THE RELATIVE EFFECTS OF MODELING ON THE ACQUISITION OF WAIT-TIME BY PRESERVICE ELEMENTARY TEACHERS AND CONCOMMITANT CHANGES IN DIALOGUE PATTERNS AND PUPIL PERFORMANCE

By

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I dedicate this work to my husband, Francis and to my children, Michael and Nicky, for sharing with me the rather trying experience of being a graduate student.

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The purpose of this study was to devise an effective method for training teachers to extend wait-time, defined as the time a teacher pauses after asking a question, wait-time I (WTI), and after a student response, wait-time II (WTII). The two treatments, a video and an audio model, were tested with and without a feedback component. The outcome variables measured were mean length of teacher talk (MLTT), mean length of student talk (MLST), proportion of teacher talk (PTT) and a student performance measure examined by a process skills test.

Fifty-two preservice elementary teachers were randomly assigned to four groups: audio no feedback; audio feedback; video no feedback; and video feedback. The subjects taught a series of three science inquiry lessons to four fourth or fifth graders in a microteaching setting. Each teaching session was audio recorded and entry level wait-times were calculated. Before Session 2 teachers observed

either a video or audio model depicting the desired criterion wait-time of three seconds. Subjects taught Session 2 using extended wait-time. Before Session 3 teachers in the feedback group listened to and rated their tape from Session 2 to determine frequency of criterion wait-time. The no feedback group read an inquiry related article. Both groups were instructed to use extended wait-time for Session 3. The 208 children were administered the process test at the end of each session.

Mean lengths of wait-time I and II and the dialogue variables were calculated from the audio tapes with a servo-chart recorder. Treatment effects were analyzed with a split plot factorial ANOVA design. Dialogue variables and student tests were analyzed by ANOVA. Multiple regression analysis was performed for each teaching session with wait-time II as the dependent variable.

The results revealed that the video group achieved significantly longer wait-time II than the audio group with both groups improving significantly from the entry level of 0.06 seconds. The effect of feedback was not significant at the 0.05 level. However, it was sufficient to bring the video group to a mean wait-time of 3.6 seconds. Wait-time I increased significantly from Session 1 to Session 3 but the increase did not reach the desired criterion for any session.

Of the outcome variables both mean length of student talk and the proportion of teacher talk were highly correlated with wait-time for all three teaching sessions. As the length of WTII increased MLST increased and PTT decreased. The mean length of teacher talk was found to correlate with WTII significantly only for Session 2 during which MLTT decreased and WTII increased. It was suspected that teachers initially attempeted to increase wait-time by controlling their length of utterance. MLTT increased to entry level for Session 3 and did not correlate significantly with wait-time. Test scores did not correlate significantly with wait-time for any teaching session possibly because of the wide fluctuation of the wait-time variable between teaching sessions. Perhaps wait-time is necessary, but not sufficient, to produce the expected changes.

This study suggests that a video model would be an effective training method for increasing teacher's wait-time. The audio model with modifications could be explored as an alternative if expence requirements prohibit the production and the use of the video model. The addition of feedback seems warranted to maintain performance although it does not appear to be essential for the acquisition of extended wait-time.

CHAPTER I

INTRODUCTION

The Design Problem

The purpose of this study is twofold. In the first part two training methods are compared to determine their relative effects on the acquisition of wait-time, as defined by Rowe (1973), by preservice teachers. During this phase the training methods are the independent variables and the teacher's puasing behavior is the dependent variable. Phase two attempts to validate the utility of the acquired teacher behaviors by measuring student outcome variables. In part two, the teacher's behavior becomes the independent variable and pupil performance measures are the dependent variables.

Rationale

Research in teacher education has become experimentally oriented only within the last ten years. Prior to 1967 Denemark and McDonald (1967) found empirical research in teacher education to be scanty in most areas and essentially nonexistent in others. One outcome of the recent research is that teacher behavior has become more operationalized partially because of the development of instruments for objectively recording teacher behaviors. With objective assessment of behaviors, teacher education is approaching a greater degree of systemization.

Reflecting and perhaps corresponding to a more methodical approach to teacher education, a movement toward competency based education (CBE) has gained widespread recognition and popularity within the past five years. A 1972 AACTE survey revealed that greater than 60 percent of the 783 responding teacher education institutions either characterized their programs as competency based or were in the developmental stages of establishing programs (Houston, 1974). Florida, for example, has already invested millions of dollars in CBE projects. Works such as the Florida State University, The Middle School CBTE Project at the University of Florida and the Self-Paced Training Module Bank at the University of Miami indicate the impact of the movement in the state.

With large numbers of prospective teachers already being trained in competency based programs, educators (Koran, J. J. & Koran, M. L., 1974-1975) have expressed a need for the development of inexpensive, adaptable instructional strategies to be used in the programs. Before devising suitable instructional methods, educators need to examine the adequacy of procedures for identifying and validating teacher competencies. Comprehensive lists of competencies written for all levels from local to statewide (Dodl, 1973) illustrate that a sizable number can be identified. The important question regarding the desirability and validity of paritcular competencies has not been sufficiently answered. Despite the professional expertise and number of dollars concentrated on competency based teacher education, the relationship between teacher competencies, instructional methodology and student gains remains highly speculative still. Research reviews of teacher education reported few studies relating cognitive teacher variables to student achievement. In a review of thirty-five studies relating teacher behavior to student gains Rosenshine (1970) found the studies relating teacher verbal behaviors to student achievement to yeild generally inconclusive results. Correlations, though consistently positive, were not significant. Similarly Rowe and DeTure (1975), reviewing science education research, encountered little empirical evidence supporting the notion that changes in teacher behavior are accompanied by changes in student achievement. The majority of the studies in teacher education were designed to measure aspects of change in teacher behavior but not changes in pupil performance.

Nevertheless a moderate number of findings indicate that certain teacher competencies do have positive influence on pupil gains. Rosenshine and Furst (1971) identified eleven variables that can be linked to student learning. In another extensive line of research Rowe (1974a) reported highly supportive evidence relating teacher pausing behavior to ten student verbal characteristics. Two studies

(Koran, J.J.,Jr., & Koran, M.L., 1973; Santiesteban, 1974) have been conducted which trained teachers in a particular competency and subsequently validated the training procedures by measuring related pupil achievement gains. Variables evolving from this kind of research would be more likely to merit inclusion in teacher training programs.

Koran and Koran (1973) utilized a two phase approach. In this study observational learning was used to train teachers to ask analytical questions and subsequently student analytic responses were measured. Pupils of trained teachers made a significantly greater number of responses in a larger number of categories than did students of non-trained teachers.

In a similarly designed study Santiesteban (1974) discovered that students of teachers trained to ask observation and classification questions scored significantly higher on an observation and classification skills test than those children who worked with teachers who did not master the skill.

Once teacher competencies have been appropriately identified and validated instructional methods for training teachers must be designed. Peck and Tucker (1973) suggest that a systems approach will subsequently improve the effectiveness of the program. An example would be the system designed by Rosenshine (1970) which follows a pattern of six cyclical steps. These are as follows: specific instructions for the desired behaviors; training procedures aimed at the objectives; measurement of results according to behavioral objectives criteria; feedback of results to the learner; re-entry into the training procedure; and measurement of results following the second training. The training procedure in this study follows a similar pattern.

To reiterate, the research problem consists of two phases; a training phase in which two methods are compared for relative effectiveness and a validation phase in which the competency is related to pupil outcome gains. The two training methods compared, video and audio modeling, have social learning theory as the theoretical basis. The research of Bandura (1963, 1965, 1971), has contributed empirical support for the theoretical tenents of modeling, or observational learning, as a theory of learning. Here the relative effects of a video model and an audio model on the acquisition of wait-time by preservice elementary school teachers are compared.

In phase two of the study the effects of wait-time, as defined by Rowe (1973), are examined. The three verbal outcome variables being measured are related to dialogue patterns of a two player model. These are mean length of teacher talk, mean length of student talk and the proportion of speak-space controlled by the teacher. The fourth outcome variable measured is pupil performance based on a test of the objectives of the task. Common objectives of the three tasks include making careful observations and drawing inferences based on evidence.

Review of Literature

The literature reviewed here provides empirical evidence to support the hypotheses and assumptions of this study. Relative to the training methods are the theoretical underpinnings of observational learning as a learning theory and the utility of modeling as an instructional design. Next the research identifying and clarifying the dependent variable, wait-time, is reviewed which is followed by a review of wait-time training.

Modeling

From casual observation it is evident that many elements of human behavior are transmitted by exposure to social models. Historically, a number of explanations for imitative behavior have been generated (Tarde, 1903; Allport, 1924; Guthrie, 1952; Miller and Dollard, 1941). However, because of a general inability of the theories to explain the diverse effects that modeled behavior can produce, theoretical controversy frequently arose. By examining social learning theory, Bandura and Walters (1963) have shown that observational learning can account for many of the theoretical discrepancies that plague imitative theories which usually rely on exact or nearly exact replication of learned behaviors.

Modeling can have as many as three kinds of effects depending upon the circumstances involved. Observers may acquire a whole new pattern of behaviors by observing the performance of others; or modeling influencies may serve to strengthen or weaken inhibition of previously learned responses. Also disinhibitory effects may become evident when the learner observes models engaged in prohibited activities without adverse consequences.

Social learning theory assumes that models operate in an informative manner with the observer acquiring a symbolic representation of the event. As a result Bandura (1971) describes the modeling process as consisting of four interrelated subprocesses each having an input upon whether or not learning takes place. One subcomponent of observational learning is the attentional process. Simple exposure to a model in no way assures that the observer will attend to the model in the desired manner. If the observer fails to recognize and differentiate the distinctive features of the modeled behaviors, matching behaviors will not be acquired. Upon attending to the stimuli the observer must retain the essential elements of the act. As behaviors are frequently observed without being immediately acted out, the input must be stored in symbolic form. Thus retention of the behaviors is the second subprocess.

Bandura, Grusec, and Menlove (1966) had children observe complex sequences of behavior. During observation the children either watched attentively, coded the response into its verbal equivalence or counted rapidly. A posttest disclosed that children who coded the material reproduced significantly more matching responses than either of the other two groups. Children engaged in competing symbolization acquired the lowest number of matched responses.

The third component of modeling is the motoric reproduction of the act in which the symbolic representation of the model serves to guide overt performance. Finally a learner may acquire a modeled behavior without ever performing it if there are unfavorable sanctions or if there are positive reinforcers for nonperformance. Reinforcement and motivation may activate a previously learned but unperformed act (Bandura, 1965). Anticipated consequences of a particular behavior may not only prevent overt expression of the behavior but may interfere with learning the behavior because the learner exhibits selective control over the events to which he attends. Conversely positive reinforcement serves as a powerful incentive for the learner to attend to the modeled behaviors.

Each of the four subprocesses, attention, retention, motor reproduction and reinforcement, can be influenced. Characteristics of the subjects, the stimulus and the model or models may act independently or jointly upon the learning process. The following research studies tend to substantiate the importance of these.

Because the subject must be able to focus his attention on the relevant features of the stimulus as well as being able to perform it, developmental processes as measured by age could be expected to interact with the modeled situation. A common finding, relating differential responses of children, is that age influences acquisition of behaviors (Denny, 1972; Leifer et al., 1972; Liebert et al., 1969). Upper level elementary children demonstrate more matching responses than younger elementary children.

Sex differences have been reported showing that males tend to respond to models of either sex more readily than females (Masters & Morris, 1971). Portuges and Feshbach (1972) report different results when examining sex and social status. Economically advantaged females acquired significantly more incidental behaviors than did white males with a positively reinforced white teacher. Disadvantaged children of both sexes displayed fewer matched behaviors than advantaged children of both sexes. The authors speculated that the use of a bearded male model may have intimidated the female subjects resulting in fewer matched responses. It may be also that the disadvantaged performed less well than the advantaged children because the children did not view the the models as being similar to themselves. The effectiveness of a model increases if the model is perceived as being similar to the learner (Burnstein, Stotland, & Zander, 1961; Rosekrans, 1967: Stotland, Zander, & Natsonlas, 1962; Stotland & Dunn, 1962).

Relating the behavioral characteristics to the stimulus act Bandura et al. (1966) found that a complex behavior is more easily learned when the act is broken into its component parts.

Of the three characteristics influencing observational learning the model is the most significant feature. An array of studies support the following findings. Bandura (1963) discovered that the power of the model is increased if the model was perceived as having a high degree of competence and status. The most influential models in a child's life are those who offer the major source of support and/or control. Parents, teachers and peers are the most frequent models for children (Bandura & Houston, 1961; Mussen & Parker, 1965; Hartup, 1969). Although children tend to imitate models similar to themselves, evidence concerning sex and race varies and conclusions cannot be drawn with confidence.

It was also noted that multiple models, engaging in the desired behaviors, produced more imitative behavior in subjects than single models (Bandura, 1969). Bronfenbrenner (1970) found that if subjects desired to become members of a group, the potency of group members as models was greatly enhanced.

Reinforcement to the model may control the conditions under which actual performance takes place (Masters & Morris, 1971; Zimmerman & Pike, 1972; Geshuri, 1972). While sanctioning behavior may either contribute to performance or inhibit it, reinforcement is not essential for either acquisition or performance (Bandura & Walters, 1963; Bandura et al., 1966; Bandura, 1969). In summary, modeling alone produces behavioral changes as does modeling with reinforcement either real or vicarious. Although the issue of reinforcement to the model is intriguing it is not central to this study. As there is research evidence to show that modeling is effective without reinforcement, in this study neither the teacher subjects nor the models received sanctions.

Investigations of symbolic modeling indicate that the physical presence of a model is not necessary for observational learning to occur if the essential features of the behaviors are depicted pictorially or verbally (Bandura & Mischel, 1965; Bandura, Ross & Ross, 1963). However, Bandura and Menlove (1968) demonstrate that different forms of modeling are not always equally effective. In instances where behaviors controlled by strong inhibitions are expected to be performed, live models generate better results.

Modeling and Teacher Education

The work of Bandura and others has helped establish the boundaries of the modeling phenomenon in children. Application of modeling theory to teacher education has been explored also. In 1967 McDonald and Allen suggested the utility of live or symbolic models illustrating desired teacher behaviors as an alternative to more traditional verbal descriptive methods of training. In view of Bandura's research McDonald hypothesized that the model-teacher could be trained to display unambiquous examples of desired behavior. To further insure control of the teaching task a film-mediated model of the desired behaviors was decided upon as a promising strategy. The objective was to reduce the length of training required and increase the subjects awareness of relevant cues. McDonald and Allen foresaw both feedback and practice as inherent parts of the modeling training procedures.

In a series of experiments designed to teach questioning techniques McDonald and Allen proceeded to probe the relationship between modeling and feedback for relative effectiveness in altering behavior. From the experiments several significant results emerged. A filmed model was consistently superior to written or verbal instruction. For teaching questioning skills the video model was characterized as having distinctive cueing properties, an advantage missing in the symbolic model. The most effective feedback system was one in which the subject viewed his own performance.

