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A STUDY TO DETERMINE THE EDUCATIONAL IMPACT OF AN INDUCTIVE LEARNING STRATEGY ON SECONDARY VOCATIONAL STUDENTS

by

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ABSTRACT

A STUDY TO DETERMINE THE EDUCATIONAL IMPACT
OF AN INDUCTIVE LEARNING STRATEGY
ON SECONDARY VOCATIONAL STUDENTS

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The major purpose of the study was to measure the impact of an inductive learning strategy on students from secondary, vocational classes. In order to determine the impact of this thinking strategy, two groups of teachers and students were selected. The experimental group consisted of eight teachers and ninety-five students, grades nine through twelve. The control group was formed by twenty-one teachers and two hundred and fourty-three students, grades ten through twelve. The experimental group teachers were given instruction by the researcher in the use of the Inductive Learning Strategy at a two-day workshop. These teachers then used the strategy a minimum of four times over a six week period. The control group teachers were given no special instruction and did not alter their teaching methods.

Testing instruments were selected for pre- and post testing the students and teachers in both groups to determine the effects of the strategy on inductive thinking skills. From the data it was learned that:

1. the students in the experimental group were younger than the the control group students.
2. there were more female students in the control group.
3. the control group students were in higher grade levels.

4. the control group had a higher number of students from the Business Education area; while the experimental group had a greater number of students from the Human Services and the Applied Technology areas.

5. the students in the control group had a higher mean gain score on the post test than the experimental group students. This gain was statistically significant at the .001 level.

6. as the students' grade levels increased, the more significant was the difference in their mean gain scores.

7. the experimental group teachers had a statistically significant increase in their inductive thinking abilities from the pretest to the post test.

8. the control group teachers took only a post test. On this test for inductive thinking abilities, the control teachers received a higher mean percentile than the experimental teachers earned as a mean percentile on their post test.

This dissertation is dedicated to Bob, Laurie, and Pat for their unselfish love; it is my hope that their dreams will also become a reality.

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CHAPTER 1

> Probably nothing has been more consistently pursued yet seemed more elusive than has the teaching of thinking. From the earliest days of educational writing, philosophers, social reformers, and educators have been trying to find some way of improving the ways human beings process information and solve problems. Thus, there are many models for the teaching of thinking. (Joyce & Weil, 1972, p. 123)

One of these models was developed by Hilda Taba (1962), a curriculum theorist who was, according to Joyce and Weil (1972), known for her sophisticated work with social studies curriculum. They suggest that it was Taba who "popularized the term teaching strategy" (p. 123) during her work in the 1960's with the Contra Costa School District. Joyce and Weil found Taba's work on the study of thinking to be significant and devoted a section of their book, Models of Teaching (1972, 1980), to her teaching strategies which focus on the learner's ability to process information.

Taba developed a series of teaching strategies designed to stimulate inductive mental processes. The Inductive Learning Strategy used by the researcher for this study was adapted from one of Taba's models of inductive thinking.

Inductive learning is an educational situation or environment that asks the learner to reason from the particular to the general or from the part to the whole. Inductive thinking or reasoning can be thought of in comparison to deductive thinking. Deductive thinking asks the learner to reach a conclusion by reasoning from the general to the specific.

The Inductive Learning Strategy used in this research is one of four teaching strategies presented to vocational education teachers in a workshop titled the Vocational Instruction Delivery Educational Opportunity Series (VIDEOS). This particular strategy focuses on group interaction and gives the teacher a structure within which to act as a facilitator for learning. Johnson and Milanovich (1978) describe the goals of the VIDEOS Program in the following way:

> . . . to help vocational educators become better teachers and to increase the possibility for developing self-reliant, cooperative students who have insights, basic competencies, and attitudes to meet job responsibilities successfully. This is accomplished by developing in vocational educators instructional techniques that they can use to enhance the student's ability to master high order concepts and theories, and to make generalizations with facts they have been taught. The development of these skills is the central purpose of the workshops. (p. 3)

The VIDEOS Workshop introduces teachers to a series of strategies which help learners to understand their own cognitive thinking patterns. Rather than concentrating on specific facts, the students learn how to mentally process information. W. Robert Houston (1977), in his Forward to the VIDEOS Modules, suggested that effective teachers are those who have learned and incorporated into their teaching plans a wide range of techniques and strategies. He encouraged teachers to consider the use of VIDEOS materials as a means of increasing effectiveness. "This set of instructional modules," Houston wrote, "provides an effective and efficient means for teachers of vocational education to learn the basic elements of four important teaching strategies, to view teachers using them, and to try their own skills in the process" (Geer & Milanovich, 1977, p. 11).

The VIDEOS Workshop is presented through the use of learning modules, video tapes, and group instruction. The learning modules contain a step-by-step explanation of each strategy. The video tapes show examples of the strategies being conducted in the classroom by teachers in various areas of vocational education. During the workshop, each strategy is presented to the teachers by involving them as learners in an actual strategy lesson. The modules and video tapes are designed to support and expand the learning which has taken place during the presentation (Geer & Milanovich, 1977).

The VIDEOS Workshop was first developed in 1976 and has been presented to vocational educators at the secondary and post secondary levels in five states and Puerto Rico. After its development, the VIDEOS staff conducted a research study in 1978 to measure student awareness of the mental processes involved in the four VIDEOS strategies. According to Norma Milanovich (1980), director of the research study, the number of vocational students participating in the study was not sufficient to accurately measure the learning effectiveness of the strategies. There has been no other study undertaken to determine the impact of the VIDEOS Workshop instruction on teachers or students.

Thus, the present study was designed to measure the educational impact of the VIDEOS Program on students. This researcher selected the Inductive Learning Strategy for the study because the mental tasks necessary for inductive thinking were more readily identifiable and able to be measured than those mental tasks involved in the other strategies used during the VIDEOS Workshop.

Statement of the Problem

The study sought to answer the question, "Does the Inductive Learning Strategy have a significant educational impact on students in secondary, vocational classes?" The VIDEOS Project was initiated and funded in 1976 for the specific purpose of developing autonomous, critical thinking abilities in vocational high school students. The main objective for this teacher inservice program has been to increase vocational students' mental skills.

Since the 1978 research study conducted by the VIDEOS staff did not yield accurate results, another study would be necessary if the workshop's impact on vocational students was to be determined. One of the problems experienced by the 1978 research team, according to the research director, was the difficulty in dealing with all four learning strategies. Therefore, this researcher selected to measure the students' abilities in only the inductive series of mental tasks.

The VIDEOS Workshop is presented to vocational teachers for the eventual benefit of students. A study was necessary to determine what educational impact, if any, could be measured at the student level.

Research Questions

This study sought to provide information to answer the following research questions and hypothesis. These questions consider the possible differences in student performance due to their age, sex, grade level, and vocational subject area.

1. What are the differences between the experimental group and the control group students in age?
2. What percentages of males and females are represented in the experimental group and the control group?

3. What are the differences in grade level for students in the experimental group in comparison to the students in the control group?

4. How do the vocational subject areas of the students in the experimental group compare to the vocational subject areas of the students in the control group?

Hypothesis

H_0: There will be no significant difference between the mean gain score of the experimental group students and the mean gain score of the control group students at the .10 level of significance.

H_1: There will be a significant difference between the mean gain score of the experimental group students and the mean gain score of the control group students at the .10 level of significance.

Need for the Study

Accountability at the level of the learners is an important part of the educational process. Today more so than in the past, it seems necessary to show evidence of the specific learning outcomes from an educational program in order to gain support and maintain funding. To determine what effect the VIDEOS Inductive Learning Strategy had on vocational students, a measure of the change in the students' abilities to perform mental tasks needed to be conducted. Since 1977, approximately twenty VIDEOS Workshops have been presented to over two hundred vocational teachers and teacher educators. The results of this study will be used for possible modifications of the Inductive Learning Module and the accompanying workshop presentation.

Another need for this study was the identification of a testing instrument for inductive thinking skills. The VIDEOS staff had not located nor developed a measurement which was both valid and reliable

for secondary, vocational students. Thus, part of the researcher's task was to identify an evaluation device that measured the student's ability to categorize, interpret data, and/or generalize and infer.

Significance of the Problem

This study was designed to measure the educational impact of one of the teaching strategies as a first step toward evaluating the impact of the entire series of strategies presented in the VIDEOS Program. The results will form the basis for the measurement of all the VIDEOS strategies. The testing instruments used for both teachers and students in this study will be considered for future use with workshop participants.

The results of the study may be generalizable to secondary students in vocational classes in the South Central Michigan Area. The methods and research design could be used as the basis for additional studies conducted by the VIDEOS staff.

Basic Assumptions

This study was based on the following assumptions made by the researcher:

1. That students learn to apply the inductive thinking process by experiencing an Inductive Learning Strategy.
2. That the strategy's impact on student behavior can be measured after a minimum of four exposures to the strategy.
3. That a test which measures a student's ability to use information and interpret data also measures the ability to apply the inductive learning process.

Terms and Definitions

The following terms and definitions may be used as a common basis for understanding in this study.

Concept Attainment Strategy - A strategy which results in learning about the nature of concepts and concept building, in discovering new ways to categorize and expand concepts within the environment.

Deductive Thinking (Reasoning) - A process of reaching a conclusion by reasoning from the general to the specific.

Generalize - Drawing a general conclusion, from many specific pieces of information, which is universally applicable.

Inductive Learning Strategy - This strategy is one which helps students develop skills related to labeling, forming concepts of categories, reasoning inductively, and making generalizations and inferences.

Inductive Thinking (Reasoning) - A form of reasoning from the particular to the general, from the part to the whole, and from the individual to the universal.

Inference - A conclusion based on a premise or on specific units of information. An implication.

Inquiry Learning Strategy - A strategy which develops in learners the mental process of inquiry. Learning by asking questions which relate to a problem. Exploring data logically and examining existing relationships.

Learning Process - A specific set of steps arranged systematically to reach a planned learning outcome.

Module - A unit of instruction focusing on one teaching strategy. Each unit contains objectives, a summary of steps, definition of major concepts, framework for conducting the strategy, sample lesson plan, and evaluations.

Strategy - A teaching design with a set course of action and a planned outcome. A strategy describes the kind of learner-teacher roles, the authority relationships, the type of norms which are encouraged, and the learner behavior which is rewarded.

Synectics (Creative Thinking) Strategy - A strategy to develop skills in creative thinking through the use of analogies, both personal and direct.

Litmitations of the Study

This study was limited by the specific concerns listed below which deal with the length of time necessary for exposing a student to a process before it is measurable, the instrument needed to measure the process, and the bias introduced into this study by the researcher.

1. It is not known how long in time or the number of times students must be exposed to a concept or process before it is measurable.
2. There may have been bias introduced into the study by the workshop instructor (the researcher). This researcher is one of the principal authors of the VIDEOS strategies.
3. One test was used for both the pre- and post test to measure the students' inductive thinking levels.
4. Since the students in this study were selected from South Central Michigan area schools, the results may be generalizable only to the students in secondary, vocational programs in this area of Michigan.

