson to a group of four elementary school pupils.
   c. the school where this will take place.
   d. the grade level of the pupils you will work with.

2. Reminder: All of you are exempt from one of the three out-of-class assignments for the course. If you are to give two lessons to your peers you may present the same lesson twice if you desire.

3. The lesson you teach in the elementary school will take place during the same time period that your small group in science normally meets. Of course you are excused from small group at that time.

4. As you notice five students will go at one time to a school. I will provide the transportation using the following schedule:

   a. For those in groups 2, 4, and 6, I will leave McDonel Hall at 9:00 and take you to the designated school. After assisting you in setting things up and started I will wait and then bring you back to Erickson Hall at about 10:00.

   b. For those in groups 1, 3, and 5, I will pick you up in front of Erickson Hall at 10:10 and take you to the designated school. After assisting you with setting things up and started I will wait and then bring you back to either Erickson or McDonel Hall.

c. As it turns out, in all schools there is enough room available for more than one lesson to be presented at a time. Therefore, time will not be a problem.

5. About the Lesson:
   a. I will give each of you an outline of the lesson you are to teach during the week of February 16. The outline will contain student objectives, a list of materials that will be provided if you wish to use them, lists of possible activities you may use, and a copy of a small oral quiz that will be administered to the pupils following your presentation. (The lesson, or at least one possible way of presenting the lesson, has been tested and successfully used with second through fourth grade children before.)

   b. You may do anything you want in terms of presenting the lesson, i.e., use other activities or materials, develop your own introduction and conclusion, devise your own questions, etc. There is plenty of lattitude for your style of planning and teaching to show. The only things we ask are:

      1) teach to the objectives provided. (They are general enough to apply to second through fourth grade level)
      2) try to make your lesson at least five minutes and not more than seven minutes.
      3) try to involve pupils in the lesson.
      4) try to make the activities and your vocabulary appropriate for the grade level.

   c. Use suggestions from previous micro-teaching sessions with peers, the Micro-Teaching Rating Form (Item Explanation), and anything else you have gleaned from small groups, lectures and auto-tutorial sessions to guide you in preparing your lesson.

6. About the Children and Schools

   All the schools are very close to campus, therefore most of the children come from parents who have some tie with the University, either as students or instructors.

   Be somewhat prepared for students to ask questions and really be interested in what you have for them.

As is the case in your practice sessions with your peers, the methods and techniques you use are what is important. Don't be afraid to say "I don't know" to a question you can't answer.

The pupils will know you are coming and will be told by their teacher that you will have something interesting for them to learn about.

Schedules in the schools have been arranged so that the pupils will not be missing any special classes such as art, gym or music.

7. Feel free to come and talk with Dr. Walsh, Mr. Liddle or myself about any aspect of the study or the lesson you are to give to the elementary school children.

Frederick Staley

APPENDIX F

MICRO-TEACHING LESSON PLAN AND INSTRUCTIONS

Name ________________________

INFORMATION ABOUT THE FINAL MICRO-TEACHING LESSONS

Contained in this packet are:

1. More details on the arrangements for the final lesson (Bottom half of page)
2. An outline of the lesson plan you are to use
3. The pupil evaluation measure you will use

Further Information About the Micro-Teaching Lessons at the Elementary Schools:

I. Make sure you have read thoroughly the first note entitled Information. Some of the important things worth repeating are:

A. About the times and transportation: I will provide the transportation:
1) For those in groups 2, 4, and 6, I will meet you at 9:00 A.M. on your designated day in front of McDonel Hall entrance leading to the stairs which takes you up to the Science Math Teaching Center Offices (this is on the Girls side of the complex).
2) I will meet those in groups 1, 3, and 6 on your designated day at 10:10 A.M. in front of the Erickson Hall main entrance (where the MSU green van-type trucks park).
3) Please make every effort to show up at the designated day and time. Arrangements have been made with the East Lansing schools and it would be difficult to make reschedules.