Peck and Tucker (1973) when reviewing feedback studies, found consistent evidence to confirm the utility of giving objective feedback about specific features of training to the subjects. The effect of feedback as a part of training is incorporated into this study.

Other research in teacher education provides evidence that the video model is superior to other kinds of models. The primary training task of these studies was questioning behavior. Koran, J. J., Jr.; Koran, M. L.; and McDonald, F. (1972) found positive video models emphasizing both the stimulus and response conditions to be superior to negative models for training Stanford interns to use techniques of asking observation and classification questions. Koran, Snow and McDonald (1971) designed a video model treatment and a written model to help teach interns to improve their ability to ask analytical questions. As might be expected the video model was superior to the written model which was superior to no treatment. The study also examined aptitude treatment interactions between the model and learner abilities.

On two other occasions Koran, J.J.,Jr. (1970, 1971) found the video model superior to a written and a self-rating model for other dependent variables and other types of conditions. Subsequently Koran, J. J., Jr., and Koran, M.L., (1973) compared two types of written models to determine relative effects on analytical questioning patterns of preservice teachers. One group received a protocol model consisting of a set of explicit definitions and sample questions. A second group received a transcript of a teacher-pupil interaction. Analytical behaviors were highlighted within the communication. The control received no treatment. Each of sixty-nine teachers prepared a twenty minute microteaching session for eighth graders. The sessions were audiorecorded and both teachers and students were administered a written test. Upon analysis of the tapes the protocol model proved to be more effective than the transcript model for producing both types and frequencies of analytical questions. On the written measures both treatment groups scored significantly better than the control except that here the transcript model subjects performed better than the protocol model group. The pupils of trained teachers scored significantly higher than the control groups in being able to distinguish between types of questions and in responsiveness.

Santiesteban (1974) in a study of classification and observation question techniques compared a video model with an audio model. No differences between video and audio model subjects were found for any of the taped interaction categories. Teacher and students of both model groups performed significantly better than the control group. This study suggests that if the competency to be acquired is verbal that the audio model may be as useful as the video model for training verbal behaviors.

As educational costs spiral Koran, J. J., Jr. and Koran, M. L. (1974-1975) point out that training teachers with modeling techniques is a promising alternative to other more expensive methods. Observational learning procedures which are based on theory and research in psychology as well as in education are both effective and inexpensive. For these reasons modeling appears to warrant investigation as a training procedure for competencies other than questioning behavior. Training teachers to extend their wait-time by means of observational learning has not been explored or tested empirically. Hence, this study examines modeling as a means of teaching wait-time.

<u>Wait-time</u>

Research that led to the theoretical development of the wait-time variable was done primarily by Rowe (1974a, 1974b, 1974c). The idea of a pausing variable emerged as a result of her work with various science curricula, particularly Science Curriculum Improvement Study (SCIS). While seeking the solution to another problem, an awareness of pausing behavior developed. Although new curricula generally upgraded the quality of science instruction in the elementary schools, the quality and quantity of inquiry behavior did not improve correspondingly. In an attempt to the discover the causes researchers like Rowe explored the related areas such as adequate teacher training in the curricula, program deficiencies and the adequacy of teacher science background. Analyses of these variables did not offer a satisfactory solution to the problem. Even when these variables were controlled the level of inquiry did not improve. Upon examining several hundred tapes of different curricula taught in suburban, urban and rural classrooms, a common factor of discourse became evident. In almost all cases the pace of instruction was rapid.

In the few examples of slower paced instruction, classroom discussions more closely approximated the desired inquiry behaviors. Children engaged in speculation, offered alternative explanations, argued over interpretations of the data and had longer speech sequences (Rowe, 1973, 1974a). In these classrooms pauses or wait-time averaged about three seconds.

Wait-time is defined as the amount of time a teacher waits in silence (a) after asking a question and (b) after receiving a response. Typically teachers pace instruction at a very fast rate with wait-time being under one second. If the child does not begin to respond within one second, the teacher either repeats the question or calls on another child to answer. Upon receiving a response the teacher usually waits less than one second before interrupting with a comment or another question. Rowe (1973) noticed that children's responses came in bursts with intermittent pauses. By interrupting, the teacher fails to allow time for the pupil to think through responses. Linked to rapid pace is a high percentage of evaluative responses. This combination serves to shift the focus from the instructional phenomenon to the teacher-pupil relationship.

Under extended wait-time conditions Rowe (1973) identified ten changes that appear to take place in pupil behavior and three in teacher behavior. The student outcome variables are as follows:

1. Student utterances increase in length. With short wait-time students infrequently offer explanations of any complexity. Data indicate that long wait-time II may be responsible for the longer responses.

2. Unsolicited, but appropriate, responses increase in number. This too seems to be affected more by wait-time II than wait-time I.

3. Failure to respond decreases. When wait-time I is short, no response or negative responses may be as high as 30 percent.

4. Confidence in answers increases. Under long wait-time fewer inflected responses are noted.

5. Speculative thinking increases. The reward schedule appears to influence this variable.

6. Teacher centered discussion decreases and student-student dialogue increases. With short wait-time and high sanctioning schedules children rarely listen to one another.

7. Evidence is more often followed by or preceded by statements of inference. Increase in wait-time II has a desirable effect on the variable.

8. The number of child-asked questions increases along with an increased number of child-proposed experiments.

9. Contributions by "slow" children increase. With slower paced instruction, responses come from a wider faction of the classroom.

10. Disruptive behavior decreases.

The three effects on teacher behavior which have been identified as follows:

1. Teachers respond with greater flexibility as indicated by fewer discourse errors. With a slowed pace the flow of conversation does not become tightly structured.

2. The number and kind of teacher questions change. As student responses become longer the number of teacher

questions decrease. The number of reflection and clarification questions increase. The pattern of discourse is not that of an inquisition as is often the case with short wait-time.

3. Teachers' expectations of children tend to change.

Thus it is evident that under prolonged wait-time a number of desired changes in classroom verbal interaction occur. Research other than Rowe's on the wait-time variable has been fairly limited partially due to the fact the research results have been published only recently. Two doctoral studies examined the effects of wait-time on the verbal dimension of classroom interaction.

Lake (1973) hypothesized that prolonged pauses would contribute to both the type and complexity of student verbal responses. Using the Bellack Classification Scheme, Lake examined the empirical and evaluative cognitive processes of classroom interaction. Seventy-two fifth graders were randomly assigned to nine groups receiving either short or long wait-time schedules. During the discovery phase of the SCIS lesson, "Making Paper Airplanes," each group was audio recorded and the questions were categorized according to Bellack's Scheme. Analysis of results showed that extended wait-time contributed to a significant increase in the incidence of conversational sequences and alternative explanation in student talk. Pupil responses also increased in cognitive complexity.

Garigliano (1971) reported somewhat discrepant results. Initially he trained SCIS teachers to engage in extended wait-times with the expectation of exploring the effects of long wait-time on pupil variables. Outcome variables included length of student responses, content oriented student solicitation, inflected responses, I-don't-know responses and pupil-pupil interactions. Only one variable reached statistical significance, length of student response. Considering, however, that none of his trained teachers reached a wait-time of three seconds, it is questionable whether any valid conclusions regarding the effects of wait-time can be drawn.

Rowe's research (1974a) indicates that wait-time of less than 2.7 seconds did not apparently contribute to any of the postulated effects. Above 2.7 seconds and up to 4.5 seconds the output variables improved in value. In this study a criterion wait-time of three seconds was sought.

Other findings concerning the conditions and factors affecting wait-time patterns were documented primarily by Rowe (1974a, 1974b, 1974c). The model used throughout this study for examining teacher-student dialogue was one she conceptualized. The teaching unit is considered a two-player model with the teacher treated as one player and the group of students as the other player. With this model moves between players would be expected to be more or less equal. In fact research notes that most verbal patterns are teacher dominated. Rapidly paced instruction produces an interaction pattern that Rowe dubs inquisition. Slower paced instruction results in an inquiry pattern with all players employing the available moves equally. The patterns exhibited by four students were found to be typical of patterns displayed by an entire classroom. However, generalizing the results of experiments in microteaching settings to classroom as a whole should be done with caution.

Another variable of considerable importance to the inquiry process also became apparent during the research analysis. Reward patterns influenced interaction considerably (Rowe, 1974c; Lawlor, 1972). Students falling in differing categories not only received different reward schedules but were given different amounts of wait-time. Teachers more frequently responded with nonevaluative remarks and the remarks were more likely to be appropriate whin interacting with high ranking students. On the other hand lower ranked students received a greater number of positive rewards but the rewards were not necessarily appropriate. For these pupils a random reward pattern resulted with both correct and incorrect responses being rewarded. Teachers allowed the lower groups less time to think out answers. Wait-time, particularly species II, was shorter for the low groups. Apparently teacher expectations developed early with reward patterns corresponding to expectations.

These ideas are borne out in two other studies. Campbell and Rose (1974), in a post hoc analysis of junior high teachers' behaviors, confirmed Rowe's data. In ten classes of low ability children and ten classes of high ability children the incidence of three second wait-time was generally low especially wait-time II. When wait-time did occur, it was almost twice as likely to be with high ability groups as with low ability groups.

Because research reveals that reward schedules can greatly affect interaction, the model maintained a neutral or reward free atmosphere.

A doctoral study by Chalker (1972) divulged another interesting aspect of wait-time. When comparing social studies teachers' scores on a measure of dogmatism with the time they were likely to pause, she found teachers who scored high on a measure of dogmatism less likely to pause. Thus it appears that personal characteristics may interact with a teachers' likelihood of engaging in extended wait-time. If this be true, differential training procedures might be expected to achieve the greatest results.

Wait-time Training

The review of the literature on wait-time training made evident the unsolved problem of finding a successful and economically expedient training procedure.

Rowe (1973, 1974a) had a success rate of 70 to 80 percent with the method she employed. Ninety-six teachers engaged in a series of three teach-reteach cycles. The teachers taught the same four students in each cycle and received specific feedback. She found during the training cycles that certain verbal patterns of teachers interfered with the acquisition of species II wait-time. Rowe described these as follows:

1. Mimicry in which teachers repeat portions of what the students say.

2. Two constructions which signal rejection of an idea; Yes ... but;... though....

3. The command to "think" without providing either a pause or cues concerning what one is to think about.

4. Evaluative comments following a student's statement; fine, good, OK, right.

5. Questions which begin with the format, "Why did you do that?" (Rowe, 1973).

Eliminating these speech patterns helped teachers to achieve criterion wait-time II better but confounded the results of the outcome variables. By manipulating the two variables, speech patterns and wait-time, Rowe was able to ascertain the separate effects on the ten pupil outcome variables.

In early experiments of wait-time measurement proved to be a technological problem. A stopwatch was too cumbersom to measure pauses accurately. As might be imagined motor control of watches and student discourse patterns did not correspond very precisely.

Difficulties with measurement were somewhat reduced by transferring the sound from the tapes onto a servo-chart plotter. The needle of the chart plotter was made to track horizontally during silent pauses. Although a tremendous improvement over the stopwatch, the chart plotter still has some technical difficulties. One problem is that the background noises are picked up and recorded on the output making it necessary for someone to monitor each tape. Despite the chart plotter's frailties the validity of experiments measuring wait-time would be questionable with out the aid of an objective measuring device.

A few other examples were located in which wait-time was the manipulated variable and in which teachers were trained to achieve extended wait-times. In the Lake (1973) study wait-time was the only manipulated variable. However, he conducted the instructional sequences himself and did not train teachers. Lake practiced achieving long wait-time in a pilot study that he conducted to familiarize himself with the lesson materials. Although training teachers was not a part of his research, he offered a number of suggestions for training including the use of video tapes with cues and feedback sessions.

Garigliano (1972) devised a procedure in which teachers were audio-taped during training sessions. After transcribing each tape Garigliano and the teacher listened to the tape while following the transcript for verbal rewards and discourse patterns. Teachers were asked to concentrate on the length of wait-time while the researcher rough counted, 1001, 1002, 1003. . . . The following teaching session was the experimental session in which both wait-time and outcome variables were measured. The single treatment was not sufficient for teachers to reach criterion wait-time. Garigliano's three experimental groups did not differ significantly. Wait-time for all teachers ranged from 0.04 seconds to 2.69 seconds. Regardless of training some teachers permitted longer pauses in discourse than others.

Garigliano's training procedures were similar to ones used by Moriber (1971) with four college level instructors. Although the results were confounded by an evaluation factor, his subjects did not reach criterion wait-time either. Thus it seems imperative to find a training method that yields good results.

Summary of the Rationale for the Hypotheses

The rationale for the hypotheses posed may be summarized as follows:

1. The movement toward competency based teacher education points out the need for identifying appropriate teacher competencies. The competencies which are selected as desirable traits for teachers should have both a theoretical and empirical framework with some evidence that the variable will have an effect on learner outcomes. Once competencies are identified instructional strategies that produce maximum teacher gains need to be developed. In

addition to helping the teachers reach a criterion level of performance for the competency, the instructional procedures need to be economically feasible.

2. Rowe's research shows that teacher pausing behavior has considerable impact on the inquiry behavior of children engaged in science activities. Extended wait-time has been shown to cause change in at least ten learner outcomes.

3. Training procedures for instructing teachers to reach criterion wait-time have not met the criterion of statement one. Some methods have proved ineffective; other more successful ones require a long series of teaching cycles.

4. Modeling as a training procedure is known to be successful for teaching certain verbal behaviors. Although modeling research in teacher education has dealt primarily with teacher questioning behavior, it is expected that modeling would be equally effective for training other verbal behaviors like wait-time.

Statement of the Hypotheses

This work is an extension of research already done on wait-time and modeling. The purpose is to combine the lines of research in seeking solutions to the problems of finding appropriate training procedures and further clarifying the boundary conditions of the variable, wait-time. With this basis the following research hypotheses were tested at the 0.05 level of significance.

1. The mean length of teacher's wait-time I and II as measured by servo-chart analysis will significantly increase upon viewing a video model.

2. The mean length of teacher wait-time I and II as measured by servo-chart analysis will significantly increase upon observing an audio model.

3. The mean length of wait-time I and II of teachers viewing the video model will be significantly greater than the mean length wait-time I and II of teachers who observe the audio model.

4. Mean length of wait-time I and II of teachers who receive feedback will be significantly greater than the mean length wait-time I and II of teachers not receiving feedback.

5. The mean length of teacher talk as measured by servo-chart analysis will decrease significantly for teachers using extended wait-time.

6. The mean length of student response as measured by servo-chart analysis will increase significantly with teachers using extended wait-time.

7. The total proportion of time the teacher controls the speak-space as measured by servo-chart analysis will decrease significantly for teachers using extended wait-time.

8. Student performance scores on a test of process skills will be significantly higher for teachers using extended wait-time.

CHAPTER II

EXPERIMENTAL DESIGN

The Design

A modified pretest-posttest design for repeated measures was uses in this study. The design, as described in Table I, was selected instead of a posttest only design because it offered two advantages. Entry behavior for preservice teachers would be measured making the assumption of equivalence between groups unnecessary. Secondly because the potential number of subjects for the study was limited, the design for repeated measures afforded larger cell sizes.