Summary of Chapters

Chapter one described the problem of measuring the impact of a specific inductive thinking strategy on vocational, secondary students from selected schools in South Central Michigan. The beginning of the chapter presented a background of the development of the Inductive Learning Strategy and the VIDEOS Workshop from which the strategy was taken. The research questions and hypothesis focus on a measurable change in student inductive thinking abilities. Accountability for learning as a measure of change in the students' abilities was sighted as a major need for the study, along with the identification of an instrument for evaluating this change. The researcher assumed that students can increase their ability to think inductively as a result of exposure to the Inductive Learning Strategy. Also, the researcher

assumed that this change could be measured after four exposures. However, the researcher did realize the limitations in the study. The number of times the learners were exposed to the strategy, as well as the instrument used to measure the students' inductive thinking abilities were seen to be the major limitations.

Chapter two presents a three part review of literature. The first section deals with the historical development of Hilda Taba's theory of cognitive thinking processes which resulted from her research studies. Section two explains the adaptation of Taba's strategies into the Inductive Learning Strategy used in this study. The third section presents a selection of inductive strategies and techniques used by teachers at the elementary, secondary, and post secondary levels.

Chapter three describes the research procedures used to determine the impact of the Inductive Learning Strategy on secondary, vocational students. The methods used for selecting the sample, instructing the teachers in the experimental group, and identifying the instruments used for the teachers and students are also explained. A research design is provided to indicate the flow of events throughout the study from the sampling to data gathering and analysis.

Chapter four presents the data and an analysis of the data for students and teachers in the experimental and the control groups.

Chapter five summarizes the research findings, draws conclusions based on these findings, makes recommendations for further research, and offers the researcher's reflections on this study and its findings.

CHAPTER 2

REVIEW OF LITERATURE

The review of literature for this study is concerned with the development of Hilda Taba's views on the growth of cognitive skills in students. This review is dealt with in three sections. The first looks at the historical development of Taba's theory of cognitive processes. Her ideas concerning the influence curriculum can have on increasing learners' cognitive skills will be considered. This section also reviews Taba's research studies and the development of the teaching strategies used in her research.

The second section of the literature review explains the historical development of the specific Inductive Learning Strategy used in this research study. The final section presents a selection of inductive learning strategies and techniques that have been used by teachers at the elementary, secondary, and post secondary levels.

Historical View of the Study of Thinking

"The past few years have witnessed," reported Bruner and Goodnow in 1956, "a notable increase in [the] investigation of the cognitive processes--the means whereby organisms achieve, retain, and transform information. This increase . . . should, we suppose, be counted as a 'revival'" (p. vii). Along with Bruner and Goodnow, educational theorists such as Suchman, Piaget, Hunt, and Taba became involved in the revived emphasis on the development of an individual's cognitive

skills. Through the work of these theorists and others, the 1960's and 70's saw a growth in curricula which was concerned with the learner's ability to conceptualize, generalize, hypothesize, and to apply present knowledge to new situations.

Autonomous learning, an independence of thinking, became a concern to theorists like Suchman (1962). Tied to this autonomy of the individual was an increasing concern for the unique needs of all students. One critical need of students in the twentieth century was suggested to be organization of and mentally coping with the tremendous explosion of knowledge. Such educators as Postman and Weingartner (1969) explained that the discovery of knowledge has been "explosive" since 1900. Their major concern was for the handling of this overload of information. People need to be capable of determining the meaning of the events in the world in which they live. "In order to survive in a world of rapid change there is nothing more worth knowing, for any of us, than the continuing process of how to make viable meanings" (Postman & Weingartner, 1969, p. 18).

William H. Kilpatrick wrote in 1932 of Hilda Taba's view of education for a changing world:

> Many indeed have been the efforts to deal with the fact of change. That times do shift and new things succeed the old has of course been remarked time out of mind . . . For our author, . . . becoming is what it is, an obvious fact of human experience. Look where we will, . . . our world is constantly in the process of becoming. And the process is one of continuous and cumulative change. (Taba, 1932, pp. xi, xiii)

With her views on change expressed in terms of a person's experience of becoming, Kilpatrick (1932) suggested that Hilda Taba brought educational methods into the modern world by conceiving the role of the teacher to be

a facilitator of learning. He indicated that Taba believed students should become "increasingly self-directing through the responsible application of intelligence to his own experience" (p. xvi). Kilpatrick considered Taba's 1932 work, The Dynamics of Education, to be a significant contribution to the progress of educational thought.

In a later book, Curriculum Development: Theory and Practice (1962), Taba expressed her views on the role of curriculum developers in meeting the educational needs of society.

> Those who work in curriculum development need to look closely at the path they have been following in order to see more clearly where it is leading, to be sure that they are not going toward unwanted destinations, and to chart the possibilities for future ends. Certain ideas and ways of thinking may not have received the recognition due them, and others may have been played up beyond their legitimate worth and role. It is especially important that the theoretical aspects of curriculum development be re-examined because of the strong tendency to assume that the theoretical foundations of our current curriculum are sound and that the difficulties occur chiefly in translating theory into practice. (Taba, 1962, p. v)

It was Taba's belief (1967) that a curriculum which would meet the needs of students in an ever changing world must encourage students to use their increasing abilities on a wider range of content as it applies to an expanding world. Taba (1962) suggested that educational programs be evaluated by their effects on students. Were the changes in student behavior a result of the educational program, and was that resulting behavior the goal of the program? Spalding indicated in 1962 that these were questions of prime importance to Taba in terms of curriculum development.

Taba spent over thirty years of her life studying the effect curriculum had on the cognitive development of the individual. She explained this effect in her 1967 Teacher's Handbook:

> Thinking has long been considered important in curriculum planning. However, this objective has been implemented poorly because there has been insufficient analysis of the skills that thinking involves. This lack of analysis made it easy to assume either that the capacity to think depended on native ability or that it was an automatic by-product of studying certain "hard" subjects, such as mathematics, without regard to how they were learned or taught. (p. 8)

Taba went on to suggest that recent research and curriculum theory supported the idea that thinking can be learned. In order to accomplish this, she (1962) analyzed the specific mental tasks involved in thinking.

In her 1962 research report, Thinking In Elementary School Children, Taba referred to a renewed interest in critical thinking beginning in the early 1930's. An Eight Year Study was begun in 1932, reported Biehler (1974), by a group called the Commission on the Relation of School and College. Aiken (1942) described the purpose of this study as "trying to develop students who regard education as an enduring quest for meanings . . . who desire to investigate, to follow the leadings of a subject, to explore new fields of thought . . ." (p. 144).

In 1933, John Dewey presented his ideas for scientific inquiry which he referred to as an "act of reflective activity" (p. 107). Dewey considered there to be five phases of reflective thought:

> (1) suggestions, in which the mind leaps forward to a possible solution; (2) an intellectualization of the difficulty or perplexity that has been felt (directly experienced) into a problem to be solved, a question for which the answer must be sought; (3) the use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide observation and other operations in collection of factual material; (4) the mental elaboration of the idea or supposition as an idea or supposition (reasoning, in the sense in which reasoning is a part, not the whole, or inference); and (5) testing the hypothesis by overt or imaginative action. (p. 107)

Taba (1932) acknowledged the inspiration she derived from the works of John Dewey who was one of her professors at Columbia. Much of the work in her book, The Dynamics of Education (1932), was directly influenced by Dewey's thoughts on education.

It was also during this time period that Jean Piaget formulated his theories of cognitive development. Taba was impressed with Piaget's work in the area of cognitive processes, even though his theories were not readily accepted in the early stages. Taba (1964) recognized the importance of his theoretical framework for the development of cognitive thinking. Piaget and his colleagues worked for more than fourty years constructing a "broad and highly original theory of intellectual and perceptual development" (Flavell, 1963, p. 1). Flavell (1963) believed that Piaget's work had not been given the recognition it deserved. Taba (1964) concurred with Flavell and gave Piaget and his colleagues credit for making "the chief contribution to understanding the developmental sequence in the growth of cognitive skills . . ." (p. 1).

In the early 1960's, Taba (1964) realized that there were still many unanswered questions concerning the nature of thinking. What had emerged from the theorists was a distinction between "the problems connected with concept formation and those pertaining to strategies by which concepts were related to each other and by which they are otherwise transformed and operated upon" (Taba, 1964, p. 5). These issues were important because Taba (1964) believed that from their resolution would evolve a conception of curriculum, instruction, and the methods needed for an individual's growth in cognitive functioning at an earlier age than even Piaget predicted. In her 1964 study, Taba wrote that "we need

to differentiate what comes about unassisted in cognitive functioning and where assistance and training are needed" (p. 5). Few studies had as yet dealt with the processes and strategies of thought. There was, Taba explained, "no theoretical framework for differentiating the elements of thought and the relationships between these elements" (1964, p. 5).

The study of cognition then began to move toward the identification of styles or modes of thinking. Milton Rokeach (1960) spoke of closed and open systems of thought. He proposed that individuals must be able to evaluate the information which comes to them from the environment surrounding them. Rokeach believed (1960) that each person must be able to distinguish between "the relevant and irrelevant information he receives from every situation" (p. 57). Rokeach went on to explain his idea of an open system:

> [The] extent to which a person's system is open . . . [is] the extent to which the person can receive, evaluate, and act on relevant information received from the outside on its own intrinsic merits, unencumbered by irrelevant factors in the situation arising from within the person or from the outside. (p. 57)

At this same time, Guilford had described convergent and divergent thinking, and Peel (1960) identified four styles of thinking: thematic (imaginative), explanatory (reflective), productive (constructive), and integrative (co-ordinative). He considered the four thinking categories to be educational rather than psychological. Considering the modes and styles of thinking to be new and interesting, Taba (1964) saw no means of translating this knowledge into a method for increasing one's thinking skills.

A few researchers were concerned with thinking strategies for the classroom. Bruner (1956) was working on a concept attainment model which became a fundemental influence on Taba's concept formation ideas. Duncker (1945) introduced some of the first strategies for problem solving. He looked at thinking in terms of a process of restating problems which were either "organic" in nature (from the student's environment) or "mechanical" when the student applies previous knowledge.

Max Wertheimer (1945) promoted the process of productive thinking in terms of specific problem solving strategies. He believed that teachers could exercise the learners' reasoning powers by giving them the appropriate classroom experiences. Wertheimer provided two views of productive thinking: a traditional logical approach and the classical theory of association of ideas. He offered several examples of learning situations though which students could practice the processes of productive thought.

Suchman (1962) studied possible methods for developing autonomous inquiry in learners. He made a distinction between the thought processes which occur when a student "discovers" an idea and when a student inquires about an idea. "Discovery," said Suchman, "is a sudden awareness that occurs under certain conditions . . . Inquiry includes the acts of search and information processing that provide many of the necessary conditions of discovery" (p. 25). One of Suchman's (1962) approaches, which was inductive in nature, asked the learner to use his or her conceptual system for hypothesizing the causal relationships in a situation the teacher presented. His inquiry

training studies involved both the analysis of the thought process and of the strategy of inquiry the students pursued.

Taba viewed the results of these studies as a stimulus toward her desire to explore more fully the connection between the learners' cognitive development and the learning experience. She used the studies on problem solving as a basic set of assumptions for her own research. These studies assumed that:

> The fundemental intellectual activity is that of "discovering" the structure of a problem, its chief principle, and the main causal relationship between events.
>
> In the discovery process there is the possibility both for developing autonomy in thinking and for the transfer of methodology and knowledge. (Taba, 1964, p. 19)

These previous studies and the assumptions that followed them inspired Taba to develop a sequential strategy for teachers that would assist them in the stimulation of the cognitive process of their students.