B. About the lesson:
1. Please re-read page 2, part 5b of the Information letter again carefully. It explains the lattitude you have in planning and carrying out the lesson.
2. Some points to keep in mind are: 1) Base the lesson on the objectives and evaluation instrument provided, 2) keep the lesson to 5 to 7 minutes, not counting the time it takes to get acquainted and to evaluate, 3) try to involve pupils in the lesson.

II. Because there will be five micro-lessons going on at the same time, it will be impossible for me to operate a tape recorder at each location. Therefore, in the car on the way to the schools, each of you will be given a small tape recorder and told how to operate it. You will then record your own lesson.

Incidently, after the tapes have been evaluated (about April 1) you may come to listen to your own lesson in my office.

III. Dr. Walsh and myself will be out of town from Wednesday February 25 to Saturday February 28, therefore, if you would like to see us about the lesson, do so before February 25 or after March 1. Those of you presenting lessons on March 2 should make doubly sure you see us before Feb. 25 if you have any questions or need help.

I will be available at 353-0909 on Sunday March 1 if there are any last minute things that come up.

Again, thanks so much for your precious time and efforts in this endeavor.

Fred Staley

OBSERVING FALLING OBJECTS

Student Objectives

At the end of this lesson the child should be able to:

1. Distinguish whether or not two objects dropped from the same height and at the same time strike the floor at about the same time.

2. Identify possible causes of observed differences in falling times of objects that do not strike the floor at the same time when dropped simultaneously from the same height.

Rationale and Background Information for the Teacher

This lesson deals with the motion produced by gravity and it will be necessary for the students to make observations of such motions. Thus, observation skills beyond the simple description of physical objects and the changes occurring in them must be incorporated as an important part of the lesson. Don't assume the students will be able to achieve Objective #1 without the experience and practice of actually observing falling objects.

Background Information: An object such as a tennis ball that is released from some position above the Earth will fall toward the Earth because of the gravitational attraction between the Earth and the tennis ball. Both the Earth and the ball have an attraction for one another and both actually fall toward one another. However, the Earth is so large that the force of gravitation moves the Earth upward a distance much too small to be measured.

The amount of this attraction between two objects is determined by the distance between them and the masses of each object. This is called the Law of Universal Gravitation. Actually, the exact nature and cause of gravitation is unknown. It is uncertain whether objects are pulled together by some force between them, or pushed together by some force on the sides away from one another. In general, however, gravitation acts like a pull between two bodies.

It might appear to you that a heavy object released simultaneously with a light object would fall faster and would hit the Earth first. This is not the case, however.

The lighter object will have a smaller mutual attraction but because it is lighter it will not need as much force (attraction) to draw it toward the Earth. In other words, a smaller force will act on the lighter object. This smaller force will move the lighter object just as fast as the larger force moves the heavy one, so that both objects arrive at the earth at almost the same time, provided they are of roughly equivalent shape. You can demonstrate this convincingly by using falling bodies of the same shape, but varying weights.

On the other hand, investigation reveals that when the weights of two falling objects are the same, their shapes can make a difference in the time they take to hit the floor. The difference in falling times is a result of the resistance of the air through which the object is falling. Because some shapes have more total surface area to resist the air, a loosely wadded piece of paper, aluminum foil or cotton would be expected to hit the ground later than tightly wadded paper, foil, cotton or an object like a ball which is spherical and has less air resistance. (This information refers to Objective #2.)

Materials Provided (You may use others but you must provide them)

Set A

1 white solid styrofoam ball
1 white solid rubber ball which is the same shape as the stryofoam ball but noticeably heavier
1 red hollow rubber ball the same shape as the other two but somewhere between the other two in weight.

Set B

2 pieces of aluminum foil which are of the same shape and weight
4 pieces of paper which are of the same shape and weight

Outline of the Lesson

The following outline of activities is the one which has previously been used with elementary school pupils in grades two through four. This does not mean you have to follow these activities or the order these activities are in. Feel free to change, delete or add anything you want.