Table 1

Experimental Design for Phase One

Measure		Treatment	Measure		Treatment	Measure
	Teachers			Teachers		
O_1	R	X_1	O_2	R	X_3	O_3
				R	---	O_3
O_1	R	X_2	O_2	R	X_3	O_3
				R	---	O_3

X_1 = video model, X_2 = audio model, X_3 = feedback, O_1 = recording of teaching Session 1, O_2 = recording of Session 2, O_3 = recording of Session 3.

In the study fifty-two preservice elementary teachers conducted three fifteen minute microteaching sessions. Pretest data were collected during the first session. Teachers were then randomly assigned to two treatment groups. Group I received an audio taped treatment and Group II received a video taped treatment. The second set of observations were collected during the second teaching session. This phase of the experiment appears diagramatically in Table 1 also.

At the end of microteaching session two, the two groups were again divided. Half of each treatment group was randomly assigned to a feedback or a no feedback group. A third teaching session was conducted and the third set of observations were collected.

For phase two the outcome variables were calculated from the taped recordings of each session and the written measure was administered to each child at the end of each microteaching session. The microteaching groups consisted of a preservice teacher and four fourth or fifth graders. The children were randomly assigned to teachers and four groups were formed according to the teacher's treatment group; audio-no-feedback, audio-feedback, video-no-feedback, video-feedback. The experimental design at this phase is shown in Table 2.

Internal Validity

Stanley and Campbell (1963) describe possible threats to internal validity. Many of these are controlled in the pretest-posttest design. As the design utilized in this study was modified somewhat control of threats to validity are described below.

Table 2

Experimantal Design for Phase Two

Treat-ment	Measure		Treat-ment	Measure	Treat-ment	Measure
X_1	O_1 O_2	R	X_2	O_3 O_4	X_3	O_5 O_6
X_1	O_1 O_2	R	X_2	O_3 O_4	X_3	O_5 O_6
X_1	O_1 O_2	R	X_2	O_3 O_4	X_3	O_5 O_6
X_1	O_1 O_2	R	X_2	O_3 O_4	X_3	O_5 O_6

X_1 = teaching Session 1, X_2 = Session 2, X_3 = Session 3, O_1 = recording from Session 1, O_2 = test 1, O_3 = recording from Session 2, O_4 = test 2, O_5 = recording from session 3, O_6 = test 3.

History and maturation were controlled by the short duration between teaching sessions. Since wait-time is calculated from tapes and not from written measures, test sensitization was not expected to occur.

Instrumentation is a potential problem due to the manner in which wait-time is calculated. As the verbal behaviors were transferred to a chart-plotter, care was taken during recording to prevent background noises and interference. When noise is picked up on the tape, it is transferred to the chart recorder vertically instead of horizontally. Additionally each tape was monitored by the experimenter and extraneous noises were marked on the charts.

Statistical regression was not expected as both students and teachers were randomly assigned and not blocked. Since all three treatments did not take place on the same day some mortality occurred. The chance of mortality is equalized over groups and treatments through randomization of assignments. Selection was also controlled by randomization.

External Validity

Although internal threats to validity may be controlled through design and randomization to be equalized between groups, threats to external validity may pose particular problems to experiments of this nature. Bracht and Glass (1968) describe some of the more common sources of error. Threats to external validity are divided into two broad classes, population validity and ecological validity.

Error related to population validity centers around selection of the sample population and the interaction of personological variables. In this study there is little reason to believe that the sample population, a group of preservice teachers at the University of Florida, is characteristically different from the target population, preservice teachers in general. Generalizing to a target population of teachers at large is less valid because the effect teaching experience on training wait-time has not been explored.

Regarding interaction effects some are expected to occur. The range of wait-time exhibited by teachers varies considerably. While most teachers do not permit long pauses of up to three seconds, there is wide variability in the 0.0 to 3.0 second range. Garigliano (1971) found a range of 0.4 seconds to 2.69 seconds in his sample. Personal aptitudes may conceivably account for much of the variation. Because continued research is needed to examine the interaction effects more closely, a post hoc analysis of the data is planned.

A question associated with treatment is whether or not the changes in behavior like extending wait-time are stable over time. Will the teachers who acquire criterion wait-time as a result of treatment continue to demonstrate the characteristic without further treatment? Due to the short duration of the experiment the question cannot be adequately answered. As treatment was generally successful a longitudinal study on wait-time stability would be an appropriate follow up study.

In the design it would appear that multiple-treatment interference would be a threat. Teacher subjects were subjected to one treatment one day and a related treatment a day later. The question raised in the study is whether or not feedback is a necessary component of the treatment. It is not considered a separate treatment. In order to make a decision about the importance of feedback each treatment group was divided into a feedback and no feedback group. Statistical differences between groups were explored as well as differences in change between groups.

The Hawthorne effect could possibly influence results but probably will not for two reasons. Alachua County children frequently experience teaching situations with preservice teachers because inservice teaching is an integral part of the teacher education at the University of Florida. Thus for the pupil subjects it was not a particularly unusual situation. Also the children did not know the nature of the experimental situation nor which variables were being measured.

Novelty effects were controlled as much as possible logistically. Microteaching sessions took place in the school in a quiet room to keep down noise interference on the tapes. The recording equipment, though placed as unobtrusively as possible, was visible. The children were given the opportunity to experiment with the tapes and to listen to themselves before the teaching sessions began in order to reduce curiosity.

Although the design is a pre-posttest design, entry wait-times were calculated from tapes and preservice teachers were not aware that it was the variable being measured. Test and treatment interactions were therefore not expected.

Because treatments occur with only one day intervals, interaction of history and treatment should not bias the results. Measurement of the dependent variable, wait-time, and student outcomes were tallied from the tapes and servo-chart plots by established criteria. The written measure was administered immediately after each teaching session.

Within the limits of the experimental situation, every effort was made to control threats to both internal and external validity.

Treatment Procedures

Sampling

Fifty-two, college-level, junior and senior, preservice teachers enrolled in the Childhood Education Program at the University of Florida volunteered to be subjects in the study. The subjects, all working in Science Methods, received Science Learning Activity Credit for participating in the study. The 208 microteaching, pupil subjects were enrolled in three Alachua County elementary schools. A breakdown of students by grade and school showed that: one hundred-five fifth-graders attended Terwilliger School in the Northwest section of town; fifty-six fourth-graders attended Idlewild School in the Southwest section of town; forty-seven fourth-graders attended Duval School in the Northeast section of town. These schools represent a cross-section of the city and have an overall 30 percent minority population. The neighborhoods from which the pupil subjects came included all economic ranges. All pupil subjects were randomly assigned to micro-teaching groups.

General Procedures

Preservice teachers in the science methods class participated in the project as an option to a regualr learning activity. After a general introduction to experimental procedures and time requirements they were asked to sign up for a convenient sequence of microteaching sessions. At the preteaching introductory session subjects were given the set induction materials to explore and inquire about. The purpose of this was to familiarize the subjects with the basic concepts of the experimental tasks equally.

The three microteaching sessions were conducted during two time blocks. The two lessons taught during the first session were the "Cartesian Diver" and the "Bouncing Raisins" tasks. The model treatment took place between the two inquiry lessons. During the second block of time subjects received feedback and thaght lesson three, "Rolling Cylinders." The schedule for a complete experimental sequence is presented in table 3.

Three microteaching groups were conducted simultaneously in one room. Teachers arrived about fifteen minutes before the children to read over the lesson materials again. When the twelve children arrived from their classroom, the task which focused on a discrepant event was demonstrated by the researcher. Afterwards the children had the opportunity to manipulate the experimental materials. For example, in the "Rolling Cylinder" task several children compared the relative weights of the cylinders. Prior to the demonstration the researcher

Table 3

Treatment Procedures and Times

Day 1	Time	Day 2	Time	Day 3	Time
Teachers					
Set Induction		Set Induction	20	Set Induction	10
a) Task 1	10	Demonstration	10	Feedback Treatment	20
b) Task 2	10	Discussion	15	Demonstration	10
c) Task 3	10	Treatment Audio or Visual	20	Discussion	15
		Demonstration	10		
		Discussion	15		
Total time*	30		85		55
Students					
		Demonstration	10	Demonstration	10
		Discussion	15	Discussion	15
		Test 1	15	Test 3	15
		Demonstration	10		
		Discussion	15		
		Test 2	15		
Total Time*			80		40

*Time is calculated in minutes.

instructed the children to observe carefully and to think about what they observed but to wait until seated with a teacher to discuss the tasks and ask questions.

With no experimental materials present the teacher and pupils verbally explored the tasks for approximately fifteen minutes. Following the discussion the teachers adjourned to another room to observe a model and the children answered the short fifteen item quiz. After observing the model, teachers had the opportunity to teach a second inquiry lesson using long wait-time. The demonstration and discussion followed the pattern of the first lesson with the second quiz ending the day's session.

For the last teaching sequence, teachers arrived thirty minutes before the children for the feedback treatment. The feedback group listened to their tape from the second teaching session. While they were listening to the tape they were asked to determine whether or not they were reaching three second wait-time. Time was estimated by rough-counting the pauses, 1001, 1002, 1003. . . . The no feedback group read an article related to teaching inquiry by Rowe (1975). At the last inquiry session both groups were instructed to try to exhibit extended wait-time behavior and set induction materials for the third task, "Rolling Cylinders," were distributed. Demonstration, discussion and student testing followed.

The total experimental procedures in the schools were completed in two weeks. The first week at Terwilliger, four groups of twelve were conducted on a Monday-Wednesday schedule and four on a Tuesday-Thursday schedule. The second week four groups followed a Tuesday-Thursday schedule and four followed a Wednesday-Friday schedule. The latter week, Idlewild was tested in the morning and Duval in the afternoon.

Treatment Materials

The Models

The first part of the video model consisted of four minutes of a task demonstration, "Boiling by Cooling," which was viewed by both groups. The latter part, of seventeen minutes duration, consisted of a female teacher and four fifth-grade students discussing the task. The models clearly demonstrated three second pauses of both wait-time species. The audio model was a taped recording of the video model. Prior to observing either model, the teachers were given a short, written description of wait-time that included a definition of variables. The purpose of the written description was to ensure that the subjects would attend to and focus upon the desired behaviors.

Tasks

A total of four tasks, depicting discrepant events, were used in the study, three for the microteaching sessions and one for the model. The following criteria were established for selecting the tasks: a) the tasks should focus on a single discrepant event; b) the topic should have high initial interest level; c) the topic should be appropriate for the grade level of the pupil subjects; d) the topic should be sufficiently novel that preservice elementary teachers would not be familiar with it; e) the tasks should be sufficiently complex to provoke a fifteen minute inquiry discussion; and f) the materials should be inexpensive, easily available, and portable.

After careful review of science-methods learning activities and various activity-oriented, elementary, science curricula, four tasks were selected which met the above criteria. These were "Boiling by Cooling,""The Cartesian Diver," "Bouncing Raisins," and "Rolling Cylinders."

Measurements

Measuring the dependent variables required three steps. The first step involved tape recording every microteaching group at each teaching session. Recording equipment included Wallensak audio-cassette recorders and Scotch Brand extended-range, high-density, cassette tapes. Next the audio signal from the tapes was transferred onto servo-chart plots. The Heath-Kit chart recorder used for this phase required technical modifications for audible sound. This enabled the researcher to monitor each tape and to identify wait-time species and speakers. Step three involved the calculation of each dependent variables; wait-time I, wait-time II, mean length of teacher talk, mean length of student response, and proportion of teacher talk.

Transferring the sound onto the servo-chart proved to be the most difficult and tedious part. All the extraneous sounds, coughs, chair-squeaks, outside noises, et cetera, were transferred onto the chart along with the desired group discussion. These noises resulted in the needle tracking vertically during silences when it should have tracked horizontally. Additionally, on some tapes static noise from the magnetic heads of the tape recorders was transferred onto the servo-chart causing horizontal tracking to be irregular. In order to make distinctions between nuisance noise and discourse, the experimenter monitored each of the 156 tapes. While monitoring, the tapes were annotated to indicate teacher talk, student talk, wait-time I and wait-time II.

Calculating wait-times was based on guidelines established by Rowe (1973). Wait-time I is measured from the time the teacher stops speaking until the time a student responds. If the teacher asks a question, pauses, or calls on another student and pauses again, the two pauses are summed. Wait-time II consists of summing all pauses from the time a student response begins until the teacher intervenes. Thus, if one student responds and pauses and a second student responds and pauses, wait-time II is the sum of the two pauses.

Using the two player model of dialogue, all four students are considered to be a single player with the teacher being the other player. Every teacher-student exchange is considered to be a conversational set. If the teacher intervenes with any response, i.e. "okay...good...all right...uh huh," the conversational set is terminated. For clarity, the term speak-space is used throughout the discussion to connote the time occupied by a speaker during a conversational set; that is, the dialogue which is stated by a single player between pauses.

Mean length of each species of wait-time was calculated by tallying the total number of seconds for each wait-time occurring during a four-minute discussion sequence, and by deviding the total number of conversational sets for a four-minute period. Two four-minute periods were averaged to determine the mean for wait-time I and II. The chart-plotter made possible accurate measurement of wait-time to within 0.25 seconds. The speed of the chart drive was set to move at the rate of 0.2 inches per second, with the chart paper calibrated to 0.01 inch segments. Measuring segments consisted of counting the calibrated distances the pen tracked horizontally.

Mean length of teacher talk and student talk were calculated by summing the seconds the teacher and students spoke respectively and dividing by the number of teacher-student exchanges. The ratio of student-teacher talk was measured as a percent of the time the teacher occupied each speak-space. Determining percent was done by dividing the total number of seconds of teacher talk by the total number of seconds for recorded period and then multiplying by 100.

Student Tests

At the conclusion of each micro teaching session, pupil subjects were given a fifteen item, multiple choice test. The students had the option of reading the test silently and answering questions or of listening to the questions being read aloud and then selecting answers. The test questions were constructed to focus on three inquiry skills. One-third of the questions tested simple observation skills. Another third required the children to make an inference in order to answer the question correctly. Another third tested their knowledge of inquiry vocabulary. The set induction materials given the teachers included a list of process words they would find useful for discussion and a list of behavioral objectives for children which included observation and inference behaviors. The purpose of the set induction materials was more for support, to assure teachers that their background knowledge of the task was sufficient for a fifteen to twenty minute discussion, than for a specific guide of what to teach.

Test reliabilities which were calculated for the three measures are reported in Table 4.

Reliability for the test measures was calculated using the Kuder-Richardson formula 21 for reliability, which gives reliability coefficients at least equal to, though sometimes lower than, the Kuder-Richardson formula 20 or the Spearman-Brown formula for split-halves (Ebel, 1972).

Table 4

Reliability of Written Measures

Measure	N	No. of Items	Reliability
Test 1	208	15	.86
Test 2	208	15	.80
Test 3	204	15	.91

CHAPTER III

RESULTS

The main objectives of this study were: 1) to compare the ralative effects of two training procedures, video and audio modeling, with and without feedback; and 2) to assess the relative effects of high and low teacher wait-time on teacher-student dialogue patterns and a student performance measure.