Taba's research (1964) was based on certain concepts of thinking. She viewed thinking as "an active transaction between the individual and the development of his environment . . . an active organizing and reorganizing of mental schema . . . with which to condense the . . . environmental stimulation and to give meaning to it" (p. 21). From the works of Burt (1931), Issacs (1948), and Wheeler (1958), Taba was convinced that children could reach the stage of formal thinking earlier as a result of training and that the development of this capacity for reasoning came about as a result of practice. Two of Taba's research studies (1964, 1966) were based on the assumption that a cognitive teaching strategy could bring students to higher levels of thinking much earlier and more systematically than could be expected if the

development were left to the standard classroom activities. Taba (1964) concluded:

> . . . how individual's think, then, depends largely on the kinds of thinking experiences they have had and on the degree of autonomy they have acquired in performing a variety of cognitive operations. (p. 34)

During Taba's research, she was driven by the need for a clear conception of the distinct skills that are used for thinking. Her analysis of thinking was both psychological and logical in nature. According to Joyce and Weil (1972), Taba identified three postulates about thinking upon which she based her research. They were that:

1. Thinking can be taught.

2. Thinking is an active transaction between the individual and data. (The material of instruction is learned only when the individual performs specific cognitive tasks which cannot be transferred directly from the teacher to the student.)

3. Processes of thought evolve by a sequence that is "lawful." (In order to master certain thinking skills, specific earlier ones must be mastered first.) (p. 124)

These postulates suggested that thinking skills could be taught if the method or strategy used were designed sequencially for specific cognitive processes.

Taba's initial curriculum development study in 1964 involved twenty classrooms of students from the Contra Costa County Schools in California, grades three through six. The study was intended to measure the change in learners' abilities to infer and generalize. Taba's studies of cognition (1964, 1966) centered on three mental tasks. The first of these tasks was concept formation, which was considered to be the first stage of all cognitive processes. Taba

divided this first mental task into three subtasks: differentiating, grouping, and labeling. The second mental task was data interpretation which included the subtasks of interpreting, inferring, and generalizing. The third task required the application of principles which were based on the student's previously acquired knowledge. These three mental tasks were sequenced into a teaching strategy for training both teachers and students (Taba, 1964).

To examine more closely Taba's three inductive thinking strategies which resulted from her 1964 and 1966 studies, the tasks are presented in Figure 1. Each task represents a stage in the inductive thinking process as Taba described it.

During these inductive thinking strategies, the classroom atmosphere is one of cooperation between the teacher and learners. The teacher initiates the phases and regulates the sequence of activities which follow the strategy steps. As the students learn the steps of the thinking strategy, the teacher allows the learners to assume more control of the time needed in each phase (Joyce & Weil, 1980).

Teaching was previously considered to be categories of operation by Smith (1960) and as a behavior which results from classroom climate and goals by Flanders (1963). Teaching effectiveness was thought to be measurable in terms of student behavior by Aschner (1963) or in relationship to the amount of control or freedom allowed by the teacher (Hughes, 1959). Taba's view of effective teaching was somewhat different and influenced the strategies she developed. Taba (1964) described effective teaching as:

> . . . an extremely complex process which includes a variety of activities ranging from imparting knowledge to asking questions, from setting tasks to organizing

Concept Formation

Overt Activity	Covert Mental Operations	Eliciting Questions
1. Enumeration and listing.	Differentiation.	What did you see? hear? note?
2. Grouping.	Identifying common properties, abstracting.	What belongs together? On what criterion?
3. Labeling, categorizing.	Determining the heirarchical order of items super- and sub-ordination.	How would you call these groups? What belongs to what?

Interpretation of Data

Overt Activity	Covert Mental Operations	Eliciting Questions
1. Identifying points.	Differentiating.	What did you notice? see? find?
2. Explaining items of identified information.	Relating points to each other. Determining cause-and-effect relationships.	Why did so-and-so happen?
3. Making inferences.	Going beyond what is given. Finding implications, extrapolating.	What does this mean? What picture does it create in your mind? What would you conclude?

Application of Principles

Overt Activity	Covert Mental Operations	Eliciting Questions
1. Predicting consequences. Explaining unfamiliar phenomena. Hypothesizing.	Analyzing the nature of the problem or situation. Retrieving relevant knowledge.	What would happen if . . . ?
2. Explaining, and/or supporting the predictions and hypotheses.	Determining the causal links leading to prediction or hypothesis.	Why do you think this would happen?
3. Verifying the prediction.	Using logical principles or factual knowledge to determine necessary and sufficient conditions.	What would it take for so-and-so to be generally true or probably true?

Figure 1. Hilda Taba's teaching strategies for cognitive tasks (1967, pp. 92, 101, 109)

> steps for accomplishing them; from creating models of thought to guiding the discovery of ideas and concepts. . . [She made an effort] to identify the particular learning tasks, and to project teaching strategies focused on these tasks . . . [and] to develop these strategies in terms of the theoretical framework concerning the targets for learning -- in this case, a particular set of cognitive tasks. (p. 47)

Taba (1964) concluded that the previous conceptions of teaching and the methods used for teacher training continually regenerated the most tradition bound teaching styles, which she believed were inadequate for coping with the complexities of the teaching-learning situation in the schools. She suggested that there was a misunderstanding of what effective teaching consisted of and that this lead to greater difficulty in recognizing the most effective means to teach the various cognitive skills. Thus, Taba concentrated (1964) on the patterns and combinations of the teaching act and defined these as teaching strategies. These strategies were conceived as consciously formulated plans for bringing about particular behavior changes in students. Such plans were translated into conditions and activities of learning, arranged into sequences according to the logical requirements of the learning tasks and the psychological requirements of the learner.

In her 1964 study, Taba learned that the role of questioning students was far more important than had previously been realized and that the way a teacher asks questions was:

> by far the most influencial single teaching act . . . that the "seeking" function of a teacher was more important than the "giving" function . . . . Asking questions to which only one "right" answer is possible builds . . . a convergent mind -- one which looks for simple "right" answers and which assumes that the "right" answers depend on authority rather than on rational judgment. (pp. 52, 53, 54)

In 1965, Gallagher found through his research on productive thinking that "the teacher has dominant control over the type of expressive thought presented in the classroom. Such a fact, presents teachers with special opportunities and special responsibilities" (p. 102). Supported by Gallagher's findings, Taba (1967) concluded:

> . . . the sequence of teaching functions and their effect on student performance leaves no doubt that the nature of the questions has a singular impact on the progression of thought in the class. The questions teachers ask set the limits within which students can operate and the expectations regarding the level of cognitive operations . . . Some questions function as invitations to heighten the performance of certain cognitive operations . . . Such questions invite invention, discovery, and the creative use of previous knowledge. Others control and limit both the content and the nature of cognitive operations. Such questions dictate both what the students are to think about and how they are to go about it, thereby limiting, both the level and the nature of thought. (p. 177)

The conclusions Taba made concerning the influence that questions have on learning, suggest that teachers get only what they ask for.

Taba's findings presented some vital information concerning teacher training. She found (1964) that "the usual preference and habit of teachers inclines them to elaborate descriptive information . . . which cultivates passive learning and under-exposes students to active cognitive operations" (p. 61). Taba realized that if teachers were going to cultivate cognitive thought processes in their students, they needed to concern themselves with the active exercise of the process instead of trying to teach the end product of the content. She presented (1964) the following example:

> . . . in connection with grouping and classification, it was necessary to free teachers of the tendency to teach a particular classification which they thought was the only "right" one and thus, in effect, teach schemes of classifications instead of the process of classifying. (p. 64)

Taba (1964) also found that teachers needed to learn to accept the seemingly slow pace of the developing of ideas by students when using the inductive process. Teachers were more familiar with the expository method of teaching and found it difficult not to state the generalization or rule at the beginning of a lesson. She realized that until teachers focused on the thought process, rather than on the answers they were looking for, the pacing of activities and questions which develop the necessary mental skills would seem unproductive and intolerably slow. If teachers are concerned mainly with answers, they find it very difficult to allow students to list the ideas they received from a stimulus before the teachers have done all the listing, interpreting, and explaining for them. She found that when "teachers supply what they should seek from the students, they [teachers] substitute their own thinking for that of the students, and consequently control thought and limit the opportunities for autonomy and self-discovery" (Taba, 1964, p. 66). Taba had learned through her research that in order to develop autonomy in thinking, individuals need opportunities "to organize their own conceptual systems and to develop their skills for independent processing of information" (Taba, 1967, p. 29). In educating teachers for this "new" direction, Taba (1967) tried to help teachers see that learning experiences should be planned so that learners would be allowed to do their own thinking and develop their own personal problem solving skills. She believed that it was necessary for learners to try out their own ideas. Teachers must not give in to the temptation to tell students the answers or solution. Teachers must realize that there could be many solutions to one problem and should allow the students to seek their own answers. The process of thinking, Taba stressed, was more important than the product.

Taba found from her 1964 and 1966 studies with the Contra Costa County Schools that training teachers to view their role in a different way took more than the ten sessions allowed in the studies. That to accurately access the results of training, she believed the ideal situation would be to train teachers during one school year and evaluate their progress during the next year. Since this could not always be done, Taba (1966) set up three criteria for teacher training that must be conducted in a limited time span:

1. Explain the theory behind the training.
2. Allow feedback on the teachers' attempts at performing the strategy.
3. Provide concrete models of the strategy as examples for teachers to use. (p. 67)

She also stressed that a rationale for the training needs to be given in the early stages of the program, along with an explanation for why the teachers need to change their modes of working with students.

What Taba was able to do through her curriculum development research was to provide teachers with a rather clear set of guidelines for the teaching of inductive thinking skills -- which apply to learners of various ages and thinking levels. In these strategies, a major task of the teacher's would be the skillful use of questions that are designed to elicit various stages of cognitive functioning. The teacher's most prominent mental task during the strategy is to monitor the way students process information. It appears essential that the teacher learn to sense the students' readiness for each successive step in these cognitive processes which make up inductive thinking (Joyce & Weil, 1980).

The primary application of Hilda Taba's model for inductive learning has been the development of the individual's thinking capacity.

During these strategies, the learner is asked to process large quantities of information. This information can come from most subject matter areas. It is not limited to the social studies curriculum which Taba worked with. It has been observed that inductive learning strategies are used in Science, English, and Mathematics curricula to name a few and for broad purposes, such as productive thinking and creative thinking (Joyce & Weil, 1980).