There are two <u>important differences in this outline from the lesson as it is in published form</u>:

1. Suggestions as to when questions should be asked and what questions could be asked have been omitted. You can teach the lesson as is or build in questions as you see fit.

2. Suggestions as to what kinds of things the students could do in terms of physical participation have also been omitted. You will note that all the activities are in terms of the teacher doing the activity. Here again you can present the lesson as indicated below or build in places where you think the children should be actively involved.

Introduction

A. Interest Grabber. This is up to you. There are all kinds of possibilities if you think you need one. If you are at a loss for an idea you can always tell them about Galileo who dropped two objects simultaneously from a high place--reputedly from the Leaning Tower of Piza.

B. Establish the ground work--find out what they know; this might well determine much of the rest of your lesson.

1. Hold a ball and describe the forces acting on it (Here is an example of where the children might be asked to describe the forces to allow you to determine their level of understanding--no more hints like this will be offered.) The forces are:
   1. You holding the ball--your energy
   2. Gravity (pull of the earth) trying to pull the ball towards it.
   3. The ball pulling toward the earth. (This is part of the gravitational attraction, remember it is a mutual attraction.) This would be quite difficult for most 2nd through 4th graders to understand, however, and probably should not be mentioned.

2. Now let the ball drop and again explain the forces:
   a. The pull of the earth (gravity). There is also the pull of the ball here but this need not be mentioned at this time.

Introduction (con't.)

b. The resistance of the air which keeps the ball from falling freely (as it would in a vacuum). This might also be hard for the students to understand at this time because it would be hard for them to observe the air resisting the ball. Besides, this is what they should learn as the lesson progresses.

3. Indicate that the ball was not moving before it started and was moving much faster when it hit the floor. Therefore, it must have speeded up as it fell. You might now drop other objects and show that they also speed up as they fall.

Activity I

Now indicate that all objects fall the same distance in the same time (provided they are of roughly the same shape):

1. Show the students the white styrofoam and the white rubber ball together.
2. Indicate that they are the same shape and color but of different weights.

NOTE: The most direct way to compare objects according to their weight is first to lift them and arrange them in order based on how heavy they feel.

3. Drop the two balls simultaneously from the same height to show the students that the balls do hit the floor at the same time. Repeat if necessary. If you do this carefully, the children will probably see that the balls hit the floor at practically the same time.
4. If necessary, repeat with two other objects from Set A.

Activity II

Now repeat the procedure using one of the balls and a piece of very loosely wadded aluminum foil. These will not hit the floor together, even when care is taken to release them at the same time.

1. Here you can either tell them this is because there is more air resisting the fall of the crumpled foil thus it does not fall as fast, or tell them nothing for now--let the experiment rest and come back to if after the next activities or in the conclusion.

2. To emphasize that the air is causing the aluminum foil to hit the floor later than the ball, do the following: Crumple two identical sheets of paper loosely and drop them simultaneously from the same height. They should hit the floor at nearly the same time. Then crumple one of these sheets very tightly and drop it at the same time and from the same height as the sheet that has been left loosely crumpled. The loosely crumpled paper should hit the floor later than the tightly crumpled paper.

3. Describe the similarities and the differences between the two sheets of crumpled paper emphasizing the difference in shape. Tell them how the shape influences the speed of falling. Point out that the air gets in the way as it falls and slows down the paper. In the less crumpled piece there are more places for the air to bump against or resist.

4. If not convinced, you might repeat with a tightly wadded piece of crumpled paper and a piece of the same size that is not crumpled at all. (The unfolded paper will fall quite slowly and erratically.) Here you can also point out that the piece of uncrumpled paper didn't fall straight down because of the air which held it up.

Instructional Closure

1. Now go back again to two of the balls that fell at the same rate and indicate that one of the reasons they did fall at the same rate was because they were of the same shape thus had the same air resistance. (Another reason, which need not be mentioned at this stage, that the lighter object fell as fast as the heavier was because the lighter object required a smaller force to move it as fast as the larger force which moved the heavier object.)