Statistical assessment of the hypotheses will be presented in the following order: treatment effects for wait-time I and II; the effects of treatment and wait-time on the dialogue variables and performance measures. Treatment effects were analyzed by analysis of variance. Outcome variables were assessed by analysis of variance for group effects. A modified Tukey's HSD Test was used for comparison among means. Multiple regression analysis was used to compare wait-time and the outcome variables for each microteaching session to determine shared variance.

Biomedical Computer Programs (BMDP, 1975) and the Statistical Package for Social Sciences (SPSS, 1975) were the statistical programs used to analyze the data.

Treatment Main Effects

The main effects were evaluated by comparing the averaged wait-time means of each group for each teaching session. The average wait-time means for subjects were calculated from the audio taped recordings.

Because the knowledge of entry behavior was desired and because treatment occurred at two levels, the design appropriate for analysis was a factorial design with block and treatment confounded, the split-plot factorial-pr.q. (Kirk, 1968; Hays, 1963). In these analyses p levels of a_i equal two audio and visual; q levels of b_j equal three, microteaching Sessions 1, 2 and 3; and r levels of c_k equal two, feedback and no feedback. The design has two between block treatments (A = modeling treatment and C = feedback), and one within block treatment (B = microteaching session).

The data met the assumptions that npr subjects are randomly assigned to modeling, feedback treatments with n blocks within each pr level. The underlying structural model for the design which test the hypotheses in the null, or no difference, mode is presented below.

$$X = \mu + \alpha_i + \gamma_k + \alpha\gamma_{ik} + \pi_{m(ik)} + \beta_j + \alpha\beta_{ij} + \alpha\beta\gamma_{ijk} + \beta\pi_{jm(ik)} + \varepsilon_{(ijkm)}$$

Main Effects

Analysis of wait-time II is described separately from wait-time I, because wait-time II is controlled only by the teacher and is therefore more likely to be influenced by treatment than wait-time I. By definition wait-time II is that period of time between the end of a student response and the beginning of teacher talk. Wait-time I is the period between the time the teacher completes a response and the student intervenes. Thus, control of wait-time is shared by the teacher and the student since both have equal access to the speak-space after a teacher question. As pupil subjects received no training, their portion of control of wait-time I would not be directly subject to treatment effects. Consequently the data on wait-time II are discussed before the wait-time I data.

Wait-time II

The entry level wait-time II mean for all subjects was 0.60 seconds with no significant differences between any of the groups. Cell means, standard deviations and treatment means for all wait-time II groups are listed in Table 5 and the analysis of variance summary table examining group mean differences are reported in Table 6. Analysis of variance for repeated measures revealed significant differences between the microteaching sessions ($F = 44.16$, $p < 0.001$). Tests for significances between means using Tukey's HSD showed that the wait-time II for Session 2 and Session 3 were significantly higher than Session 1. The Session 3 wait-time II mean of 2.83 seconds was not significantly higher than the Session 2 wait-time II mean of 2.32 seconds. The summary for Tukey's HSD Test is listed in Table 7.

Table 5

Means and Standard Deviations for Wait-time II

	Audio No	Audio Feed	Visual No	Visual Feed	Marginal
Session 1					
Mean	0.52	0.64	0.66	0.56	0.60
S.D.	0.55	0.54	0.37	0.33	
Session 2					
Mean	1.77	1.99	2.89	2.61	2.32
S.D.	1.44	1.02	1.90	1.49	
Session 3					
Mean	2.21	2.78	2.71	3.70	2.87
S.D.	1.31	1.75	1.13	2.32	
Marginal	1.50	1.81	2.09	2.29	
Count	12	13	13	14	52

Table 6

Analysis of Variance for Wait-time II

Source	SS	df	MS	F
Model (A)	9.83	1	9.83	3.96*
Feedback (C)	2.20	1	2.20	.89
AC	.09	1	.09	.03
Error	104.24	42	2.48	
Teaching Session (T)	126.99	2	63.49	44.16**
TA	4.55	2	2.28	1.58
TC	4.77	2	2.38	1.66
TAC	1.26	2	.63	.44
Error	120.77	84	1.43	

*$p < .05$
**$p < .01$

Table 7

Tukey's HSD Test for Difference Between

Means Wait-time II

Treatment	Cell Mean		Cell N
1) Microteaching Session 1	.598		46
2) Microteaching Session 2	2.32		46
3) Microteaching Session 3	2.87		46
Contrasted pairs	1-2	1-3	2-3
Differences between Means	1.72*	2.27*	.55
Tukey's HSD:	.644		

*$p < 0.05$

For the between block treatments, a significant difference was found between the modeled treatment subjects. The video model group achieved a significantly higher wait-time mean than did the audio group ($F = 3.96$, $p < 0.05$). The wait-time II mean for the feedback group was not significantly higher than the mean of the no feedback group.

The percent of subjects reaching the desried criterion wait-time of 3.o seconds for each treatment group at Session 2 and Session 3 is reported in Table 8. No subject reached criterion for Session 1. The subjects not reaching the three second criterion are separated into groups, those achieving wait-time between two and three seconds and those who do not reach two seconds. Although some subjects failed to reach the two second level, the amount on increase was usually significant. For example, although one subject reached a post treatment wait-time II of only 1.93 seconds, her entry level wait-time II was 0.38 seconds.

Table 8

Percent of Subjects at Criterion Wait-time II

Group	A	B	C
	Session 2		
Video	30%	19%	51%
Audio	21%	21%	58%
	Session 3		
Video Feedback	62%	31%	08%
Video No Feedback	50%	31%	20%
Audio Feedback	54%	23%	23%
Audio No Feedback	33%	25%	42%

A = > 3.0 seconds, B = 2.0-2.99 seconds, C = < 2.0 seconds

Wait-time I

The average entry level mean for wait-time I was 0.99 seconds which was slightly higher than the entry wait-time II mean. However wait-time I did not increase in magnitude between sessions nearly as much as wait-time II. None of the group means reached two seconds. The highest wait-time I achieved by any subject was 2.95 seconds. Cell means, treatment means and standard deviations are reported in Table 9.

As with wait-time II, analysis of variance revealed significant differences between microteaching sessions although the magnitude of change was considerably smaller ($\underline{F}$ = 11.10, $p < .01$). No differences between block treatment groups were found to be significant but a significant interaction occurred between the type of model and effect of feedback ($\underline{F}$ = 4.21, $p < 0.05$). Wait-time I analysis of variance summary is listed in Table 10. The breakdown of significance between group means revealed a significant difference between microteaching Sessions 1 and Session 3, but not between Session 1 and Session 2 nor between Session 2 and Session 3. Tukey's HSD Test also revealed that the mean of the audio feedback group was significantly higher than either the audio no feedback group or the visual feedback group. The summary of Tukey's HSD Test is listed in Table 11.

Table 9

Means and Standard Deviations for Wait-time I

	Audio No	Audio Feed	Visual No	Visual Feed	Marginal
Session 1					
Mean	0.77	1.21	1.24	0.74	0.99
S.D.	0.48	0.85	0.64	0.33	
Session 2					
Mean	0.72	1.77	0.85	0.79	1.04
S.D.	0.49	1.68	0.59	0.51	
Session 3					
Mean	1.50	1.56	1.60	1.65	1.58
S.D.	0.84	0.49	0.76	0.34	
Marginal	0.99	1.52	1.23	1.06	1.20
Count	12	13	13	14	52

S.D. = standard deviation

Table 10

Analysis of Variance for Wait-time I

	SS	df	MS	*F*
Model (A)	0.43	1	0.43	0.44
Feedback (C)	1.03	1	1.03	1.05
AC	4.13	1	4.13	4.21*
Error	41.24	42	0.98	
Teaching Session (T)	9.82	2	4.91	11.10**
TA	1.72	2	0.86	1.95
TC	1.79	2	0.89	2.03
TAC	2.00	2	1.00	2.26
Error	37.13	84	0.44	

*$p < 0.05$
**$p < 0.01$

Table 11

Tukey's HSD Test for Difference Between Means Wait-time I

Treatment	Cell Mean		Cell N
1) Microteaching Session 1	.99		46
2) Microteaching Session 2	1.04		46
3) Microteaching Session 3	1.58		46
Contrasted pairs	1-2	1-3	2-3
Differences between Means	.05	.59*	.54*
Tukey's HSD:	.405		

*p 0.05

Outcome Variables

The variables, mean length of teacher talk, mean length of pupil response, proportion of teacher talk and the student performance measure, were analyzed according to group membership with analysis of variance. Because of the large differences found to exist between microteaching sessions for wait-time II, each teaching session was analyzed separately by a stepwise multiple regression with wait-time as the dependent continuous variable. In the analyses scores on the outcome variables were regressed on wait-time scores with the dependent variables entering the equation in order of significance.

Analysis of variance results for group differences of each outcome variable are reported first followed by the multiple regression analysis for each of the three microteaching sessions. When reporting the statistical results for the outcome variables the following abbreviations will sometimes be used: mean length of teacher talk (MLTT), mean length of student talk (MLST), proportion of teacher talk (PTT), and student performance test (SPT).

Mean Length of Teacher Talk

The data for mean length of teacher talk revealed that teachers talked an average of 6.74 seconds every time they occupied the speak space for the pretreatment session 1. Cell means, treatment means and standard deviations for MLTT are reported in Table 12. Analysis of variance showed significant differences between microteaching sessions but not between treatment groups. Tukey's HSD Test indicated that the mean length of teacher talk decreased significantly from 6.74 to 4.86 seconds between Session 1 and Session 2 ($F = 18.81$, $p < 0.01$). The decrease proved to be only a temporary change because the mean of the third session increased to 6.89 seconds which is essentially equal to the Session 1 mean. An analysis of variance summary table for mean length of teacher talk is listed in Table 13 and Tukey's HSD Test in Table 14.

Table 12

Means and Standard Deviations for Mean Length of Teacher Talk

	Audio No	Audio Feed	Visual No	Visual Feed	Marginal
Session 1					
Mean	5.99	7.68	6.92	6.34	6.74
S.D.	1.24	2.42	2.46	2.69	
Session 2					
Mean	4.81	5.39	4.92	4.31	4.85
S.D.	1.52	2.35	1.21	1.19	
Session 3					
Mean	6.44	7.21	6.48	7.39	6.89
S.D.	2.28	2.13	1.57	2.31	
Marginal	5.75	6.76	6.11	6.02	6.17
Count	12	13	13	14	52

S.D. = Standard Deviation

Table 13

Analysis of Variance for Mean Length Teacher Talk

	SS	df	MS	$\underline{F}$
Model (A)	1.31	1	1.31	.65
Feedback (C)	7.31	1	7.31	1.18
AC	10.53	1	10.53	1.70
Error	259.85	42	6.19	
Teaching Session (T)	116.65	2	58.33	18.81*
TA	2.00	2	1.00	.32
TC	4.30	2	2.15	.63
TAC	8.28	2	4.14	1.34
Error	260.45	84	3.31	

*$p < 0.01$

Table 14

Tukey's HSD Test for Differences Between Mean Length Teacher Talk

Treatment	Cell Mean		Cell N
1) Microteaching Session 1	6.74		46
2) Microteaching Session 2	4.86		46
3) Microteaching Session 3	6.89		46
Contrasted pairs	1-2	1-3	2-3
Differences between Means	1.89*	.14	2.04*
Tukey's HSD:	.881		

*$p < 0.05$

Mean Length of Student Response

As noted in Table 15 in which cell means, treatment means and standard deviations are listed, the mean length of student response almost doubles from 4.59 seconds to 9.79 seconds between Session 1 and Session 2 and remains high for Session 3. These differences are found to be very significant ($F = 33.35$, $p < .001$). Although the differences between treatment groups were not found to be significant ($F = 1.83$, $p = .16$) the MLST for the video groups at Session 2 are more than two seconds longer than the audio groups. These distinctions disappear or are possibly confounded by the effect of feedback for Session 3.

Analysis of variance and Tukey's Test are reported in Tables 16 and 17 respectively.

Table 15

Means and Standard Deviations for Mean Length Student Talk

	Audio No	Audio Feed	Visual No	Visual Feed	Marginal
Session 1					
Mean	4.32	4.73	4.28	4.98	4.59
S.D.	1.78	2.75	1.11	2.67	
Session 2					
Mean	8.08	8.89	11.93	10.33	9.79
S.D.	5.00	4.38	8.53	4.77	
Session 3					
Mean	7.83	8.54	10.96	9.68	9.24
S.D.	3.43	5.44	6.02	5.99	
Marginal	6.74	7.38	9.06	8.33	7.88
Count	12	13	13	14	

S.D. = Standard Deviation

Table 16

Analysis of Variance for Mean Length Student Talk

	SS	df	MS	F
Model (A)	91.75	1	91.75	2.02*
Feedback (C)	.05	1	.05	.00
AC	16.06	1	16.06	.36
Error	1894.54	42	45.12	
Teaching Session (T)	757.57	2	378.78	33.36**
TA	41.47	2	20.73	1.83*
TC	6.11	2	3.06	.27
TAC	12.17	2	6.09	.54
Error	953.91	84	11.35	

* $p = 0.16$
**$p < 0.001$

Table 17

Tukey's HSD Test for Differences Between Mean Length Student Talk

Treatment	Cell Means		Cell N
1) Microteaching Session 1	4.59		46
2) Microteaching Session 2	9.79		46
3) Microteaching Session 3	9.29		46
Contrasted pairs	1-2	1-3	2-3
Differences between Means	5.21*	5.08*	0.50
Tukey's HSD:	1.684		

*p < 0.05

Proportion of Teacher Talk

As with mean length of teacher talk and mean length of student response the proportion of teacher talk was found to be significantly different for microteaching sessions but not for treatments ($\underline{F}$ = 99.64, p < .001). For teaching Session 1 teachers talked about 60 percent of the time which decreased to about 35 percent for Session 2. Session 3 increased about 10 percent from Session 2. Cell means, treatment means and standard deviations are listed in Table 18. The analysis of variance summary is reported in Table 19 and Tukey's HSD Test is in Table 20. For ease of reading the proportions in these tables are expressed in percents.