Taba's belief in the possibility of teaching people to think was held by other educators. She found strong support in the 1960's for her work from several sources including the National Education Association. Robert W. Reynolds, Committee Chairperson for the 1964 National Education Association's Developmental Project in the Social Studies and Elementary Education Consultant for the California State Department of Education, stated:

> The development of significant concepts and generalizations has as its basis the cultivation of the rational powers of each pupil. The development of the powers to recall and imagine, classify and generalize, analyze and synthesize, deduce and infer, and compare and evaluate leads to the development of the pupil's powers to perceive significant relationships, to achieve personal goals, and to contribute to the management of society. The importance of providing opportunities for pupils to acquire, develop, and practice the skills of inquiry, gather and classify data, and reshape knowledge better to serve the goals of the individual and society is stressed as essential. (1964, p. 34)

In support of his beliefs and those of the committee, Reynolds presented the Education Policies Commission's statement on developing these rational powers he speaks of above. In the Commission's publication called Central Purpose of American Education (1961), the following reference is made:

> A person with developed rational powers has the means to be aware of all facets of his existence . . . He can escape captivity to his emotions and irrational states. He can enrich his emotional life and direct it toward ever higher standards of taste and enjoyment. He can enjoy political and economic freedoms of the democratic society. He can free himself from the bondage of ignorance and unawareness. He can make of himself a free man. (pp. 8, 9)

Hilda Taba's work in curriculum development has been adapted for a variety of needs in classrooms all over the United States. From her original work and the adaptation of her teaching strategies by other educators, inductive thinking strategies have offered students at all levels of education an opportunity to "discover" knowledge on their own. Taba, Piaget, Bruner, Suchman, and others in the area of cognitive skills development have presented their strategies or designs for increased cognitive functioning in learners of all ages and ability levels. Following are examples of the many adaptations of Hilda Taba's inductive thinking strategies. The specific use of an inductive thinking strategy adapted from Taba's work has been basis for this research study.

Development of the Inductive Learning Strategy

The Vocational Instruction Delivery Educational Opportunity Series (VIDEOS) was originated in 1976 with funds from the New Mexico State Department of Education, Vocational Division. The idea for the VIDEOS Program was suggested by two faculty members at the University of New Mexico. The director of New Mexico's Vocational Education Division requested a proposal be written to address the specific needs of the State's vocational teachers. A major goal was indicated as the need for increased student involvement in learning. The teachers in the

State were in isolated areas (geographically) where professional development was seldom possible. Thus, the proposal had to address the student learning needs while answering the problem of teacher access.

The project was originally funded under the title of the Vocational Instruction Delivery System (VIDS). The co-directors were the two University of New Mexico faculty members, Norma Milanovich and Carol Geer.

The proposal called for the development of an audio-visual workshop that would travel to three university locations in the State. During the first year of the project, workshops were offered at the University of New Mexico (Albuquerque), Eastern New Mexico University (Portales), and New Mexico State University (Las Cruces).

Four teaching strategies were selected to be presented in the workshop. The strategies selected were Concept Attainment, Inquiry Learning, Inductive Learning, and Synectics (Creativity). Sample lessons were created and workshop materials prepared which would assist the participants in the rapid assimilation of these strategies into their classrooms. Competency-based learning modules were written to assist teachers in the use of each strategy.

Video taped samples of each strategy were produced to be used in the workshop as an instructional technique. Master teachers in each area of vocational education were identified and invited to take part in a set of intensive training sessions. Each teacher was video taped teaching two of the four strategies. Students from their classes were used for these video tapes. The resulting tapes were incorporated as part of the instruction for the workshops.

The workshops were first offered in the Spring of 1977. Figure 2 represents a sample of the typical workshop design used during that first year of the program. Approximately fourty-five secondary, vocational teachers and seventy-five teacher educators and state educational representatives took part in workshops and conferences during this initial year.

In June of 1977, the workshop was given a new title which was more representative of the audio-visual nature of the workshop: Vocational Instruction Delivery Educational Opportunity Series (VIDEOS).

Continuous evaluation and revision took place during the first two years of the project. Teachers who were participating in the workshops were asked for suggested changes -- ideas that would make the materials more understandable and useable by teachers. The learning modules have been revised five times as a result of these evaluations. The VIDEOS Workshop has been offered as a professional development opportunity for teachers in Florida, Michigan, Nevada, Texas, Wyoming, and Puerto Rico.

A Selection of Inductive Learning Strategies and Techniques

There are several examples of inductive learning situations at all levels of education and in almost every subject area. Following are examples of inductive thinking integrated into the curriculum of elementary, secondary, and post secondary learners. In all of these examples, the instructors are striving to offer the learners a personal experience with the subject matter. Ole Sand (1971), director of the National Education Association's Center for the Study of Instruction, suggested that students only learn by experiencing:

VOCATIONAL INSTRUCTION DELIVERY EDUCATIONAL OPPORTUNITY SERIES
NEW MEXICO WORKSHOP DESIGN FOR TEACHER TRAINEES

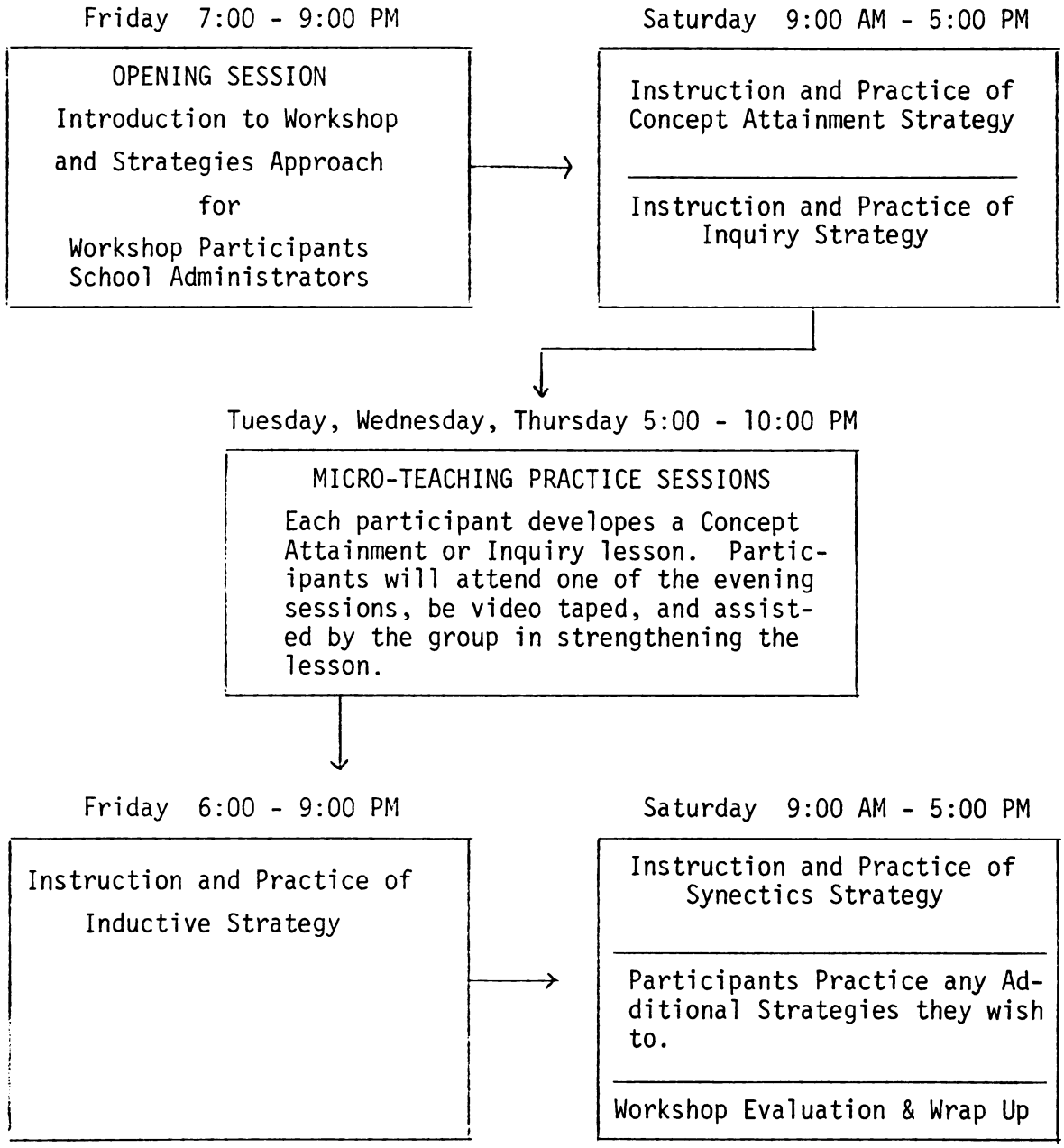


Figure 2. A typical VIDEOS Workshop design used from 1977 - 1979.

> Like blowing one's nose, [knowing] cannot be done by proxy . . . We must understand and define the nature of the educational experience toward which we hope to guide students. We cannot, on the one hand, have that experience for them; nor can we accept dates, names, and mental facility for associating quotations with characters as proof that the student has had the experience. (p. 21)

One common goal that educators share for students involved in discovery learning is well expressed by Sand (1971) as he described the goals of historical inquiry. Sand believes the student has grasped the nature of inquiry when:

> His curiosity has been aroused, his mind jostled, his understanding nudged; in a small or large way he has become a historian, and all the dates he failed to memorize are not one-tenth as important as the relationships he is now capable of investigating for himself. (p. 21)

Hosen (1976) suggested an instructional strategy which would motivate learning and increase the retention of economic principles by college students. He believed that to introduce the undergraduate student to the abstract concepts of economics at the beginning of the course caused many students to panic and begin memorizing everything instead of understanding. "Students frequently are unenthusiastic about introductory college economics courses and retain over time little of what they learn" (p. 125).

What Hosen found was that it seemed best to "start not with the abstract concept of the 'investment multiplier' but with something as concrete as the building of the Astrodome" (p. 125). He started by asking questions concerning a concrete, familiar situation, event, or problem. The questions were designed to lead students to a solution for the problem posed. As Hosen explained:

> . . . this is a strategy which attempts to produce an inductive acquisition of theory. Students are free to raise issues in which they are interested and it is the task of the instructor to utilize class time to bring out the principles relevant to understanding the issues. (p. 126)

A course taught with this inductive approach, Hosen believed, could offer students a "generalized ability to analyze economic phenomena" (p. 126). Because the atmosphere was one of cooperative problem solving, students were more likely to be involved with economic analysis which could be transferred to other current economic issues and events (Hosen, 1976).

Thomas R. King (1964), considered the most effective way to begin a course in the basic principles of public speaking was to use an inductive opening exercise. King believed this process could be used for elementary and secondary students, as-well-as college students. An inductive technique was used to point out to the students the qualities of effective communication. Using this method, the principles become evident -- they are realized by the learners without the instructor "telling" the students. King described the procedure to follow and gave suggestions for the adaptation of the technique for all levels of learners.

The teacher starts the exercise by asking the students to get out pencils and paper. The teacher then asks one of the students to tell the rest of the class how to draw the geometric figure on a card the instructor has given him/her. The figures on the cards (prepared in advance) range in complexity from simple ones used early in the lesson to more difficult ones used later.

By using gestures, descriptions and labels, and specific instructions, the speaker attempts to get the audience to draw a figure that is identical

to the one on the card. The speaker is not allowed to show the figure on the card to the audience or draw the figure on the chalkboard. The audience does not talk to the speaker or show him/her what they have drawn.

After the speaker finishes, the teacher shows the audience the original figure, and they all compare their drawings with the original. This exercise is done again several times with different figures until the students are able to recognize which speakers have communicated most effectively with their audience. It is at this point that the teacher steps in to assist students with a verbalization of the principles of effective oral communication. King suggests the teacher ask a series of questions that will lead the students inductively toward the development of these principles or that the students be divided into buzz groups. The students are then instructed to list several reasons why some of the speakers communicated better than others. When this task is completed, King asks the students to draw a model or diagram of what had occurred during the speeches. While doing this, the students discover most of the principles usually developed by the teacher in lecture.