2. Next, tell the children that any two objects would fall the same distance in the same time if they were acted on only by the downward earth pull and weight of the objects and there was no air to get in the way. (Known as a vacuum)

3. Point out that here on Earth, however, we do have air which acts like an upward force or resistance to the falling objects. Thus, some objects like the crumpled aluminum have more surface and therefore more places for the air to resist it when it is falling, thus making it fall slower.

Pupil Evaluation Measure

Upon completion of your lesson you will then administer the following evaluation measure. The check list on the following page is to be used by you to indicate whether the students attained the objectives of not. Please follow this evaluation format as best you can. Also, please be as honest as you can in indicating whether a child achieved an objective or not. It is expected that there will be some in your group who will not attain the objectives. This is not necessarily a reflection of your teaching skills. For this study we are primarily concerned with the teaching skills you display rather than the knowledge the children display.

Note 1: Before beginning the evaluation segment tell the group of pupils you are going to see what they remember and that you only want them to respond when you call on them.

Note 2: As you proceed through the evaluation try not to make this a discussion session. You can provide feedback for each answer but then move on.

APPENDIX G

AUDIO-TAPE ANALYSIS INSTRUMENT

PART II

(DIRECTIONS AND EXPLANATIONS FOR EVALUATORS)

MICRO-TEACHING TAPE ANALYSIS INSTRUMENT
PART II

Directions and Explanations for Evaluators

1. Each teacher question is numbered and underlined in black. Each response to a child's answer or comment is underlined in red.

2. A "T" before a comment indicates that it's the teacher talking and a "C" indicates a child talking.

3. Each question number on the transcript corresponds to the numbers in the Q.E. (Question Episode) columns on the evaluation form. It is after each number in the Q.E. column on the evaluation form that you are to classify the following bits of teacher verbal behavior:

   A. Type of teacher question (Q Column)
      1. Lower order question (signify with a "L")
      2. Higher order question (signify with a "H")

   B. Type of teacher verbal response to a pupil (R column)
      1. Neutral response (signify with an "N")
      2. Other kind of response (signify with an "O")
         Note: other kinds of responses may be positive, positive but qualified or negative in nature.
      3. No opportunity for a child to respond (signify with an "X")

4. The following explanation sheets will provide definition and examples of these question and response types.

5. If, during the task, you come across a teacher comment that has not been underlined and you believe it to be a question or a response, please circle it. When you have finished the last Question Episode, come back to the circled comments and then 1) number them with the number following the last completed episode number and 2) classify it as you see fit.

6. Or, if during the task, you do not think a comment should have been underlined (i.e., it's not a question or a response to a pupil, in your judgment) cross out the number on both the transcript and on the Evaluation form and continue.

7. If there is some question as to the appropriate classification of a question or response, place it in the category which, in your opinion, it most closely belongs.

tion Sheet with Examples

Question Types

A. Lower Order Questions

Lower order questions require the student to recognize or recall information. A question is framed in such a way that if the student remembers information presented to him he will know it applies to the question (assuming the question is properly stated. This may not always be the case in the questions you will be asked to classify) The student is not asked to compare or relate or make any inductive or deductive leaps on his own.

For the most part, lower order questions solicit single facts: "What color is the ball?" However, a lower order question may also require a series of facts to answer the queation: "What was the evolution of U.S. tariff policy from 1789 to the present?"

The following are the most common types of lower order questions you will run across in these transcripts:

1. Recall questions
   ex. Which one was the heaviest?

2. Memory questions
   ex. Again, why did we say the ball fell?
   ex. What is the definition of gravity?

3. Yes-No questions
   ex. Can you throw this ball higher than you can jump?

4. Most questions requiring a one-word answer
   ex. Is this one lighter than this one?

5. Most fill in the blank questions
   ex. The shape of this is ________?

6. Command Questions--the teacher may ask for recall of fact, usually the answer is implied in the question.
   ex. The ball is red isn't it?
   Or, the teacher may really command a child to do something in the form of a question.
   ex. Will you drop this for us?