Table 18

Means and Standard Deviations for Proportion of Teacher Talk

	Audio No	Audio Feed	Visual No	Visual Feed	Marginal
Session 1					
Mean	59.86	62.60	61.60	52.66	59.11
S.D.	12.52	13.51	10.50	10.99	
Session 2					
Mean	38.96	40.29	34.87	30.42	36.10
S.D.	12.57	11.22	13.14	8.57	
Session 3					
Mean	47.12	49.43	40.03	44.67	45.38
S.D.	11.99	16.78	11.79	13.27	
Marginal	48.65	50.77	45.49	42.59	49.86
Count	12	13	13	14	52

S.D. = Standard Deviation

Table 19

Analysis of Variance for Proportion of Teacher Talk

Source	SS	df	MS	F
Model (A)	1106.50	1	1106.50	3.28*
Feedback (C)	5.33	1	5.33	.01
AC	218.71	1	218.71	.65
Error	14167.00	42	337.31	
Teaching Session (T)	12359.60	2	6179.80	99.64**
TA	48.77	2	24.38	.39
TC	271.57	2	135.78	2.19
TAC	283.29	2	141.64	2.28
Error	5209.74	84	62.02	

$*p = 0.077$
$**p < 0.001$

Table 20

Tukey's HSD Test for Differences Between Means Proportion of Teacher Talk

Treatment	Cell Mean	Cell N
1) Microteaching Session 1	59.11	46
2) Microteaching Session 2	36.10	46
3) Microteaching Session 3	45.38	46

Contrasted Pairs	1-2	1-3	2-3
Difference between Means	23.01*	13.28*	9.28*
Tukey's HSD:	7.49		

*p < 0.05

Student Performance Measure

Analysis of variance for the test scores revealed a significant difference between teaching sessions and a significant interaction between teaching session, model treatment and feedback. Cell means, treatment means and standard deviations are presented in Table 21. A difference was also found between model treatment groups which was significant at the 0.076 level of probability ($\underline{F} = 3.30$). The audio group scores were generally higher than the video group. Analysis of variance summary table is reported in Table 22. The Tukey's HSD Test statistic for differences between cell means is 5.789. This means that for any two comparisons between cell means, a difference greater than 5.789 is significant at the 0.05 level of probability.

TABLE 21

Means and Standard Deviations for Tests

	Audio No	Audio Feed	Video No	Video Feed	Marginal
Session 1					
Mean	37.94	41.79	37.14	37.64	38.61
S.D.	7.93	9.91	6.93	7.75	
Session 2					
Mean	30.97	29.79	25.35	27.93	28.45
S.D.	8.90	7.97	5.01	8.04	
Session 3					
Mean	33.72	37.16	33.15	28.16	32.94
S.D.	11.75	10.53	7.58	7.60	
Marginal	34.20	36.24	31.88	31.24	33.33
Count	12	13	13	14	

TABLE 22

ANALYSIS OF VARIANCE FOR TESTS

Source	SS	df	MS	*F*
Model (A)	521.11	1	521.11	3.30
Feedback (C)	18.80	1	18.80	.12
AC	69.26	1	69.26	.44
Error	7580.28	48	157.92	
Teaching Session (T)	2659.31	2	1329.65	46.89**
TA	35.08	2	17.53	.62
TC	55.94	2	27.97	.99
TAC	242.81	2	121.40	4.28*
Error	2772.32	96	28.36	

*p < 0.05
**p < 0.001

Microteaching Sessions

Upon finding significant differences between teaching sessions and all the outcome variables as well as the pausing variable, wait-time II, the researcher used a stepwise multiple regression analysis to see whether significant correlations and variances were shared by the variables. This analysis also helped to determine whether the wait-time variable was behaving at a threshold level or on a continuous increment level. For each teaching session the dialogue variables were regressed on the independent variable, wait-time. Test scores were analyzed in a similar manner but separately in order to examine parital score results of the three catagories as well as the total test results.

Microteaching Session 1

The means, standard deviations and intercorrelations for wait-time II and the dialogue variables are presented in Table 23. Initially both mean length of student talk and percent of teacher talk had sufficient F's to enter the regression equation (MLST, $F = 15.28$; PTT, $F = 8.14$). However, once MLST entered the equation, the PTT, F to enter dropped appreciably due to the high negative correlation between the two variables (-0.75). Mean length of teacher talk did not correlate significantly with either wait-time II or mean length of student talk. For the first teaching session only the mean lenght of student response shared a significant amount of variance with wait-time having a multiple R of 0.49. The amount of variance shared by the variables accounted for about 24 percent of the total variance.

Table 23

Means, Standard Deviations and Intercorrelations Session 1

Mean S.D.	Variable	WTII	MLTT	MLST	PTT
0.64 0.46	WTII	1.000			
6.53 2.35	MLTT	0.007	1.000		
4.76 2.15	MLST	0.491	-0.178	1.000	
57.39 13.36	PTT	-0.381	0.580	-0.750	1.000

WTII = wait-time II, MLTT = mean length teacher talk, MLST = mean length student talk, PTT = proportion of teacher talk.

Microteaching Session 2

The means, standard deviations and intercorrelations for teaching Session 2 are presented in Table 24. Initial F's-to-enter were sufficiently high for all dialogue variables to enter into the regression equation. As in Session 1 mean length of student response had the highest F value of 67.59. Mean length of teacher talk and percent of teacher talk had F's-to-enter of 6.14 and 9.57 respectively. The entry order for the variables was MLST, PTT and MLTT. With MLST entered into the equation alone a significant amount of variance was accounted for producing a multiple *R* of 0.76 ($F = 67.59$, 1 & 49 df, $p < .05$). When PTT entered the equation, multiple *R* increased to 0.802 ($F = 8.52$, 1 & 49 df, $p < .05$). Mean length of teacher talk did not increase the multiple *R* significantly.

Table 24

Means, Standard Deviations and
Intercorrelations Session 2

Mean S.D.	Variable	WTII	MLTT	MLST	PTT
2.29 1.45	WTII	1.000			
4.73 1.62	MLTT	0.334	1.000		
9.81 5.6	MLST	0.761	0.109	1.000	
35.39	PTT	-0.404	0.471	-0.702	1.000

WTII = wait-time II, MLTT = mean length teacher talk
MLST = mean length student talk, PTT = proportion of teacher talk.

As in Session 1 mean length of teacher talk showed low correlation with mean length of student talk. Unlike Session 1 the correlations between wait-time II and mean length of teacher talk were significant. In microteaching Session 2 the amount of variance shared by MLST and wait-time II was 58 percent which increased to 64 percent with the addition of PTT. Mean length of teacher talk did not increase the amount of shared variance significantly upon entering the regression equation.

Microteaching Session 3

The means, standard deviations and intercorrelations for this session are listed in Table 25. Although both mean length of student talk and percent of teacher talk had sufficient *F*'s-to-enter into the equation originally, only MLST yielded a significant multiple *R* (*F* = 19.76, 1 & 17 df, p < .01). Neither percent of teacher talk nor mean length of teacher talk contributed significantly to the amount of wait-time II variance.

Table 25

Means, Standard Deviations and Intercorrelations Session 3

Mean S.D.	Variable	WTTII	MLTT	MLST	PTT
2.91 1.75	WTII	1.000			
6.75 2.09	MLTT	0.2562	1.000		
9.12 5.17	MLST	0.544	0.175	1.000	
45.03 13.36	PTT	-0.328	0.353	-0.726	1.000

WTII = wait-time II, MLTT = mean length teacher talk
MLST = mean length student talk, PTT = proportion teacher talk.

As in Session 1 and 2 the mean length of student talk had a high negative correlation with the percent of teacher talk (-.762) and a low correlation with the mean length of teacher talk (.1752). The multiple regression summary tables for the three teaching sessions are presented in Table 26.

Table 26

Multiple Regression Summary Data

Variable	Multiple R	RSQ	Increase in RSQ	F
		Session 1		
MLST	0.491	0.241	0.241	15.27*
		Session 2		
MLST	0.761	0.580	0.580	67.58**
PTT	0.802	0.643	0.063	8.52*
		Session 3		
MLST	0.544	0.295	0.295	19.75*

*p < 0.05
**p < 0.01

Pupil Performance Tests

In addition to dialogue variables the students completed a fifteen item multiple choice test at the end of each session. The quiz contained three types of questions: observation, inference and vocabulary. Scores on the test and partial scores of each component were regressed on the wait-time variable.

In teaching Session 1 no significant multiple *R* occurred. The *F*'s-to-enter the regression were small, the highest being observation questions with an *F* value of 0.1666. Thus for teaching session the scores of the test did not correlate to any significant degree with the time teachers paused.

Regression analysis of Session 2 revealed an interesting statistic. The mean length of wait-time two correlated negatively with inference type questions. The *F*-to-enter for inference questions resulted in a significant multiple *R* of 0.302 ($F = 4.9$, 1 & 49 df. $p < 0.05$). The scores on observation and inference questionsboth had negative correlations with the mean length of wait-time. The variance shared by inference questions and wait-time although significant was small only accounting for about 9 percent to the total variance.

For teaching Session 3 significance at .05 level was not reached for any variable. The intercorrelations for observation and inference questions and wait-time are low though no longer negative. Table 27 presents means, standard deviations and intercorrelations for test scores at each of the three teaching sessions.

Table 27

Means, Standard Deviations and Inter-correlations Test Scores

Mean S.D.	Variable	WTII	OBS	INF	VOC	TOT
		Session 1				
0.64 0.46	WTII	1.000				
14.51 2.75	OBS	0.058	1.000			
9.51 2.57	INF	-0.032	0.466	1.000		
14.05 4.58	VOC	-0.001	0.522	0.567	1.000	
38.27	TOT	-0.006	0.714	0.778	0.854	1.000
		Session 2				
2.29 1.45	WTII	1.000				
8.90 3.07	OBS	-0.244	1.000			
8.09 2.78	INF	-0.301	0.510	1.000		
11.41 4.36	VOC	0.075	0.126	0.306	1.000	
28.56	TOT	-0.149	0.684	0.771	0.689	1.000

Table 27 - continued

Mean S.D.	Variable	WTII	OBS	INF	VOC	TOT
		Session 3				
2.91 1.75	WTII	1.000				
13.41 3.71	OBS	0.137	1.000			
10.65 3.81	INF	0.062	0.727	1.000		
8.97 4.12	VOC	0.154	0.542	0.554	1.000	
33.14	TOT	0.132	0.908	0.794	0.741	1.000

WTII = wait-time II, OBS = observation questions, INF = inference questions, VOC = vocabulary questions, TOT = total test score.

CHAPTER IV

DISCUSSION AND IMPLICATIONS

There are two basic objectives of this study. One is to devise a reasonably expedient method for training teachers to increase their wait-time behavior during inquiry lessons with children. The other is to examine accompanying changes in discourse patterns and pupil performance.

Four hypotheses were designed to test the first objective related to training. Another four hypotheses were formulated to test the effectiveness of increased wait-time on dialogue patterns. For the sake of continuity, the results of the experiment related to treatments will be summarized and discussed first. For these hypotheses wait-time functioned as the dependent variable and treatment groups as the independent variables.

The second set of hypotheses testing the outcome variables will then be summarized and discussed. When testing related outcomes, wait-time served as the independent variable and dialogue patterns as the dependent variables.

Treatment Variables

In this study treatment occurred at two levels: one in which teachers observed a model displaying extended wait-time I and II behaviors and one in which teachers received direct feedback of their own performance of wait-time behaviors. In order to maximize control over the subjects' entering knowledge of lesson materials, all subjects were exposed to a set of induction materials for a specified amount of time. Thus teachers were assumed to have similar knowledge of the materials on which to base the inquiry discussions. Subjects were not given any specific format for asking questions because it was suspected that too much direction for the discourse would interfere with and confound the chances of achieving criterion wait-time.

Wait-time can be thought of collectively as all pauses, or periods of silence, in teacher-pupil dialogue or it can be separated into two subspecies, wait-time I and wait-time II. In the discussion, the effect of treatment on each specie of wait-time is examined separately.

The first hypothesis tested the change in mean length of wait-time behavior for teachers who viewed the video model. Support for this hypothesis depends upon a significant difference between the length of wait-time prior to treatment and the length of wait-time after exposure to the model. Analysis of variance indicated that the mean length of wait time II was significantly greater after exposure to the video model. Conversely, wait-time I did not increase significantly after exposure to the video model.

Hypothesis two tested the difference between the teachers' mean length of wait-time before exposure to an audio model and after exposure. The statistical analysis of wait-time II yielded a very large F value supporting the hypothesis that exposure to a model would significantly increase wait-time. As with the video model, wait-time I of teachers who listened to the audio model did not increase significantly from entry level to post audio treatment.

Hypothesis three tested the relative effects of the video and audio models. Significant mean differences between the two groups supported the hypothesis for wait-time II. No statistical differences occurred between the two treatment groups for wait-time I.

Hypothesis four tested the differences in wait-time between the group who received specific performance feedback and the group not receiving feedback. Results of analysis indicated no significant differences between groups for either wait-time I or II. However, the effect of feedback was confounded by the model treatment variable. Wait-time II of the video model group was significantly higher at Session 2 which served as the base level for the feedback treatment. A second analysis was done to examine the average differences in the amount of increase that occurred for the feedback and no feedback groups. The average increase for the no feedback group, 0.26 seconds, and the feedback group, 0.92 seconds, differed at the 0.076 level of probability.

Differences between the feedback and the no feedback groups for wait-time I were not significant. However, the overall average of wait-time I did increase significantly from teaching Session 1 to Session 3. This would appear to be a delayed, overall, treatment effect rather than a feedback effect.

For summarization the four hypotheses related to the main effects will be stated below:

1. The mean length of teacher's wait-time I and II as measured by servo-chart analysis will significantly increase upon viewing a video model.

2. The mean length of teacher's wait-time I and II as measured by servo-chart analysis will significantly increase upon observing an audio model.

3. The mean length of wait-time I and II of teachers viewing the video model will be significantly greater than the mean length of wait-time I and II of teachers who observe the audio model.

4. The mean length of wait-time I and II of teachers who receive feedback will be significantly greater than the mean length of wait-time I and II of teachers not receiving feedback.

For wait-time II the data analyses supported the first three hypotheses. Therefore the three hypotheses were not rejected for wait-time II. For wait-time I, despite an overall significant increase from pretest to posttest the three hypotheses were not directly supported because the mean length of wait-time did not reach the hypothesized threshold criterion of 2.7 seconds. Hypothesis four was rejected because there was no significant difference between groups at 0.05 level of significance. However, three of the four groups (audio feedback; video no feedback; video feedback) reached the mean wait-time II level of greater than 2.7 seconds with the video feedback group averaging 3.6 seconds.

Interpretation of Treatment

Wait-time II and Modeling

As previously reported in the review of literature section, modeling has been shown to be an effective training procedure. Bandura (1965) has reported that the modeled behaviors are most effectively transmitted when the responding behaviors occur infrequently or are weakly established. From the initial wait-time mean of 0.688 seconds, with a mean standard deviation of 0.006 seconds, it is evident that the desired response of 3.0 seconds is indeed rare. Thus modeling would be expected to have great utility as a training procedure.

Various modeling formats, video, audio, written, or protocol, appear to have differential rates of success. In research using video models and written models, the video model usually proves to be superior. (Koran, J. J., Jr., 1970, 1971, 1972; Koran, J. J., Jr., & Koran, M. L., 1974-1975). Evidence supporting the superiority of the video or audio model is limited. Santiesteban's research (1974) found no significant differences between the effects of the two kinds of models.

Since the task is primarily verbal, without a large psychomotor component, one might expect the difference between the two types of models to be negligible. In fact, Santiesteban argued that the visual model might distract the subject by presenting a too rich mixture of relevant and irrelevant cues. If the models were manipulating objects, as well as discussing the processes, the subject's attention to the desired behaviors might be redirected from the verbal behavior to the manipulated activities. For these reasons, the video tape used to model the pausing behaviors portrayed only the five discussants with no supplementary visual aids or materials.