Through this inductive excercise several of the following principles of speech were generally recognized by the students: 1) organization improves comprehension, 2) the need for repetition in oral communication, 3) use of effective gestures, and 4) concern for audience (King, 1964).

Jerald Foster (1978) described himself as "a devoted addict of inductive methodology" (p. 926) who often finds himself awake at night dreaming up ways to introduce literary concepts to his university students.

He presents topics to his students in a way that has them discovering for themselves the concepts to be discussed. Foster achieves this goal by first assigning selected readings to give the students sufficient background. At the next class session, Foster shows samples of art work, music, and architecture representative from many areas of the Western World. He allows the students time to examine them and then asks what similarities the students see between the various samples from that time period. "Invariably," Foster stated, "they are able to list those characteristics which have been considered by most critics to be reflections of the times" (p. 926). He also pointed out that since the students do not know what they are "supposed" to see, they often suggest unique characteristics which are not listed by the critics.

Once the students have discussed the general characteristics of that literary period, Foster brings out samples from another part of the world created during that historical period. The students compare and contrast these with the previous works. This allows the students to see the similarities in art forms as well as their unique differences. Usually a discussion is stimulated and a re-evaluation of the characteristics originally listed. During the following class periods, Foster invites guest lecturers in Music, Art, and Architecture to offer their perspectives on the period under study.

Foster explained that the inductive method he uses has limitations, but he believes that the teacher can compensate for these by using other methods along with induction. Foster strongly promoted the use of inductive learning and stated that he had "found it to be one of the best ways of stimulating student involvement" (p. 927).

John Steinkamp (1970) described the early 1970's as a "period of seemingly revolutionary change. What we teach one day may be irrelevant knowledge, and the perceptive teacher finds himself re-evaluating his role" (p. 99). Steinkamp characterized this role of teacher as one who "not only presents facts but also creates an atmosphere which engenders the exchange of ideas and judgments" (p. 99). In his article, The Demands on the History Teacher Using the Inquiry Method (1970), Steinkamp offered suggestions for using the inductive approach with high school students. He emphasized the importance of lesson plans that center on a sequence of questions. A lesson can easily "revolve around one or two basic questions" (Steinkamp, 1970, p. 100) which relate to the topic being studied. The teacher and students must be well informed. With the inductive approach, issues are discussed between the students -- not for the benefit of the teacher. The teacher is the moderator and questioner. He suggested printing up basic questions from the current textbook and placing these around the room as a constant reminder of the topic being studied. Steinkamp also advised that test questions be given to the students in advance to assist them with notetaking and studying.

Steinkamp indicated that the student's feeling and attitudes are extremely important to the success of the teacher using the inductive method. "For a meaningful exchange of ideas," he suggested that "an atmosphere of mutual respect must be developed and the teacher must encourage genuine open-mindedness" (p. 101). When using this method, a teacher must take on the specific role of the patient questioner.

Seifman (1973) spoke of a teacher who involved a fourth-grade class in an inductive learning experience during a review of a test on geographic

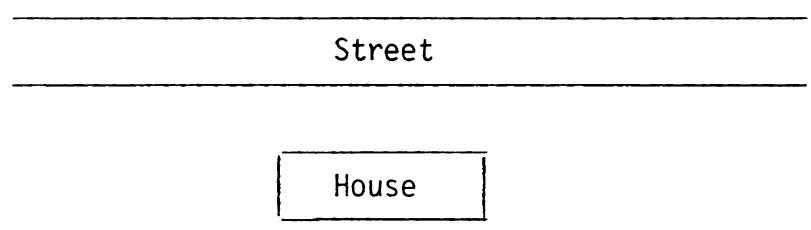
concepts. He observed the teacher using an inductive teaching strategy to enable a student to discover the "correct" answer to the test question: "The sun rises in the East and sets in the West" (p. 289). After determining that the student did believe that the question was false, the teacher used a series of questions to help the student realize the "correct" answer. The following dialogue ensued:

Teacher: Now Lysa, let's see if we can help you see where you went wrong with this question. O.K.?

Student: (Student nods in acknowledgement.)

Teacher: Lysa, can you come to the chalkboard, draw your street and locate your house on that street?

Student:

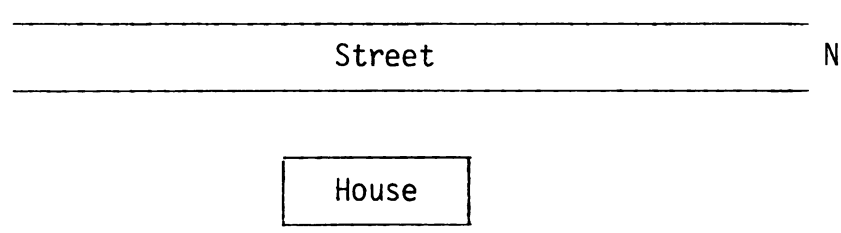


Teacher: Very Good! Now, Lysa, do you happen to know which direction would be North?

Student: Yes, the street is a North-South street and North would be here (pointing to the right.)

Teacher: Good. Then write "N" for North there.

Student:



(Seifman, 1973, p. 289)

The teacher continued to question Lysa in this manner until the street map had all the directions written on it. This process took only a few minutes and the class continued to look on with a great deal of interest.

Teacher: O.K., now Lysa, when you get up in the morning and look out of your window, where do you see the sun?

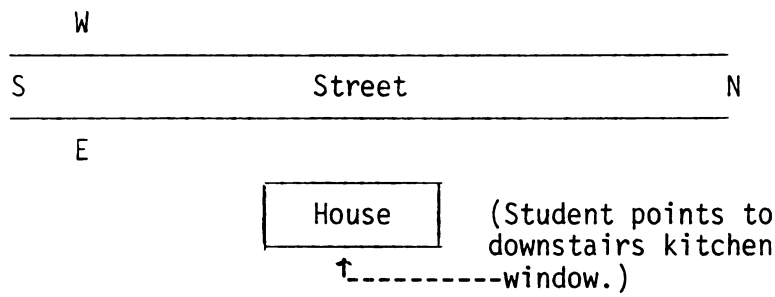
Student: I don't really see the sun in the morning from my room because my room only has windows on the North side of the house. (Student points to "my windows.")

Teacher: Well then, when do you see the sun in the morning?

Student: When I go downstairs to eat breakfast. I can see the sun when I look out of the windows in the kitchen---in the back of the house.

Teacher: Very good! Now can you show us on this map of yours which window you can look out of in the morning and see the sun?

Student:



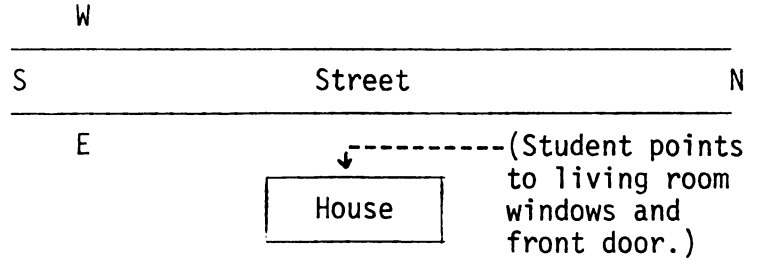
Teacher: Good. Now when it's late in the day and beginning to get dark as the sun sets, through which window do you see the sun?

Student: (Hesitating.) Well . . . in the evening I can see the sun by looking out of the living room windows or the front door in the front of the house.

(Seifman, 1973, p. 289)

Teacher: Can you locate this on your map?

Student:



Teacher: Excellent! Now then, Lysa, when you wake up in the morning and look out of the window and see the sun, in what direction is the sun?

Student: East.

Teacher: And in what direction is it in the evening?

Student: West.

Teacher: Very good! Then you see, Lysa, that's what question number two was all about. You see, you have been able to figure out for yourself, "inductively" (the emphasis was the teacher's), what the correct answer is; and now you have a "concrete" way of remembering this basic geographic fact that the sun rises in the East and sets in the West.

(Seifman, 1973, p. 298)

According to the observer (Eli Seifman), the teacher was very pleased with this "ideal," spontaneous use of inductive teaching. Lysa, however, returned to her seat looking a little unhappy and was mumbling something to herself. The rest of the class was very impressed with their teacher. Seifman decided to get Lysa's reaction to this "impressive" use of inductive learning, and asked Lysa what she had said as she returned to her seat. She replied as follows:

> The sun doesn't rise and set, the earth rotates! You see, the apparent motion of rising and setting is one thing, but the real rotation of the earth on its axis from West to East is something else! (p. 298)

Lysa appeared to have a deeper understanding of the sun's movements than even her teacher realized. The lesson in this, suggested Seifman (1973), for all educators seems to be that enthusiasm for what we consider exciting teaching can sometimes make us lose sight of the purpose behind the method. He expressed his concerns:

> Sometimes we become so caught up in our technique that we lose sight of our real objectives . . . To the extent that we educators sometimes allow concern with technique to predominate teaching-learning situations we run the risk . . . of confusing the "apparent" with the "real." When this occurs, inductive teaching (or any other teaching strategy) may easily become seductive teaching. (p. 298)

Joyce and Weil (1978) make the same point as they described a model of teaching as a "flexible, fluid instrument" (p. 8) which should be adapted to the needs of the subject matter and the students. They viewed the role of a teaching model as one which creates an "environment from which students are likely to learn certain kinds of things" (p. 8). To bring their point home, Joyce and Weil (1978) used the following analogy:

> There is an old saying that fencing coaches preach to their students: Treat the sword like a bird. If you hold it too tightly, you choke it! If you hold it to loosely, it will fly away! So it is with a model of teaching. If one uses it too rigidly, it becomes a blunt instrument. If one holds it too lightly, it dissolves and becomes undistinguishable from any other method of teaching. It fails to do its work! (p. 8)

CHAPTER 3

RESEARCH PROCEDURES

Included in Chapter three are a description of the population and sample, the research design and instrumentation, and the procedures used to collect the data.

Population

The population consisted of students in grades nine through twelve enrolled in secondary, vocational classes in South Central Michigan.

Sample

Teachers and students from secondary, vocational classes were identified as willing to take part in the research study. A personal request was made by the researcher to school administrators for assistance in locating the necessary number of teachers. A written flyer was sent to vocational teachers through their school district or principal's office. This flyer described the Inductive Learning Strategy Workshop to be presented to the teachers who consisted of the experimental group.

The initial results of the teacher recruitment yielded 12 vocational teachers for the experimental group. These teachers were willing to take part in the workshop and subsequent research. Each teacher was asked to select one of his or her classes to become the research subjects.

Twenty-eight additional teachers volunteered to form a control group. These teachers selected one of their vocational classes to be

the control group students. The control group teachers would only be required to pre- and post test their students. All of the teachers and students in this study came from the South Central Michigan area.

At the beginning of the study, there were 171 students in the experimental group. There were 430 students in the control group. It was the intention of the researcher to have at least twice the number of students in the control group as in the experimental group, in order to match each student in the experimental group with a student in the control group based upon selected variables.

A manual method was used to match the students in the experimental group with students in the control group. This was accomplished by making a list of the experimental group students in rank order according to their pretest score on the selected inductive thinking instrument. A similar list was made for the students in the control group. The pretest score was used as the first priority in the matching of students because it represented the student's initial information processing skills.