B. Higher Order Questions

The therm "Higher Order Question" is used here in a global fashion. No attempt was made to distinguish different types of higher order questions with the students in the study during the practice sessions, thus, no attempt will be made to differentiate between sub types of higher order questions in this evaluation-analysis. The following sub types and examples are only mentioned to give you a bit of an understanding of higher order questions and how they might differ from lower order questions.

1. Higher Order Questions, for the most part, are questions that prompt the student to use ideas rather than just remember them. These might be questions which require the student to:

a) Evaluate - to make a judgement of quality
ex. Which of the three balls do you believe would be the most useful in playing hand ball? Note: this may call for a single word response.

b) Infer - to make an inductive or deductive leap, to draw a conclusion where there are not as yet evidence.
ex. What might you think if two balls of quite different weight were dropped at the same time from the same height and they hit the ground at the same time?

c) Compare -
ex. How are these two balls alike?
ex. How are they different?

d) Apply a Concept or Principle-
ex. Why does an unfolded piece of paper not fall directly to the floor when dropped?

e) Solve a Problem -
ex. If two men of equal weight jump out of an airplane, one with and one without a parachutte, which one will hit the ground first?

f) Perceive Cause and Effect -
ex. Describe why the one man would hit before the other?

g) Make an observation--
ex. What can you tell me about this object?
ex. Describe what happened?

2. Divergent Questions are a subtype of higher order questions. The intent is to challenge students to make hypotheses, project themselves into historical situations, guess at a solution to an unsolved problem and dream up new ideas. There are normally questions which have no 'correct' answer or which are open-ended and may have more than one 'correct' answer.
ex. What are some uses we can make of this ball?

3. Probing Questions are another sub type which are use to urge students to think beyond their first answer to a question. Examples of five kinds might be:

a) Asking pupils for more information and/or more meaning.
ex. What do you mean when you say they have the same use?

b) Requiring the pupil to justify rationally his response.
ex. What did you observe that leads you to that conclusion?

c) Refocusing the pupil's or classes attention on a related issue.
ex. Yes, the one bounces higher than the other but did you observe anything else when we dropped them?

d) Prompting the pupil or giving him hints.
ex. And what so you think the shape of the paper has to to with the way it falls?

e) Bring other students into the discussion by getting them to respond to the first student's answer.
ex. Billy has an interesting idea, John, how might we test it?

Note how the following questions differ in terms of divergency and open-endedness.

Higher Order Questions	Lower Order Questions
1. What did you observe?	1. How many balls are there?
2. Tell me about your object?	2. What shape is your ball?
3. What happened in your experiment?	3. Did you find out if you were right?

II. Response Types

In your evaluation of the transcripts the term "response" means:

A. The teacher's verbal comment to a child after the child has answered a question or made a statement. A teacher response does not have to be initiated by a teacher question.

B. The teacher's lack of response. This occurs when:
The teacher does not allow the child time to make a comment after the teacher has asked a question.

Following are the 3 categories of teacher responses which you are to classify. You are not to be concerned with the degree of the response (i.e., how strong or weak it is.).

N. Neutral response-- no sign of rightness or wrongness is implied by the response. Often used to get the student to think a little more about his answer.

Examples: Well, I'm not sure about that; Hum; Teacher repeats the student's comment; teacher repeats the student's comment but states it in the form of a question, i.e., C--The red one will bounce higher.
T--You think the red one will?

O. Other kind of response--There are basically three other kinds of responses the teacher can make. All would be in the "c" category.

1. Positive response--an indication of approval, that the student's answer was correct or good.
ex. Right, O.K., Alright, Yea, Your right by golly, Hey that's a good idea, good, great, etc.