In Bandura's theory of the effectiveness of modeling, the whole modeling process is thought to consist of four subprocesses, one of which is the attentional process. Examining this process offers an explanation for why the video model was superior to the audio model in this study.

It could be maintained that the video model produced longer, teacher wait-times because the subject was required to focus his attention in two modes, visual and auditory, for the video model, but only one for the audio model. On the other hand, with the audio model the visual senses were not focused and it is possible that the general, surrounding environment would produce many visual distractions.

An additional explanation, which might account for the differences in performance of subjects observing the audio and video models, is the attributes of the model. Bronfenbrenner (1970) suggests that these dimensions of the model have the greatest potential for influencing the modeling process. In the video model, the subjects were able to observe many irrelevant behaviors which could not be detected in the audio model. Portuges and Feshbach (1972) found incidental behaviors of the model performed nearly as frequently as essential behaviors.

Certain irrelevant personal characteristics of the master teacher may have enhanced the value of waiting for the subjects. For example, she may have looked particularly relaxed and comfortable in her role. In the video model, subjects could see that pauses appeared to be a natural part of discussion. The pupil models could be observed also. The subjects could see that the children were actively involved in the inquiry process. Silences could be seen as a dynamic phase of the learning process. The model children exhibited facial expressions and hand gestures indicating that something was happening during silence. In other words, the subjects could "see" that silence was an active part of the inquiry process. This may have served as positive reinforcement for the value of waiting. In the audio model these visual cues could not be detected.

Wait-time II and Feedback

In general, the feedback group did not differ significantly from the no feedback group nor was the overall increase from Session 2 to Session 3 significant. However, the results of the average increase, using Session 2 wait-time II means as the control or entry scores for assessing feedback effect, had an F value approaching significance.

Before discarding the notion that feedback is not a necessary element of the treatment, further investigations need to be done. By rejecting the hypothesis at the 0.05 level of significance, the researcher may discard a potentially valuable component of the overall treatment procedure. Because of the differences noted in Table 8, additional research may determine that feedback is necessary for some types of learners. Examination of interactions between aptitude and treatment could yield significant information for determining appropriate training methods.

Although the differences between groups for the last teaching session were not technically significant, the differences were of practical significance, especially when considering Rowe's hypothesis of a threshold effect for wait-time. The model exhibited pauses of three seconds or longer and this criterion was the goal of treatment. The audio feedback and video feedback groups reached a mean of 2.7 seconds and the video feedback group surpassed the 3.0 second level.

Rowe (1973) reported a mean wait-time threshold effect of about 2.7 seconds, below which no discernible changes in the outcome variables occurred. If a threshold effect does exist as suspected, the addition of a few tenths of a second becomes practically significant. The feedback component may be essential to get the subject to increase her wait-time that half second or so needed to reach or exceed criterion.

Wait-time I

Wait-time I is discussed separately from wait-time II because it did not increase significantly as hypothesized nor was a mean greater than 2.0 seconds reached for any group at any session.

By definition wait-time I is the pause space between the time the teacher asks a question and the time the student responds or the teacher asks another question. Although the teacher subjects received training in wait-time I, as well as wait-time II, she could only control the length of time she waited before asking or rephrasing another question. The student could begin a response whenever he wished. The children participating in the inquiry sessions received no wait-time training nor, in fact, were they cognizant of wait-time being used.

Analysis of results of the wait-time I data reveals that wait-time I increased significantly from Session I to Session 3. These results were not totally discrepant with expectations. In routine instruction, where the average wait-time is 0.9 seconds (Rowe, 1974a), students learn they must respond quickly, often impulsively, if they want a chance to speak. In micro-teaching sessions where four children are competing with each other, as well as the teacher, for that 0.9 seconds, it is surprising that any wait-time I exists at all. As a matter of fact, the tapes from the initial micro-teaching sessions were characterized by several student voices frequently chiming in simultaneously after a teacher question. As teachers increased the length of pauses in Session 2, the children were given more time to express their ideas. Perhaps they began to realize it was not necessary to grab the first speak space in order to have an opportunity to talk. This notion of delayed effect would seem to be supported by the data in the form of a significant increase of wait-time I in micro-teaching Session 3.

One other significant difference was found in the analysis of wait-time I. An interaction between the model and feedback treatments occurred. The audio model feedback group achieved significantly higher wait-time I than either the audio no feedback group and the video feedback group. Interpretation of differences between these groups remains questionable at best, because the differences, although significant, are small and because no one reached criterion level. A possible explanation is offered in regard to pupil performance. Test scores for children in the audio feedback group were consistently higher than the other three groups for all teaching sessions. Perhaps the difference can be attributed to the characterisitics of the children, instead of the treatment, because the children share control of wait-time I. The children in the audio feedback group scored higher on a test measuring observation and inference type skills at the entry level as well as the post test level. Perhaps these children possessed the skills to a greater degree than the children in the other groups. If true, it is possible that when given the opportunity to pause, these childern would be more likely to be reflective in nature than the other children. Wait-time I might have been longer because the children waited longer before responding particularly if the teachers tried to extend wait-time I.

Outcome Variables

Dialogue Variables

Three hypotheses were tested to examine changes in the discourse patterns that accompanied increased wait-time. Hypothesis five stated that as wait-time increased the mean length of teacher talk would decrease. Hypothesis six stated that as wait-time increased, the mean length of pupil response would increase. Hypothesis seven was formulated to examine the relationship between teacher-pupil moves. Using the two player model, the pupils were expected to have at least equal speak-space as the teacher. The hypothesis stated that the total proportion of teacher talk would decrease as wait-time increased.

Data results showed the length of teacher talk decreased sharply between the initial session and the second session and wait-time increased between sessions. The decrease in mean length of teacher talk proved to be only temporary. For teaching Session 3, MLTT increased to the entry level while wait-time II continued to increase for Session 3. Furthermore, multiple regression analysis revealed a significant correlation between wait-time and length of teacher talk for Session 2 only. The two variables did not share a significant amount of variance for either Session 1 or Session 3.

Examination of wait-time II and its relationship to mean length of student talk revealed high correlations between the two variables for all three teaching sessions. Mean length of student talk increased significantly from Session 1 to Session 2 and remained high for Session 3.

The correlation between the proportion of teacher talk and wait-time was high for Sessions 2 and 3. During Session 1, the proportion of teacher talk was very high, about 60 percent. The proportion decreased significantly, to about 35 percent, for Session 2 and increased slightly for Session 3. A high negative correlation existed for the portion of teacher talk and the mean length of student talk for all three sessions.

These results were interpreted collectively because the contribution of each affects the total changes in teacher-student dialogue. The dialogue pattern of Session 1 can be characterized in the following manner. The teacher appears to exert a large amount of control over the discussion. This is indicated by the large total amount of time that she occupies the speak space and by the low mean length of student talk. The lesson was intended to promote inquiry behavior, which is characterized by children exploring ideas, observing and making inferences. Yet each child was given little time to either think or talk without teacher intervention. The children averaged about four seconds per speak space or approximately one second per child. This type of dialogue pattern may indicate the development of an extrinsic motivation model as Rowe (1974) suggests. Ogunyami (1972) inferred that dialogue in which children build on each others ideas cannot occur under these conditions. It seems unlikely that children would be able to develop or explore any idea under such a fast pace.

Micro teaching Session 2 differed from the first session in that wait-time II almost quadrupled and teacher talk decreased by one-half while student talk doubled. It could be inferred that teachers attempted to extend wait-time pauses by simply talking less. The tapes revealed that the speak space was more evenly distributed among all the model players including the teachers making inquiry less teacher centered. Although not examined quantitatively, the tapes from Session 2 contained more instances of idea-changing by students. Verbal contributions by all of the student players became more equal.

In teaching Session 3, the overall length of wait-time II increased and the mean length of student talk remained high. However, the mean length of teacher talk increased almost to the level of teaching Session 1. The overall proportion of teacher talk increased only about 10 percent. It may be that teachers discovered that they can both talk and control pauses. The characteristics of conversation changed again. The teachers talked longer during any single conversational set but, once yielding to the students, were less likely to re-intervene into the flow of conversation. Chart plots from Session 3 show that pupil dialogue extended over 30 seconds without teacher interruption in several places. Frequently all four voices of the children could be heard in the conversational sequence before the teacher would respond with another question.

Pupil Performance Test

The last hypothesis tested the idea that as teachers increased their wait-time, inquiry processes as measured by written test should improve. Regression analysis showed that scores on the tests did not share a significant amount of variance with wait-time II for any teaching session. Interestingly enough analysis of variance revealed statistically significant differences between various cell means, but the differences were scattered over all groups. A trend seemed to be that pupil test scores were higher for audio groups than for video groups; this was so across all testing sessions. The entry scores for the audio groups were slightly higher, and remained so, negating the likelihood that scores were related to treatment group. Pupil test scores tended to be lowest for the group of teachers having the highest mean wait-time II.

The scores from Session 2 were significantly lower than the scores of Session 1 or 3. It is possible that the level of difficulty was greater for the second test. Upon examination of the "Bouncing Raisin" test the inference questions appeared to require more background knowledge than the inference questions on the other two tests. Taking into consideration the variation in test scores across groups and the low degree of shared variance for test scores and wait-time II, hypothesis 8 is rejected.

The lack of correlation between the two variables, test scores and wait-time, might best be interpreted by considering the relationship between the variables over time. Process behaviors, like making careful observations; and like making inferences that are supported by evidence, are skills that develop with practice, implying the passage of time. If teachers regularly incorporate criterion wait-time into inquiry sessions, the development of these skills would be fostered because the children would have an opportunity to use them. In a teacher training process that occurs over several teaching sequences, the teacher's behavior is expected to change between sequences. In this research the training schedule resulted in large and conspicuous changes in teacher bevarior from one session to the next.

The general dialogue pattern changed drastically between Session 1 and Session 2. It could be maintained that these changes, instead of fostering the development of inquiry skills, served to confuse the children. For example, in Session 1 the dialogue pattern required the children to compete for speak-space and for the teacher's attention. This initial contact with the teacher would lead the children to expect a similar pattern for the second teaching session. Instead the inquiry pattern changed considerably for Session 2 and then changed again during Session 3. Inquiry skills like observing and making reasoned inferences would be expected to develop with a long wait-time schedule. To produce improvement in these skills the long wait-time schedule would need to be relatively constant. Then changes in student behavior could be examined as a function of the teacher's behavior rather than as a function of change in teacher behavior.

Summary of Outcome Variables

The effect of increased wait-time on four outcome variables was tested. The data supported two of the hypotheses. One measured the increase in mean length of student talk and the other measured the decrease in proportion of teacher talk. Two hypotheses were rejected. The mean length of teacher talk did not decrease significantly and consistently as the amount of wait-time increased. Test scores did not respond to changes in wait-time.

A question is raised regarding the boundary condition, threshold wait-time. Rowe (1974) suggested in her research that a threshold level needed to be reached before significant changes in the outcome variables occurred. In this study it appears that for dialogue variables, of which wait-time is only one, that a threshold effect is not a necessary condition for change in other dialogue variables. Altering one variable in the dialogue system appears to cause proportional changes in the other dialogue variables in the system. Garigliano's data support this idea. Although his subjects did not reach criterion wait-time, a significant increase in the length of student response accompanied the increased wait-time values. This supports the notion that wait-time does not have to be held constant or at a particular criterion for these variables.

It may be that the threshold effect is necessary for learner outcomes of a different nature than were measured here. The results of this study cannot offer empirical support for this notion because it appears that the process outcome variables results were confounded by the fluctuating wait-times of the teachers between teaching sessions.

A second question is raised about the unique contribution of wait-time I on the outcome variables. It appears that because the pupil subjects' wait-time behavior was not controlled in the experiment that teachers were not able to reach the desired criterion for wait-time I. Observations of the cassette tapes indicated that teachers attempted to extend wait-time I as well as wait-time II but that the pupil subjects intervened before wait-time I could be reached. It could be speculated that if given the opportunity teachers who reached wait-time II criterion would also reach criterion for wait-time I. The data, however, do not contain the necessary information to meet this assumption leaving the question of unique contribution for wait-time I unresolved.

Implications for Future Research

The study attempted to assess the effects of four methods for training teachers to engage in wait-time. The video model proved to have the most potential as a suitable means of training. Before advocating its success, several questions need to be resolved. The conditions in which the question of amount and kind of feedback as a component of training has not been fully answered.

One way to examine the effect of training would be to explore the differences between subjects who reach criterion and those who do not. Perhaps personal attributes are interacting with training effects. If subjects who do not reach criterion are found to have common characteristics, the training model could possibly be altered to compensate for differences. An aptitude and treatment interaction approach for matching learner characteristics to instructional method could tease out valuable relationships. These might determine relative values of various training procedures for particular groups. A post hoc analysis of the data is planned to examine some of the questions raised in this study which could be originating from individual differences interacting with treatment variables.

Research examining the effects of wait-time on student outcome variables warrants further investigation. The data from this study suggest that in order to be able to examine process outcomes successfully the independent variables need to be carefully controlled. This is difficult because very few behaviors have clearly established and stable criterion levels. By manipulating wait-time in a variety of ways, a plethora of possibilities opens up for exploring outcome variables. Investigations of the effect of extended wait-time on the process skills commonly used in the process elementary science curricula open many avenues of research.

This research study provoked many ideas for future research. More questions were raised than were answered. Each variable that was investigated could be a potential source for future research. Several related research investigations are anticipated which may provide potentially useful information concerning unresolved questions of treatment and wait-time.

APPENDIX A

SET INDUCTION MATERIALS

INTRODUCTION

*VIDEO, AUDIO MODEL TREATMENTS

One purpose of this project is to train teachers to engage in prolonged wait-time. Wait-time refers to the pausing patterns of teacher-pupil dialogue. The teachers verbal interaction with children can greatly enhance or inhibit exploratory or inquiry learning.

A child learns by inquiry when he is presented with a curious event and is allowed to observe and explore the phenomenon. Frequently contradictory information will require further examination of the phenomenon. The exploratory phase of learning is often followed by a discussion period with the teacher. The manner in which the teacher capitalizes on the children's observations by asking appropriate questions will affect learning. It is also important during the discussion phase of inquiry that the children be allowed time to think about what they have been doing.

Research, however, has shown that teachers generally don't give children a long enough period of time to think about what they have done or time to think through their answers. Pauses, or the length of time teachers are prepared to wait a) after asking a question (WAIT-TIME I) or b) after receiving an answer (WAIT-TIME II) are usually less than one second. When teachers increase this "wait-time" to three or more seconds, children have time to think about their ideas and their answers are more likely to be insightful. Discussion frequently becomes less teacher centered and more student centered, characterized by children talking with each other more and sharing and building on each others ideas.