Once the students in both groups were ranked by pretest score, each student from the experimental group was matched with a student from the control group with the same score and in decreasing order of priority by their age, sex, grade level, and vocational subject area. Post test scores were not considered in the matching process. Table 1 represents the pretest scores and the distributions for both the experimental and the control group students. From Table 1, it can be observed that the maximum raw score for students in both the experimental and control groups was 37 on the pretest. The range of pretest scores for the experimental group students was from nine to thirty-seven. There was a range of scores from 10 to 37 for the control group students. The mean score

Table 1

A Comparison of Pretest Scores for the Experimental Group and the Control Group Students

(N = 190)

Raw Score Maximum Score = 37	Experiment Group Students Frequency	Percent	Control Group Students Frequency	Percent
9	1	1.1	0	0
10	1	1.1	2	2.1
11	1	1.1	1	1.1
16	1	1.1	1	1.1
17	1	1.1	1	1.1
18	2	2.1	2	2.1
19	1	1.1	4	4.2
20	7	7.4	2	2.1
21	2	2.1	2	2.1
22	0	0	3	3.2
23	2	2.1	1	1.1
24	3	3.2	3	3.2
25	3	3.2	3	3.2
26	4	4.2	4	4.2
27	3	3.2	3	3.2
28	4	4.2	5	5.3
29	9	9.5	8	8.4
30	6	6.3	6	6.3
31	5	5.3	5	5.3
32	10	10.5	10	10.5
33	4	4.2	4	4.2
34	10	10.5	10	10.5
35	4	4.2	4	4.2
36	6	6.3	6	6.3
37	5	5.3	5	5.3
TOTALS:	95	100.0	95	100.0
MEAN:	28.621		28.621	
STANDARD DEVIATION:	6.405		6.378	

was 28.621 for both groups of students. The standard deviation for the experimental group students was 6.405 and was 6.378 for the control group students.

A total of 601 students were pretested during March, 1980. By the completion of the study in June, 1980, there were 338 students post tested: 95 students from the experimental group and 243 students from the control group. In order to be included in the research results, students had to complete both a pretest and a post test. Sixteen students from the experimental group were absent on the day the post test was administered to their classes. Fourty control group students were also absent for the post testing. Eight experimental group students and fifty-eight control group students were out on a job as part of a cooperative work program. Two control group students had dropped out of school.

Two control group teachers lost the post tests their students had taken. This represented 35 students. Four control group teachers decided not to take the time at the end of the school year to give the post test. This group represented 44 students.

Four teachers in the experimental group and their fifty-two students were not included in the results of the study. Three of these teachers were unable to take part in the second session of the Inductive Learning Strategy Workshop. Since they did not receive the training necessary to successfully use the strategy, these teachers did not continue the research with their 44 students. One of the experimental group teachers who had completed the workshop failed to post test his students before the end of the school year. Thus, he and his eight students were not included in the results of the study. At the end of the study, 76 students from the experimental group and 187 students from the control group

were not included in the results. Table 2 contains the attrition rate for the students in the experimental group in terms of numbers and percentages.

Table 2

Attrition Rate of Experimental Group Students by Teacher
(N = 12)

Teacher Number	Pretest	Post Test	Attrition Rate
	Number	Number	Percent
1	18	5	72
2	12	11	8
3	10	8	20
4	25	16	36
5	18	17	6
6	10	10	0
7	17	16	6
8	14	12	14
9	14	0	100
10	17	0	100
11	8	0	100
12	13	0	100
Totals:	171	95	44

Table 3 represents the rate of attrition for students in the control group in terms of numbers and percentages. There were 28 control group teachers in comparison to the 12 experimental group teachers.

Table 3

Attrition Rate of Control Group Students by Teacher
(N = 28)

Teacher Number	Pretest	Post Test	Attrition Rate
	Number	Number	Percent
1	13	13	0
2	16	15	6
3	11	7	36
4	11	4	64
5	14	14	0
6	8	8	0
7	15	13	13
8	14	13	7
9	15	14	7
10	14	9	36
11	26	25	4
12	42	20	52
13	20	16	20
14	15	13	13
15	4	3	25
16	9	7	22
17	9	6	33
18	11	8	27
19	11	10	9
20	19	15	21
21	11	8	27
22	14	14	100
23	10	10	100
24	23	23	100
25	21	21	100
26	12	12	100
27	35	35	100
28	7	7	100
Totals:	430	243	43

Research Design

Figure 3 has been provided to indicate the flow of events which include the sample selection, the workshop presentations, and the testing of the students and the teachers in both the experimental and the control groups.

Workshop Presentation for Experimental Group Teachers

A two-day workshop was conducted for the twelve experimental group teachers. The workshop provided these teachers with the necessary instruction in the use of the Inductive Learning Strategy. The researcher served as the only instructor for all workshop sessions. The control group teachers did not attend this workshop. They received no instruction of any kind and were asked only to pre- and post test their students.

The two workshop sessions were held one week apart. During the first session, the experimental group teachers were given a pretest to determine their inductive thinking skills in the areas of data interpretation, recognition of inferences and generalizations, and reasoning to a conclusion. The purpose for this measurement was to allow the researcher to observe any change in the teachers' inductive thinking skills after they received instruction in the Inductive Learning Strategy. A post test was, therefore, given to these teachers at the end of the study.

After the strategy presentation, each teacher was given a competency-based learning module which explained the use of the strategy and the mental process of inductive thinking. The module contained the necessary instruction for planning and teaching an Inductive Learning Strategy lesson.

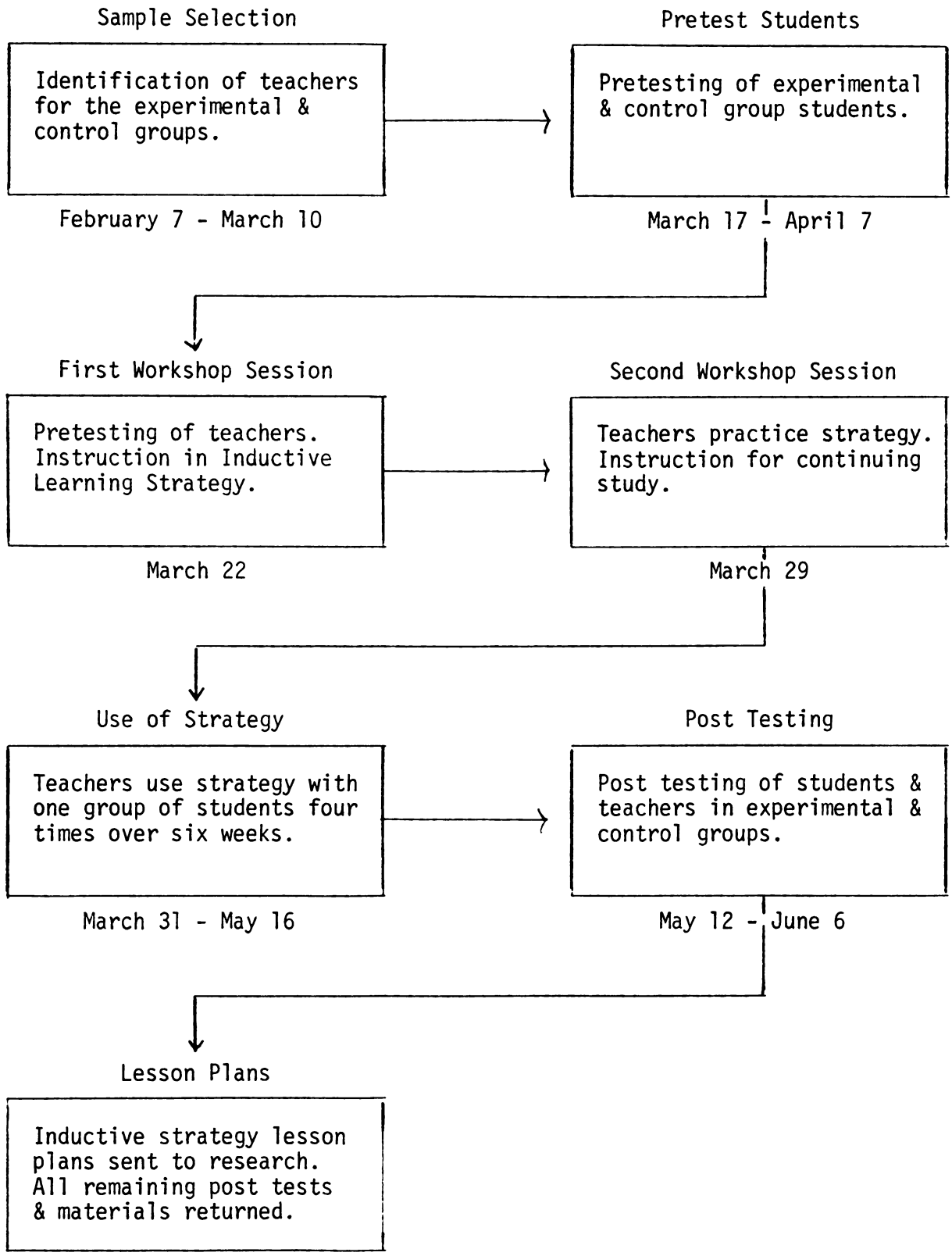


Figure 3. Research design.

The teacher group was guided through the module by the researcher, and they were encouraged to ask questions pertaining to their next task: planning an Inductive Learning Strategy lesson for presentation at the second session. At the close of the first session, the researcher suggested various applications of the strategy. The teachers considered the possible ways they might use the strategy in their own curriculum areas.

The second session of the workshop was designed to give the teachers practice in using the strategy. Many questions and areas of uncertainty were brought to light during this practice session. Each teacher came prepared to present her or his strategy lesson to the group. The teachers were video taped during their lessons. After each lesson was completed, the researcher replayed parts of the lesson for critiquing by the group. A critique sheet was used in conjunction with the video tape review. This form concentrated on the completion and execution of each step of the strategy. These evaluations were completed by all teachers in the group, and the sheets were given to each teacher so that he or she would better understand the areas of strength and weakness in the strategy lesson.

All of the teachers were encouraged to critique the presentations according to the accurate performance of the strategy steps, not the teacher's abilities as a teacher. This was done so that criticism would be focused on the strategy not on the teacher's ability. A more positive form of criticism results from this approach and is easier for teachers to accept. This form of evaluation points out the phases of the strategy that need changing or strengthening.

The researcher also selected specific phases of the strategy presentations that were examples of the effective performance of the strategy and replayed these for the teachers. This was done to reinforce the correct use of the strategy steps and to act as model performances for the teachers. Also, areas of teacher confusion concerning specific steps of the strategy were replayed and corrected. Approximately one hour was given to each teacher to complete this process.

During the second and final session, teachers were given instructions for the fulfillment of the research requirements. All teachers agreed to teach the Inductive Learning Strategy a minimum of four times over the remaining six to eight weeks of the school year. The teachers were encouraged to use the strategy lesson practiced in the workshop as their first lesson with their students because it is easier to present a new idea when it has been rehearsed. They were then asked to mail the next three strategy lesson plans to the researcher. Stamped, pre-addressed envelopes were provided for each of these lessons. It was the researcher's intent to monitor the teachers' progress with the strategy by reviewing the lesson plans.

A post testing schedule was established at the end of this session for the experimental group students. Tests would be delivered or mailed to the teachers one week in advance of testing. Finally, the teachers were encouraged to call the researcher if they had any further questions or difficulties.