2. Positive but qualified response--an indication that some of the student's answer or comment is correct but something is a bit wrong or not quite right.
ex. Yes, but (indicates where the answer is a bit wrong)
Yes, well, that's partially right but did you think about______.
Yea, and (adds more information)

3. Negative response--an indication that the answer or comment is not correct.
ex. No; that's not quite right; you just about got it, try again; well, I think not; Your wrong, etc.

X. No opportunity for response--This occurs <u>only</u> when the teacher asks a question and does not allow students to comment or answer. The teacher follows her question immediately with another question or more comments. Examples:

T - Which is the lightest? The red one isn't it?
C - The white one is.
T - No, you're wrong. But John, you were right on that last quess.

In the above the first question is evaluated as a higher order or lower order question. The response for this is labeled "x". The second question is a command type question or a lower order question. The response type for this is negative or other and labeled "c".

Note: There is a second response to the second question as well. This is a separate response-a positive or other type-and should also by labeled "c" in the same cell on the Evaluation Form.

Follow-Up Note: On the Evaluation Form there are places to record the types of questions and responses for sixty Question Episodes. Each Question Episode has only one question. Therefore, each new question is the beginning of another question episode. There may be, as in the previous example, more than one response which may or may not be related to that one question. No matter, these are still recorded in the "R" or response cell for that question. It is also possible for there to be no verbal response in a particular Q.E.

III. Other Points To Consider

A. The use of the phrase or word "O.K.".

1. As a question.

The word OK, along with other words like "Right," and "Alright" are often used solely or at the ends of statements to solicit a response, thus they are questions and for the most part should be considered lower order questions because they are seeking a "yes-no" confirmation of some fact or occurance that the child should know about.

Examples: T - When you drop them do it carefully, OK?
T - Do it carefully. OK?

T - The ball is heavier, right?
T- You all agree, alright?

2. As a response

a. Positive response (rated a "c" type)

Examples: T - What color is this?
C - Red
T - OK. Now what do you think makes it fall?

b. Neutral response (rated an "N" type)

Examples: T - What color is this?
C - Red
T - OK, you think it's red, hugh?

c. Positive but qualified response (rated a "o" type)

Examples: T -What shape is it?
C - Round and thin
T - OK, I agree with your first part but I don't think you can call it thin.

3. As part of a statement which is neither a question nor a response. Example: T - OK, now let's go on.

Many times the word "OK" is used just to give the teacher a chance to say something, or to think, or to make a transition to another point and it can not be called a question or a response.

B. Statements which are both questions and responses

Many neutral responses are in question form. The only way one can tell if it is a question is by the inflection of the teacher's voice. The cue to you, however, is the presence of a question mark and the fact that the statement should be underlined both in black and red. Example: C - It's red.
T - You think red?

(This is both a neutral response for the previous question and the beginning of a new question episode.)

Example: C - It's red.
T - You think red.

(This is only a neutral response. It is a statement not a question.)

EVALUATOR ______________________ STUDENT ______________

MICRO-TEACHING AUDIO TAPE ANALYSIS INSTRUMENT PART II

EVALUATION FORM

KEYS:

Lower Order Question = L   Neutral Response = N   No Opportunity for response = X

Higher Order Question = H

Other Types = 0

QE	Q	R	QE	Q	R	QE	Q	R	QE	Q	R
1			16			31			46		
2			17			32			47		
3			18			33			48		
4			19			34			49		
5			20			35			50		
6			21			36			51		
7			22			37			52		
8			23			38			53		
9			24			39			54		
10			25			40			55		
11			26			41			56		
12			27			42			57		
13			28			43			58		
14			29			44			59		
15			30			45			60		

TOTAL # QUESTIONS ______ % H.O. ______ %L.O. ______

TOTAL # RESPONSES ______ %N ______ % 0 ______ %X ______

Practice Questions

1. When he drops those two balls which one do you think will land first?

2. That doesn't make a whole lot of sense does it?

3. What do you think about that, Carol?

4. Now what did we find out about the ball?

5. They're going to hit at the same time aren't they?

6. They bounce at the same time don't they?

7. Which one hit first?

8. Can you tell me what are the differences between these two balls?

9. Why would it fall?

10. Is there something that makes it fall?

11. Why don't you try it again so we can see?

12. What shape are they?

13. How is the shape of this different from the shape of that?

14. Why did they fall fall at the same time?

15. If two identical objects were dropped from the same height and at the same time, one falling through a vacuum, however, which one would hit the ground first?