During this session please carefully observe a tape demonstrating wait-time I and wait-time II. You should pay particular attention to the length of each pause. Not all pauses will reach three seconds criterion and some pauses will be more than three seconds. As you observe the tape, please rate the pauses to determine the number of each kind of wait-time. Each time the teacher asks a question you will hear a beep if the wait-time I has been three seconds. Each time a child responds you will hear two beeps if wait-time II has been reached. Thus you will know whether you have rated each pause correctly.

*This title was not present on the original materials given to subjects.

Diagramatically wait-time I and wait-time II look like this:

Teacher asks a question	WAIT-TIME I	Student answers question	WAIT-TIME II	Teacher or other student talk

At the end of this tape you will lead another inquiry session with four children. During this session please try to lengthen your pauses to three seconds. To help you achieve the three second pause you might try to rough count for three seconds, 1001, 1002, 1003. Try to reach the three second pause level for both Wait-time I and wait-time II.

*FEED BACK GROUP

For this phase of the training you will listen to your tape from the previous session. Please rate yourself to help you decide whether or not you have reached a three second wait-time level.

When you have finished rating your tape please lead another inquiry discussion with four children. Again you are asked to use pauses of three seconds for wait-time I and II.

Teacher asks a question	WAIT-TIME I	Student answers Question	WAIT-TIME II	Teacher or other student talk

*NO FEEDBACK GROUP

During your last inquiry session you were asked to slow down your rate of instruction so that you have three second pauses between teacher and student exchanges. Today you are asked to lead another inquiry discussion with children. Again try to wait at least three seconds for both types of pauses.

Teacher asks a question	WAIT-TIME I	Student answers question	WAIT-TIME II	Teacher or other student talk

You are asked to read the folowing article before teaching your next inquiry lesson.

*This title was not present on the original materials given to subjects.

APPENDIX B

TEACHING TASK

EXPERIMENTAL TERMS

During the three inquiry sessions, you will use terms related to experimenting. Please try to use terms like these with children and encourage the children to use them in expressing their ideas.

A list of some of these terms with operational definitions follow:

1. EXPERIMENT: things you do and processes you go through to test an idea that you have.

2. OBSERVATION: to pay attention to or notice carefully events, particularly those connected to an experiment.

3. INFERENCE: a guess or idea that you have about part of an experiment based on the observations you made during the experiment.

4. EVIDENCE: observations you make which lend support to your inferences.

5. SYSTEM: collections of objects that can be grouped together like the parts of an experiment or the parts of a bicycle.

6. VARIABLE: any part of the experiment that can vary or change.

7. CONSTANT: any part of an experiment that does not vary. Something that you keep the same.

8. COMPRESS: to push parts of something together like the molecules of air.

9. EXPAND: when things move apart like the molecules of air.

10. HYPOTHESIS: a guess you have about why a particular thing happens. One reason you experiment is to test your hypothesis.

THE CARTESIAN DIVER

ORIENTATION:

You will soon observe a science inquiry task being demonstrated for children. At the end of the demonstration you and four children will discuss the lesson for a fifteen minute period. The purpose of the discussion is to help the children discover the possible causes of the phenomenon. In science, explanations of many events can be discovered by making careful observations of the phenomenon and trying to draw conclusions from the evidence. During inquiry sessions you should try to keep the children focused on the observations (evidence) as a means of coming to a reasoned conclusion (inference). You should not tell the children why the event occurred, but guide their discussion so that they can discover possible solutions for themselves.

YOU WILL SEE:

A tall glass cylinder filled with water. An inverted test tube half filled with water floats just at surface level. As pressure is applied to the rubber diaphragm covering the cylinder, the test tube dives to the bottom of the cylinder. As the pressure is released the tube rises to the top of the cylinder. Without the rubber diaphragm the test tube will not go to the bottom and remain there even when it is pushed directly.

THE BASIC QUESTION? Why does the bottle dive to the bottom?

EXPLANATION:

When you apply pressure to the rubber diaphragm you apply pressure to all parts of the system. However, since water cannot compress, you force the air in the test tube to compress. The compressed air occupies less space and since that space must be filled, water moves into the test tube. The increased amount of water plus the compressed air make the bottle heavier than the water it displaced. The bottle (test tube) being heavier sinks to the bottom of the cylinder. As the pressure applied to the rubber diaphragm is released, the air inside the test tube expands pushing out some of the water. The tube is once again lighter than the water it displaces and rises to the top of the cylinder.

DISCUSSION SUGGESTIONS:

In talking with the children you should help them to define a variable as some part of the experiment that may vary or change. Some possible variables in this task are:

the amounts of water in the cylinder and in the test tube; the temperature of the water; the size of the tube; and the kind of covering over the cylinder. You may think of others. By carefully observing the task, you may decide that altering the variables will also alter the effects of the experiment. You might discuss how changing the variables would affect the results of the experiment. You should review the observations with the children. You might call to their attention the fact that the water is able to enter and leave the test tube and question them as to what effects that may or may not have on making the bottle sink. Other vocabulary related to the task that the children should understand are system, cylinder, compressed, expand and experiment.

OBJECTIVES:

At the end of the lesson the children should be able to:

1. define: variable, compressed, expand.

2. identify three variables in the experiment.

3. describe the effects of altering one variable.

4. state that the water cannot be compressed.

5. define: system, cylinder.

6. discuss why air can be compressed and expanded.

7. state that pressure applied to a system will be transmitted equally to all parts of the system.

8. discuss the notion that when air is compressed something must fill the space that the air occupied.

9. describe why water fills the space.

10. state that the additional water added to the test tube makes it heavier causing the tube to sink.

11. infer what might happen if the pressure on the diaphragm is decreased rather than increased.

BOUNCING RAISINS

ORIENTATION:

You will soon observe a science inquiry task being demonstrated for children. At the end of the demonstration you and four children will discuss the lesson for a fifteen minute period. The purpose of the discussion is to help the children discover the possible causes of the phenomenon. In science, explanations of many phenomena can be discovered by making careful observations of the event and trying to draw conclusions from the evidence. During the inquiry session you should keep the children focused on the observations (evidence) as a means of coming to a reasoned conclusion (inference). You should not tell the children why the event occurred, but guide their discussion so that they can discover possible solutions for themselves.

YOU WILL SEE:

About a teaspoon of baking soda being dissolved in a glass of water. Four raisins are dropped into the solution. Gradually, vinegar (8p to 30 ml.) is added to the solution. After observing for several minutes some or perhaps all of the raisins will bounce to the top and some may sink and rise again. Others may float or remain on the bottom.

THE BASIC QUESTION? How do you explain what happens to the raisins?

EXPLANATION:

Baking soda ($NaHCO_3$) dissolves in water. When vinegar is added a chemical reaction occurs between the baking soda and the vinegar releasing a gas, carbon dioxide (CO_2). The tiny carbon dioxide bubbles adhere to the surface of objects as observed by the bubbles collecting on the side of the glass. The raisin, being wrinkled, has a large surface area and many crevices where the bubbles may collect. If enough bubbles collect around the raisins, they become bouyant and rise to the surface. Upon hitting the surface many bubbles pop and escape. The raisins may flip over, bounce around, or fall back to the bottom. The variability of the raisins account for some raisins bouncing and some remaining on the bottom. Density, size and surface area vary from raisin to raisin. For example, a very plump, juicy raisin may not bounce at all.

DISCUSSION SUGGESTIONS:

In talking with the children you should help them define a variable as some part of an experiment that may vary or change and a constant as some part of an experiment that remains constant or stays the same. Some variables in this task are: the amounts of water, soda, vinegar, and raisins; and the kinds of materials, old raisins, juicy raisins, other kinds of acids. These are examples but you may think of others. After closely observing the task you might discuss how altering the variables might alter the results. You might ask them what effect cutting the raisins in half might have. You could ask them to predict what would happen if they substituted other objects for the raisins. Examples are peanuts, paper wads, moth balls, or buttons. You could discuss the effect of decreasing or increasing the amounts of soda, vinegar, or water. Try to get them to recall their observations. Help them to distinguish between observations and inferences. Ask if they noticed if and where the bubbles collected. Try to develop the relationship between the raisins and the bubbles in illiciting an explanation.

OBJECTIVES:

At the end of the lesson the children should be able to:

1. identify three variables in the experiment.
2. suggest three ways in which the variables might be altered.
3. distinguish between an observation and an inference.
4. predict the effect of leaving out the baking soda.
5. define variable, experiment, constant, and system.
6. predict the effect of altering the number of raisins.
7. predict the effect changing the amount of water.
8. suggest what the results might be if a peanut or something similar was substituted for a raisin.
9. recognize that the parts in the system are reacting with each other.
10. suggest possible reasons to account for the raisins bouncing.

ROLLING CYLINDERS

ORIENTATION:

You will soon observe a science inquiry task being demonstrated for children. At the end of the demonstration you and four children will discuss the lesson for a fifteen minute period. The purpose of the discussion is to help the children discover the possible causes of the phenomenon. In science, explanations of many events can be discovered by making careful observations (evidence) as a means of coming to a reasoned conclusion (inference). You should not tell the children why the event occurred, but guide their discussion so that they can discover possible solutions for themselves.

YOU WILL SEE:

Six sets of cylinders roll down an inclined plane, one pair at a time. The following sequences will be observed:

a. large black cylinder _____, large silver cylinder ____
b. short solid cylinder _____, long solid cylinder ______
c. fat solid cylinder _______, thin solid cylinder ______
d. large solid cylinder _____, large hollow cylinder ____
e. small solid cylinder _____, large hollow cylinder ____
f. can A ____________________, can B ____________________

THE BASIC QUESTION: If both cans weigh the same and are the same size, why does one always win the race?

EXPLANATION:

Theoretically all solid cylinders roll down in the same amount of time. However, in practice there may be small differences due to variations in experimental arrangements. If you race a solid cylinder and a hollow cylinder, the solid cylinder will always win. Characteristics such as weight, length, and material are no so important as the location of the material or "mass". If more mass is located near the center of the cylinder (the axis of rotation), it will roll faster than if it is located farther away. A solid cylinder has more material near the center than a hollow cylinder. The two cans though similar in size and weight have their mass distributed in different locations. The one that wins has its mass near the center.

DISCUSSION SUGGESTIONS:

In talking with the children you might help them identify variables. Some variables in this experiment are length, diameter, material and location of mass (hollow of solid). You might talk about whether the inclined plane is a variable or constant. It could be but we are keeping it constant in this experiment. Don't try to convince the children that all solids roll faster. Let them make their own decisions. However, if one cylinder wins by a very slight margin, you might discuss whether an exact tie is necessary in calling the winner. When discussing the two cans, you might compare them to children riding a merry-go-round (the kind you push). If they sit near the center, it will go faster than if the children sit near the edge.

OBJECTIVES:

At the end of the lesson the children will be able to:

1. define cylinder, inclined plane, variable, hollow and solid.

2. identify three variables related to the cylinder.

3. describe the effects of altering one variable.

4. describe why the inclined plane is a constant in this experiment.

5. predict the effects of having a steeper inclined plane.

6. predict the winner in a series of six races with different kinds of cylinders.

7. predict whether a tennis ball or baseball would win the race.

8. suggest reasons for the similar cans rolling down at different rates.

APPENDIX C

MATERIALS LIST

CARTESIAN DIVER TASK

1000 Milliliter Graduate Cylinder
1 medium size test tube
1 rubber stopper with hole
several large balloons
wide rubber bands
water

BOUNCING RAISIN TASK

Raisins
Baking Soda
Vinegar
Water
8-ounce clear plastic cups
wooden stirs

ROLLING CYLINDERS TASK

Inclined Plane
6 solid cylinders
6 hollow cylinders
2 similar looking cans with mass distributed differently
hollow spheres (optional)
solid spheres (optional)

AUDIOVISUAL MATERIALS AND EQUIPMENT

4 Wollensak Cassette Recorders
Sony 336 Videorecorder
Monitor
Videotape Model
Audiotape Model
52 Audiotape Cassettes

APPENDIX D

WRITTEN MEASURES

CARTESIAN DIVER

Student Code ____________

Please read the questions below and circle the letter of the answer that you think is best.

1. When two or more things go together like a ball and bat you have a/an

   a. variable
   b. system
   c. experiment
   d. object

2. When something changes in an experiment it is called a/an

   a. system
   b. constant
   c. variable
   d. object

3. The cylinder was filled with

   a. air
   b. oil
   c. water
   d. gas

4. When things are pushed together they

   a. get cold
   b. are expanded
   c. are compressed
   d. are variables

5. The test tube was filled with

   a. air and water
   b. just water
   c. just air
   d. neither air nor water

6. The covering on the top of the cylinder was made of

   a. cloth
   b. rubber
   c. paper
   d. plastic

7. When things spread out, they

   a. are compressed
   b. are variables
   c. get hot
   d. are expanded

8. The water in the test tube could

   a. not leave the test tube
   b. not go into the tube
   c. leave the test tube
   d. could go in and out of the tube

9. When air is compressed, it

   a. shrinks
   b. gets cold
   c. expands
   d. gets hot

10. When you press the rubber cover, you cause the air in the tube to

    a. expand
    b. compress
    c. get hot
    d. get cold

11. When you press the cover, the tube inside will

    a. float
    b. rise
    c. pop out of the cylinder
    d. sink

12. If you pull on the rubber cover, the tube might

    a. rise to the top
    b. dive down
    c. sink
    d. fill with water

13. The tube dives to the bottom when you press the cover because

    a. air goes into the tube
    b. water goes into the tube
    c. air goes out of the tube
    d. water goes out of the tube

14. When you look at something in an experiment, you make a/an

    a. observation
    b. guess
    c. hypothesis
    d. answer

15. The tube sinks because it

    a. loses weight
    b. gets hot
    c. gets heavy
    d. gets cold

BOUNCING RAISINS

Please read the question and circle the letter of the answer that you think is best.

Student Code ______________

1. All of the following are variables in the experiment except

   a. heat
   b. soda
   c. raisins
   d. vinegar

2. An observation is something you

   a. guess
   b. feel
   c. see
   d. think

3. If you leave out the baking soda, the raisins will probably

   a. float
   b. stay on the bottom
   c. bounce
   d. flip over

4. The raisins that bounce best are

   a. fat ones
   b. skinny ones
   c. juicy ones
   d. you can't tell until you put them in

5. A peanut will probably

   a. bounce
   b. float
   c. stay on the bottom
   d. act like raisins

6. The bubbles formed when you added the

   a. water
   b. raisins
   c. soda
   d. vinegar

7. The raisins will not bounce if you leave out

   a. part of the vinegar
   b. vinegar and soda
   c. part of the soda
   d. any of the parts

8. What do you think caused the raisins to bounce?

   a. the raisins themselves
   b. vinegar
   c. sugar
   d. the bubbles

9. If you change paper wads for the raisins, you have changed a/an

   a. variable
   b. the answer
   c. inference
   d. science

10. The part of the experiment that does not change is called a/an

    a. variable
    b. system
    c. constant
    d. observation

11. The bubbles will not form if you

    a. use salt instead of soda
    b. add more raisins
    c. use nuts instead of raisins
    d. add extra vinegar

12. When you look at something and decide what it means, you make a/an

    a. inference
    b. observation
    c. system
    d. variable

13. The raisins bounce if you leave out the

    a. vinegar
    b. some of the water
    c. soda
    d. water and soda

14. When two or more things fit together like the wheels and handlebars of a bicycle, you have a

    a. variable
    b. object
    c. experiment
    d. system

15. If you have a guess about something and try to test it, you have a/an

    a. experiment
    b. object
    c. system
    d. variable

ROLLING CYLINDERS

Student Code__________

Please read the questions and circle the letter of the answer that you think is best.