Instrumentation

The purpose of this study was to measure the educational impact of a teaching strategy which is believed to help develop in learners their inductive thinking abilities. In order to measure this impact on learners, a test of inductive thinking skills needed to be identified for secondary level students. The researcher found that measurements for one's inductive thinking abilities were scarce. It was decided that a test which would measure one or more of the mental skills of categorizing, interpreting data, making inferences, forming hypotheses, and/or generalizing would be acceptable.

To locate such an instrument, the researcher began the investigation by reviewing the Eighth Mental Measurements Yearbook, Volumes I and II, by Burros (1978). All entries under the topics of inductive thinking, concept learning, intelligence testing, achievement testing, and critical thinking were reviewed. Tests in Print II (1974) by Burros was also examined for possible tests of inductive thinking skills. No tests reviewed in any of the Burros books directly measured any one or all of the inductive skills for students in grades nine through twelve.

The researcher contacted the Educational Testing Service at Princeton, New Jersey for their assistance in identifying tests of inductive thinking. The testing service representative suggested the Watson-Glaser Critical Thinking Appraisal (1964) as one possibility. She indicated that much of the content of the Critical Thinking Appraisal would also measure induction. Also, it was the only test they knew of that came close to the needs of the researcher's

study. The researcher obtained copies of the Watson-Glaser test and had the reading level assessed by a reading specialist that works with vocational education students. It was learned that the reading level was twelfth grade. Since the Watson-Glaser test did have content that measured inductive thinking skills and was written for twelfth grade and above, the researcher decided to use this measurement for the teacher testing.

The American Council on Education in Washington, D.C. was also called to request their aid in identifying additional tests or sources of information on available tests. The researcher was informed that the Tests of Critical Thinking published in the early 1950's by the Council were out of print and no new or revised tests were available. It became increasingly clear to the researcher that tests for inductive thinking skills were scarce.

Resource people at Michigan State University's College of Education were contacted. These authorities in the field of tests and measurements were interviewed for their knowledge of test of mental skills. They reconfirmed the belief that a test for any of the inductive thinking skills would be difficult to locate, especially for the secondary level students. The researcher was directed to consider the Sequential Tests of Educational Progress, Series III (1979). In reviewing the STEP Series III measurements, the researcher learned that a recent test had been developed in the area of study skills for the secondary level. This measurement consisted of content familiar to all secondary students. The test was not developed to measure information from any subject matter area but was based on general information processing skills.

This investigation continued for several weeks and lead the researcher to choose, from the measurements available, the instruments considered to be the most effective measure of the specific inductive thinking skills taught by the Inductive Learning Strategy.

Teacher Instrumentation

The researcher selected the Watson-Glaser Critical Thinking Appraisal (1964) for the teacher pretest and post test. It was found to be the most appropriate instrument for measuring the teachers' abilities in the areas of data interpretation, hypothesizing, inferring, and generalizing.

The Watson-Glaser Appraisal consists of one hundred items and takes approximately fifty minutes to complete. Two equivalent forms of the test were used in the study: Form YM for the pretest and Form ZM for the post test. The experimental group teachers were given the pretest and the post test. Only the post test was administered to the control group teachers.

Content Validity

To have content validity a test must accurately provide results which are representative of the knowledge and behavior the tester wishes to measure. The extent to which a test measures the change in this knowledge and behavior is the degree to which the test is valid. In the area of critical thinking, there does not seem to be a general agreement on a clearly defined universe of knowledge and skills. Watson and Glaser viewed critical thinking as a composite of attitudes, knowledge, and skill (Watson and Glaser, 1964). They designed a test which would measure attitudes of inquiry that involve

the ability to recognize the existence of problems and an acceptance of the need for evidence for asserted truths. Their Critical Thinking Appraisal measures these abilities as well as one's knowledge of inferences, abstrations, and generalizations. These are the same skills necessary for inductive thinking.

Reliability

The reliability of a test to measure consistently over time and from one group of students to another is a major concern in testing. Test scores represent a measure of student behavior obtained at a given point in time. Thus, in order to generalize from the measurement, it must be reasonably consistent over different occassions and over different samples of the same behavior.

Reliability data was reported for Form YM and Form ZM of the Critical Thinking Appraisal. These coefficents are shown in Table 4. The odd-even split-half reliability coefficients were corrected by the Spearmen-Brown Formula.

Table 4

Summary of Critical Thinking Appraisal
Split-Half Reliability Coefficients
(N = 25,647)

	Normative Sample	Number	Reliability
Form YM	Grade 9 - 12	10,114	.86
	Lib Arts Freshman	5,297	.85
	College Seniors*	200	.85
Form ZM	Grade 9 - 12 (No data above Grade 12)	10,036	.80

*Random sample of 200 cases from a population of 554 senior women in ten liberal arts colleges.

Student Instrumentation

Tests were reviewed for the students using the same criteria for selection as described for the teacher test. The researcher found very few test that measure the secondary level student's ability to categorize, hypothesize, make inferences, and/or generalize. It was determined that a test measuring even one of these abilities would be considered for the student pre- and post tests. An instrument having equivalent forms would be given higher consideration than a test having only one form which would have to be used for both testing times. There was concern on the part of the researcher that students might become bored and not present an accurate account of their mental growth on a test which would be taken twice in a relatively short time span.

The Sequential Tests of Educational Progress (STEP), Series III, developed by the Educational Testing Service in Princeton, New Jersey, had a study skills test available for grades nine through twelve. During an examination of the Study Skills instrument, Level J, several advantages for using this test became clear to the researcher. First, the test was written relatively free of any specific academic content areas. Second, the STEP Series III was a standardized testing program completed in 1979, and there were two forms of the Study Skills test available according to the publisher, Addison-Wesley Publishing Company.

The STEP Study Skills test measures a learner's ability to process information. The learner is asked to locate and organize the information presented and to use common reference sources. Library skills such as indexing and categorizing are evaluated. The use of maps, graphs,

time lines, and tables are also a part of the data interpretation and information processing emphasis of this test.

A Student Preview of the test was included with each Study Skills test to introduce the students to the type of questions possible on the instrument. Sample questions with correct answers were shown to the students as a part of the directions for the test.

The Study Skill, Level J, consisted of 37 questions in the multiple choice style. Students were given 25 minutes to complete the test. Answer sheets were provided and later hand scored by the researcher. The researcher planned to use Form X of the Study Skills test as the pretest for the students in both the experimental and the control groups. Form Y would be used as the post test. After the pretesting was completed, the researcher learned from the publishing company that Form Y, the equivalent Form of X, was not available as promised. Thus, the researcher used only Form X of the instrument for the pretesting and the post testing of the students.

Content Validity

When the entire STEP III Series was developed, the Educational Testing Service had the content validated by curriculum experts and educators across the country. Each test item received approximately eight reviews to insure the appropriateness of content and a clear and concise presentation. The suggested test levels were another assurance of content validity.

The Study Skills test was believed valid for measuring the inductive thinking skills of categorization and data interpretation.

It was realized to be limited in its measurement of the higher inductive thinking abilities such as inference and generalization, but no other instrument could be located which measured these at the nineth through twelfth grade levels.

Reliability

One way to look at the reliability of a test is to measure the consistency of the items selected as representative of a specific domain of knowledge and skills. A high reliability indicates that the items in the test adequately sample this domain. The test authors determined the internal consistency of the Study Skills test by comparing the variance of the items in the test with the variance of the test as a whole. They considered this method to be the most accurate estimate of the test's internal consistency. Kuder Richardson Formula 20 was used.

It was suggested in the Test Manual that the reliability coefficients given for each test would be lower than those obtained by less conservative procedures. Reliability coefficients for the STEP III - Study Skills, Level J, are reported for three grade levels, see Table 5.

Table 5

STEP III Study Skills, Level J,
Reliability Coefficients for Form X

Grade Level of Students	Reliability
Spring Term - Tenth Grade	.90
Fall Term - Eleventh Grade	.91
Spring Term - Eleventh Grade	.89
Fall Term - Twelfth Grade	.91
Spring Term - Twelfth Grade	.90

Data Gathering

The data for this research study was collected through the pre- and post testing of teachers and students in the experimental and control groups. Additional information was gained from the Inductive Learning Strategy lesson plans developed by the experimental group teachers.

Pretesting of Teachers and Students

From March 17 to April 11, 1980, the teacher and student pretesting was accomplished. The 12 experimental group teachers were given Form YM of the Watson-Glaser Critical Thinking Appraisal (1964). This testing was completed during the first session of the Inductive Learning Strategy Workshop. The test was untimed but was completed by all teachers within 60 minutes. The Appraisal was hand scored by the researcher and returned to the workshop participants at the second session so that each could consider her or his own strengths in the areas of inductive thinking.

All students in both the experimental and the control groups were pretested during this span of time with the STEP III Study Skills, Level J, Form X, (1979). The students in the experimental group were tested before their teachers completed the workshop instruction. The answer sheets were hand scored by the researcher and the resulting raw scores and percentages were sent to the teachers. Teachers were instructed that they could share the scores with their students according to the teacher's own judgment. If the teacher believed that

knowing the results of the pretest would motivate the students to take the post test, the researcher suggested that the teachers share the scores.

Post Testing of Teachers and Students

Teachers were sent Form ZM of the Watson-Glaser Critical Thinking Appraisal (1964) at the same time the student post tests were mailed. The students in the experimental and the control groups were given Form X of the STEP III Study Skills, Level J, as a post test. All post testing was done at least six weeks after the pretests were administered. Since pretesting had been completed as early as March 17th and as late as April 7th, post test dates were staggered throughout May and June in order to maintain the six week time requirement of the research. Thus, post test were administered from May 12 through June 6, 1980.

Teachers in the experimental and control groups were sent a teacher post test along with the post tests for their students. Teachers in the control group were sent a letter from the researcher along with the test requesting that they complete the Watson-Glaser Critical Thinking Appraisal, Form ZM. The control group teachers' participation in this testing was voluntary. Upon receiving the student and teacher post tests, the researcher again hand scored the answer sheets. All scores were returned by mail to the teachers within two weeks or before the end of the school year.

Teacher Lesson Plans

The teachers in the experimental group were asked to send to the researcher a copy of at least three of their Inductive Learning

Strategy lessons used with the experimental group students. It was requested that the copies be sent immediately following the presentation of each lesson. Teachers were given pre-addressed, stamped envelops for this purpose. The researcher intended to monitor the progress each teacher was making with the strategy. The researcher also wished to observe the time span between strategy lessons. The teachers had been instructed to allow at least one week between each use of the strategy so that the students would not become bored or resentful of the inductive learning process. The variety of ways that the teachers used the Inductive Learning Strategy was also of interest to the researcher.

The teachers did not meet this request of the researcher's. None of the eight teachers sent their lesson plans as they completed them. All of the teachers used the strategy lesson practiced in the workshop as their students' first exposure to the inductive learning process. The teachers sent the additional three lesson plans at the end of the study. The only explanations given to the researcher by all of the teachers were the high demands made on the teachers at the end of the Spring term and at the closing of the school year. The lesson plans did indicate that the teachers used the Inductive Learning Strategy at least four times in the six week period and at approximately one week intervals.

The researcher remained in contact with the teachers in this experimental group during the study by phone and by letter. Approximately three weeks after the workshop, a letter was sent to these teachers reminding them of the research requirements and

requesting a copy of their second lesson plan. The letter also requested that post testing dates be scheduled at their convenience (but at least six weeks after the workshop).