Practice Responses

T - Which is the heaviest?
1. C - Oh, this one.
T - This one seems like the heaviest to you?

T - Which is heaviest?
2. C - This one.
T - Is there something that makes it fall?

T - Why would it fall?
3. C - Cause it's heavy.
T - Yes, but is there another reason?

T - Which is heaviest?
4. C - This one.
T - OK, this one is the heaviest.

T - What makes it fall?
5. C - Gravity
c - Gravity
T - Ah hugh, there's another force acting on it too, becuase if I wasn't here it would fall to the ground.

T - What holds it up?
6. C - You do.
T - That's right.

T - Do you think they will hit at the same time?

7. C - No.
T - Don't you? I think they will.

T - What keeps the paper in the air?
8. C - Air.
T - Air, how did you ever think of that kind of answer?

Sample 1

T - This morning we're going to talk about gravity and discuss and observe some of the movements of objects to see if we can find out some things about gravity. Have you ever tried to jump real high in the air?

c - Ah hugh.

C - Ah hugh.

T - Joel can you tell me what happens or what did you discover when you did that?

C - That gravity pulls you down.

T - Ah hugh, yea.
Have you tried to throw something into the air?

C - Yea.

C - Yea.

T - Can you throw something higher than you can jump?

C - Yea.

C - Yea.

T - Yea. I wonder why that is?

C - Because it's lighter.

T - O.K. and you can put some force behind it and cause it to go up. But then what always happens to it?

C - It comes back down.

T - It comes back down.
Well, let's do a few observations of gravity and we'll see if we can come to some conclusions about it. O.K.?

So will you hold this ball for me?
Can you tell me the forces that are acting on that ball when you hold it?
Do you know what I mean?

C - I don't know what it means.

T - Oh, O.K. At any time that you hold something the gravity is always acting on it to pull it towards the earth. But the ball doesn't fall towards the earth. Do you know what causes it to stay up here?

C - Ah, your strength and because the gravity isn't as strong as your strength and you can hold the ball up.

T - Oh, yes, that's right. That's right.
Can you now drop the ball for us?
Would one of you like to describe the movement or the forces acting on it when it falls?

(drops the ball)

C - Air.

T - Yea, that would, that's one.
Well, what's the main one that causes it to fall?

C - Gravity

C - Gravity and that should bounce more but it doesn't.

T - Well, now we have another little experiment with two balls. How are these two alike?

C - They are both round.

C - Both the same size.

T - Good, they're both round and both the same size.
Which one is heavier?

C - This one.

C - That one.

T - OK. Joel would you stand up so all can see and drop them at the same time from the same height?

(Confusion)

(drops them)

T - What did you notice about them when they hit the floor?

C - They hit evenly and one bounded and the other didn't.

C - And one rolled farther than the other.

T - <u>You think they both hit at the same time hugh? Sally what did you observe?</u>

C - It seemed to me they did hit together.

T - <u>I think maybe you are right.</u>
<u>So we can say that when we have two balls of the same shape and different weight and drop them they will</u>
<u>_____________?</u>

C - Bounce.

T - <u>No, we're not concerned with that now.</u>

Sample 2

T - Do you know what this is?

C - A ball.

T - It could be a ball. What do you think will happen if I let this go?

C - It will probably fall to the ground.

C - It will bounce.

T - So, you think it will fall and bounce. Here is another kind of ball. Now tell me, how are these balls alike and different?