1. When something in an experiment changes, it is called a/an

   a. system
   b. constant
   c. object
   d. variable

2. In this experiment the inclined plane was a/an

   a. system
   b. constant
   c. variable
   d. hypothesis

3. Something that is long and round like this is a/an

   a. sphere
   b. cylinder
   c. circle
   d. rectangle

4. Things that go together like the cylinders and the inclined plane are a/an

   a. variable
   b. observation
   c. system
   d. constant

5. If something has a hole going all the way through the center, it is

   a. hollow
   b. a sphere
   c. a cylinder
   d. solid

6. If the incline were higher or steeper, the cylinders would roll down

   a. faster
   b. slower
   c. at the same time
   d. together and tie

7. The part of the experiment that we did <u>not</u> keep constant was

   a. the starting time
   b. the distance the cylinder rolled
   c. the size of the cylinder
   d. the height of the incline plane

8. The winner of the race will usually be a

   a. hollow cylinder
   b. solid cylinder
   c. fat cylinder
   d. thin cylinder

9. When we race the cylinders down the incline to see which one will win the race, we are <u>not</u>

a. experimenting
b. making observations
c. measuring a constant
d. looking at a system

For each pair of cylinders below mark the one that you think would win the race. Check both if you think they will tie. A colored end means the cylinder is solid.

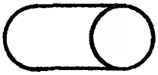
10.  ______  ______

11.  ______  ______

12.  ______  ______

13.  ______  ______

14.  ______  ______

15.  ______  ______

APPENDIX E

SERVO-CHART PLOTS OF WAIT-TIME

SERVO-CHART PLOT EXAMPLES

CHART I

Chart I is a sample of short wait-time I and short wait-time II. This example is typical of the dialogue patterns found in teaching Session 1. As can be noted from the plot the teacher allowed very little time for wait-time II. Frequently the teacher interrupted the student before his conversational sequence was completed resulting in the pen not dropping back down to the base line. These actually represent no wait-time. The mean lengths of wait-time I and II for this subject are 0.94 and 0.62 respectively.

CHART II

Chart II is the wait-time plot demonstrating the desired criterion for wait-time II. Wait-time I is greatly extended from Session 1 but does not reach criterion. The two charts were drawn from the same teacher subject. Chart II occurred after treatment during Session 3. The mean length of wait-time I is 2.25 seconds and wait-time II is 4.76 seconds.

CHART III

This chart is a sample of dialogue taken from the model that was used for treatment. The mean length of both wait-time I and II exceeded the criterion level of 3.0 seconds.

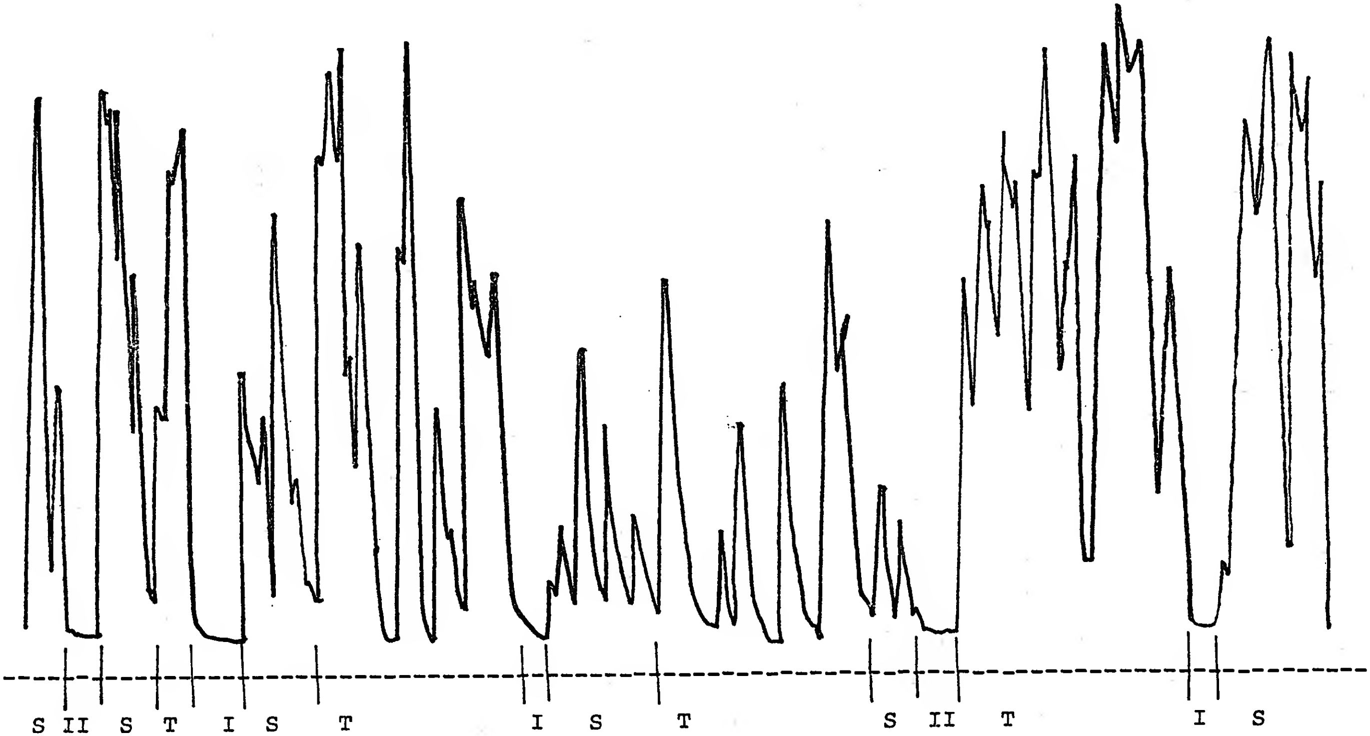


CHART I

SHORT WAIT-TIME
(--) = one second

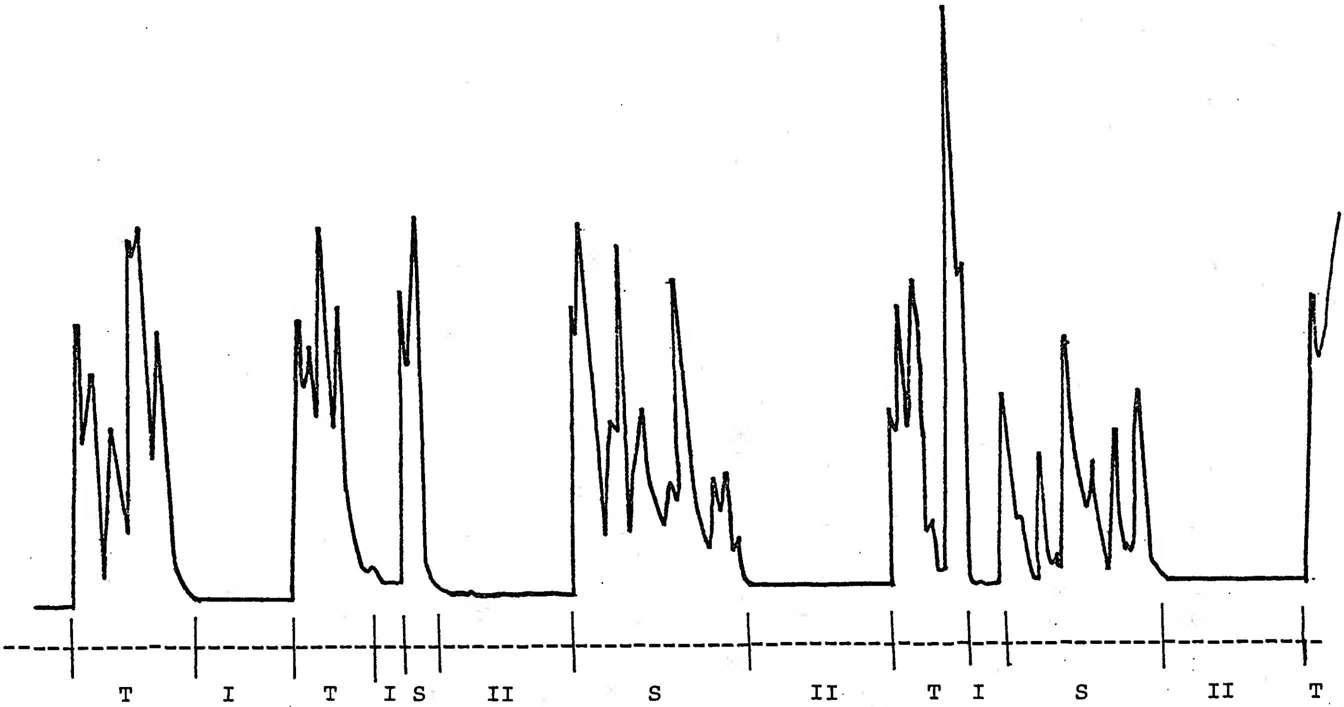


CHART II

LONG WAIT-TIME
(--) = one second

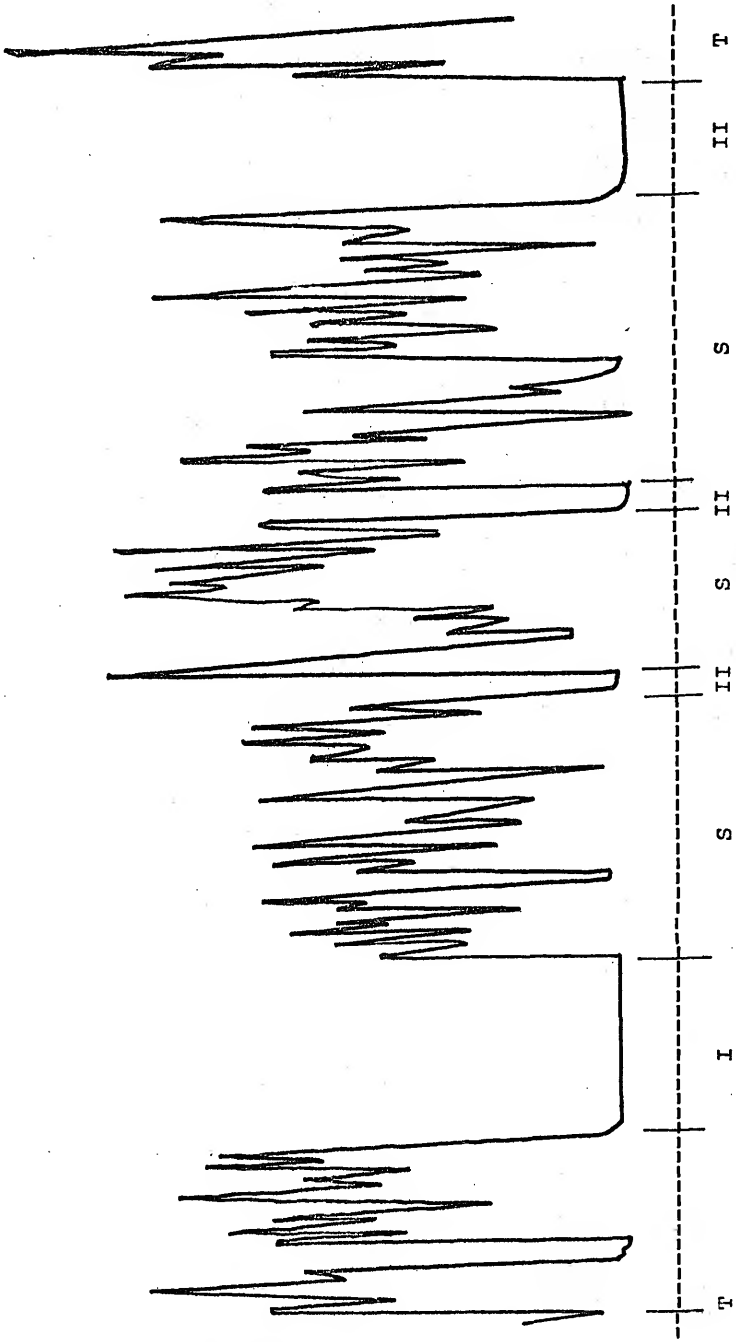


CHART III

APPENDIX F

VARIABLE DEFINITIONS

VARIABLE DEFINITIONS

The variables in this experiment are defined below. If the calcualtion of the variable is not part of the definition, the method of calculation is descirbed also. They appear in the order in which each is referred to in the hypotheses.

Wait-time I: the time between when a teacher stops talking and the student begins to speak. If the teacher pauses and the asks another question and pauses again, the two pauses are summed. Wait-time I is calculated by tallying the total number of seconds measured on a chart recorder for a given period of time that the teacher pauses and dividing by the number of conversational sets. A conversational set consists of a teacher-student exchange.

Wait-time II: the time between a students response and a teacher intervention. If one student begins a response and another also responds before the teacher breaks the conversational set, the pauses between the children's responses are summed. Wait-time II is calculated like wait-time I.

Mean length of teacher talk: MLTT is determined by summing the seconds the teacher speaks during a given time period and by dividing by the total number of exchanges for that given time period.

Mean length of student response: MLST is determined by summing the seconds that one or more students speaks during a given time period and by dividing by the total number of exchanges for that time period.

Proportion of teacher talk: PTT is measured as a percent of the time that the teacher occupies the speak-space in a conversational set. The percent is determined by dividing the total number of seconds for the time period that the teacher talked by the total number of seconds and then multiplying by 100.

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BIOGRAPHICAL SKETCH

Linda R. DeTure was born in Birmingham, Alabama, but moved with her family to Naples, Florida, in the fifties. She enjoyed the South Florida sun and water while growing up. Upon graduating from high school, she entered Florida State University and earned a Bachelor of Arts degree with a major in microbiology.

In 1965, she married Francis A. DeTure and they relocated in Gainesville, Florida, where he attended medical school and she worked as a clinical chemistry technologist before beginning a teaching career. While teaching high school biology and chemistry she earned a master's degree in education and began a doctoral program. As a graduate student at the University of Florida, she taught science methods in the Childhood Education Program.

The DeTures have two children, Michael Anthony and Christopher Nicholas. In 1975, they moved to Bethesda, Maryland, for Francis to fulfill his service obligation at the National Naval Medical Center. In Maryland she completed her Doctor of Philosophy degree with a major in curriculum and instruction and began working as the Science Coordinator for the Learning Resources Center at the University of Maryland Baltimore Campus.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

John J. Koran, Jr., Chairman
Professor of Curriculum and Instruction

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Mary Budd Rowe
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the College of Education and to the Craduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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