C - They're both the same size.

T - Right, good.

C - One might weigh more than the other.

T - One might weigh more than the other.

C - Well maybe not. You'll have to feel them and find out.

T - You want to come here and see?

C - Yea.
C - Can I try too?

C - This one feels heavier, the white one.

T - The white one feels heavier.

C - And this one is squishier.

T - And that one is squishier. If we drop these both at the same time from the same height, which one do you think will hit first?

C - Why don't we try it and see.

T - That sounds like a good idea. Let's do that. Come here will you and hold these. Now before you start, which one did we say was heavier?

C - The white one.

T - OK.

C - I didn't get to feel them. Can I hold them?

T - Sure, it's good to have more than one person do it. The white one is heavier isn't it?

C - Yea but I think the light one will hit first.

T - You think the light one. Why do you say that?

C - Well, because, um. . . . I'm not sure why.

T - Now well, let Ted drop these two and some think the heavy one and some think the light one will hit first. Which is your right hand? Put the white one in that hand. Now watch. Drop them.

(drops them)

T - Which ball hit first?

C - The white one.

C - No the other one.

T - Let's try it again. Make sure you let them go at the same time. Light one in his left hand, right?

C - And the light one will bounce higher.

T - No, we're not concerned with which one bounces higher, just which one hits first. Ok, are you ready to drop them? Let them go at the same time.

(drops them)

T - Which one hit first?

C - They both did that time.

C - Both.

C - Yea.

T - Do you think we should try it again just to be sure?

C - Yea.
C - Yea.

T - OK, both at the same height? The light one's where? Can you all see?

(drops them)

T - Both at the same time again. Why do you think they do that even though one weighs more?

C - Well, they both are the same shape.

T - Ah hugh.

C - And the air passes right by both of them equally.

T - The wind passes right by. What does that have to do with it? Is there anything else that might explain why they both fall at the same time?

C - (can't here)

T - You think maybe gravity acts equally.

C - Everything falls at the same time and speed.

Sample 3

T - Today we're going to do something scientific. What will happen when I roll this ball across the table?

C - It will fall on the floor.

T - Right.

C - It will hit the floor and bounce.

T - It will bounce.

C - And it will roll away.

T - OK, today we're going to talk about gravity. How many of you know what gravity is?

C - I do.

C - Oh, that's easy.

T - Do you remember a man named Galileo?

C - Who?

C - Didn't he invest the telescope?

T - You think he invented the telescope, hugh?

C - Yea.

T - Good. Well then, do you recall what he did at the Leaning Tower of Piza?

C - He dropped some balls out the window and discovered gravity.

T - And what kind of balls were they?

C - Heavy ones and light ones.

T - Good, you really have a good memory.

C - Yea, we just studied that in history.

T - OK, I have two balls here. Can you tell me the differences in these two balls?

C - One's made of styrofoam.

T - Styrofoam.

C - Oh, I used to make things with that stuff for Christmas.

T - Really, that's neat. What is different about these two though?

C - Well one will probably bounce higher.

C - And one's better to play baseball with.

T - But, here hold these. Can you fell any difference? Doesn't the styrofoam one feel lighter?

C - Yea it does.

T - I think you're right. Do the rest of you want to feel them?

T - Now what did we say will happen when I roll these across the table?

C - They will fall.

T - They fall.

C - And one will bounce higher.

T - Now, when I hold these up here and let them go from the same height and at the same time which one do you think will fall first? Which is heavier again? What will happen? You watch very carefully now and tell me.

(drops them)

T - What did you observe?

C - They both hit at the same time.

C - Just about the same time.

T - About the same time?

C - Yea.

T - I think they did too.
Why do you think that happened?

C - Cause they fell at the same time.

T - OK, they did fall at the same time. How fast were they moving when they left my hand? Were they moving faster when they hit the floor?

C - I can't remember. Do it again.

T - Now watch very carefully again and see what happens.