Calls were made to individual teachers for post test scheduling and to arrange the delivery and pick-up of the test materials. Teachers were able to ask questions and gain assistance at these times. Contacts were not made on any regular basis, but the researcher did call all of the teachers in the experimental group at the midway point of the research in order to be sure all were proceeding on schedule.

CHAPTER 4

FINDINGS

This chapter presents an analysis of the data gathered from the student information and student pretest and post test scores. There were a total of 190 students used in the analysis of data: 95 students in the experimental group and a matched 95 students in the control group. Tables six through ten are reported in terms of frequencies and percentages. The percentages are rounded to 100 percent by the computer.

Research Question 1: What are the differences between the experimental group and the control group students in age?

Table 6

A Comparison Between the Experimental and Control Group Students by Age

(N = 190)

Age	Experimental Group		Control Group	
	Frequency	Percent	Frequency	Percent
14	4	4.2	0	0
15	11	11.6	5	5.3
16	18	18.9	26	27.4
17	39	41.1	39	41.1
18	22	23.2	24	25.3
19	0	0	1	1.1
Totals:	95	100.0	95	100.0

Table 6 gives the range of ages for both the experimental and control groups. The experimental group ranged in age from 14 to 18 years. There were 39 students in the 17 year old age group. This group represented

41 percent of the experimental group students. Nineteen percent of the experimental group students were 16 years old and twenty-three percent were 18 years of age.

In comparison, the control group had more 16 year olds. This age group made up 27 percent of the control group students. As in the experimental group, 41 percent of the control group students were seventeen years of age. Twenty-five percent fell into the 18 year old age group.

The experimental group of students did have a larger number of students who were 14 and 15 years old. Five percent of the students in the control group were 15 years of age. While in contrast, fifteen percent of the students in the experimental group were 14 and 15 years old.

Research Question 2: What percentages of males and females are represented in the experimental group and the control group?

Table 7

A Comparison of Males and Females in the Experimental Group and Control Group Students

(N = 190)

Sex	Experimental Group		Control Group	
	Frequency	Percent	Frequency	Percent
Male	48	50.9	32	33.7
Female	47	49.5	63	66.3
Totals:	95	100.0	95	100.0

There were an almost equal number of males and females in the experimental group. Approximately 51 percent of the experimental students were male, and 49 percent were female.

In contrast, the control group was represented by 34 percent males and 66 percent females. Thus, there was a larger number of females in the control group, see Table 7.

Research Question 3: What are the difference in grade level for students in the experimental group in comparison to the students in the control group?

Table 8

A Comparison of Grade Levels for Students in the Experimental and Control Groups

(N = 190)

Grade Level	Experimental Group		Control Group	
	Frequency	Percent	Frequency	Percent
9	7	7.4	0	0
10	19	20.0	18	18.9
11	28	29.5	38	40.0
12	41	43.2	39	41.1
Totals:	95	100.0	95	100.0

The experimental group students came from the nineth through the twelfth grades. The largest represented group, 43 percent, were twelfth graders. Twenty-eight percent were in the eleventh grade and nineteen percent were tenth graders, see Table 8.

The control group was represented by an almost equal number of twelfth grade students, 41 percent. A larger number of eleventh

made up the control group at 40 percent. The remaining 19 percent were students in the tenth grade.

Research Question 4: How do the vocational subject areas of the students in the experimental group compare to the vocational subject areas of the students in the control group?

Table 9

A Comparison of the Vocational Subject Areas Represented by Students in the Experimental and Control Groups

(N = 190)

Vocational Area	Experimental Group Frequency	Experimental Group Percent	Control Group Frequency	Control Group Percent
Business & Office Education	45	47.4	51	53.7
Applied Technology	27	28.4	24	25.3
Human Services	23	24.2	20	21.1
Totals:	95	100.0	95	100.0

The vocational area classified as Business and Office Education was made up of students from a range of courses. These courses ranged from typing to data processing. All classes which dealt with the teaching of business services were grouped into this category. Fourty-seven percent of the students in the experimental group were in this vocational classification. In comparison, 54 percent of the control group students came from Business and Office Education classrooms. This data can be observed in Table 9.

The area of Applied Technology made up 28 percent of the experimental students. Twenty-five percent of the control group were from Applied Technology areas. The area of Applied Technology represented a wide range of technical courses. Vocational Agriculture, Automotive Technology and Electrical Services were included.

Human Services was the third classification of students. Students from courses that developed skills in service areas such as Nursing, Consumer Marketing and Child Care made up this area. Twenty-four percent of the experimental students were from the Human Services area. The control group was made up of a similar number of students in this classification at 21 percent.

Research Hypothesis

H_o: There will be no significant difference between the mean gain score of the experimental group and the mean gain score of the control group of matched students at the .10 level of significance.

A one sample t-test was used to analyze the data for the research hypothesis. This analysis was done to determine if there was a significant difference between the mean gain scores of the two groups of students. The mean gain score represents the average number of points gained by each group of students from the pretest to the post test. A summary of test results is presented in Table 10.

The sample was made up of 190 students from secondary, vocational classes. There were 95 students in the experimental group and 95 matched students in the control group. Using a one sample t-test, the F value was 1.92 with a .001 level of significance. Thus, it can be assumed from the statistical evidence that there was a significant difference between the mean gain score of the experimental group and

the mean gain score of the control group. Even though the control group had a higher mean gain score, neither group of students gained on the average more than one and a half points on the post test.

Table 10

One Sample T-Test for the Mean Gain Scores of the Experimental and Control Groups (N = 190)

Variable	Number	Mean Post Minus Mean Pretest Scores	F-Value	*Sign
Experimental Group Students	95	.0947	1.92	.001
Control Group Students	95	1.5474		

*a = .10 level of significance

Post Hoc Analysis

When it became evident that the control group students had a higher mean gain score than the experimental students, the researcher determined that further analysis of the data was necessary. A post hoc analysis could give a clearer picture of the statistical outcomes of the research study.

It is believed that teacher knowledge may directly influence student results. Thus, it became evident that teacher scores on an inductive learning test should be explored. Also, the differences in the students' gain scores were analyzed by grade level and sex of the students. It was thought that the sex and grade level of the students may be

factors which could explain some of the differences between the experimental and control group students.

The teachers in the experimental group were given a pretest before the workshop instruction. Six to eight weeks later, they were given a post test, see Table 11. The mean percentile score on the pretest was 61.4737 with a standard deviation of 29.6000. The post test mean percentile score was 74.0211 with a standard deviation of 26.669. This was an average gain of 12.5474 percentage points on the post test for the experimental group teachers. The t-value of 6.20 with a significance of .000 indicates that there was a significant difference between the pretest and the post test scores for these teachers.

Table 11

Analysis of Experimental Teacher Gain Scores
From the Pretest to the Post Test

(N = 8)

Test Variable	Number	Mean Percentile	Standard Deviation	t-Value	*Sign
Pretest (Form YM)		61.4737	29.600		
	8			6.20	.000
Post Test (Form ZM)		74.0211	26.669		

*a = .10 level of significance

When comparing the experimental group teachers' test scores with those of the control group teachers, an interesting situation can be observed, see Table 12. All of the experimental group teachers took

the pretest and the post test. A definite gain was made by these teachers in their critical thinking abilities.

There were only 13 control group teachers who took the post test because it was voluntary. The control group teachers were not asked to take the pretest. The post test mean percentile of 86.5085 was scored by these control group teachers. Since this was the their first exposure to the Critical Thinking Appraisal, it was essentially a pretest for the teachers in the control group.

The results in Table 12 show a greater orientation to critical thinking processes for the 13 teachers in the control group who were tested. Their mean percentile score of 86.5085 was 12.4874 percentage points higher than the post test percentile score of the experimental group teachers. The control teachers scored 25.035 percent higher on their first exposure to the Critical Thinking Appraisal than the experimental teachers scored on their first exposure.

Table 12

Comparison of Teacher Pretest and Post Test Scores
for the Experimental and Control Groups
(N = 21)

Teacher Variable	Number	Pretest Mean Percentile (Form YM)	Post Test Mean Percentile (Form ZM
Experimental Group	8	61.4737	74.0211
Control Group	13	(No pretest given)	86.5085

Table 13 displays the analysis of mean gain scores for each grade level of students. Caution should be used when interpreting data from Table 13 due to the low number of subjects in each group by grade level. There were only seven students in the ninth grade. All were in the experimental group. Their mean gain score represented a loss of 3 points from the pretest to the post test. There were no ninth graders in the control group. The significance level of .5000 indicates that there is not a high probability that these results would be duplicated in another study.

The tenth graders were equally divided between the experimental and the control group. The 19 experimental group students had a mean gain score of .2632 with a standard deviation of 3.942. The control group of 18 tenth graders had a mean gain score of 1.7222 and a standard deviation of 3.444. In this sample of subjects, the tenth grade control group students had a greater gain score than the experimental group tenth graders. The F-value was 1.31 with a .2910 level of significance. This low level of significance suggests that these results would occur by chance about 30 percent of the time.

There was less difference between the two groups of eleventh grade students. The 28 experimental group students had a mean gain score of .7500 and a standard deviation of 4.394. There were 38 control group students in the eleventh grade. Their mean gain score was 1.1053 with a 3.286 standard deviation. The F-value for the eleventh grade was 1.79 at the .0505 level of significance. Thus, there was a difference between these experimental group students' and the control group students' mean gain scores at the .10 level of significance.

The twelfth graders in the experimental group had a mean gain of .0976 and a standard deviation of 4.364. The control group of twelfth grade students had a 1.8974 mean gain score with a 3.251 standard deviation. The F-value of 1.80 was significant at the .0355 level. From this data, it can be observed that the twelfth grade students in the control group gained the largest number of points on the average as a group from the pretest to the post test. The data in Table 13 also indicates that the higher the students' grade level, the more significant is the difference between the two groups' mean gain scores.

Table 13

Analysis of Mean Gain Scores from the Pretest to Post Test of Students by Grade Level

(N = 190)

Grade Level	Student Subjects	Number	Mean Gain Score	Standard Deviation	F-Value	*Sign
9	Experimental	7	-3.0000	7.165	0	.5000
	Control	0	0.0	0.0		
10	Experimental	19	.2632	3.942	1.31	.2910
	Control	18	1.7222	3.444		
11	Experimental	28	.7500	4.394	1.79	.0505
	Control	38	1.1053	3.286		
12	Experimental	41	.0976	4.364	1.80	.0355
	Control	39	1.8974	3.251		

*a = .10 level of significance

Since the ninth grade students in the experimental group had an average loss of three points from their pretest to the post test, an analysis of the gain scores was done without these seven subjects. This was done to determine whether the lower mean gain score of the experimental group students was due to the low mean gain score of the ninth graders. Without these seven ninth grade students, the experimental group students had a mean increase of .2462 points, from .0947 mean gain to .3409, see Table 14. This was not a significant change in the mean gain score for the experimental group students. Thus, a major difference in the gain scores of the two groups did not occur because the ninth graders were included in the first analysis. Without these seven students, there was still a significant difference in the mean gain scores in favor of the control group students at a .0075 level of significance.

Table 14

Analysis of the Mean Gain Scores for the Experimental and Control Group Students Without the Ninth Graders

(N = 183)

Variable	Number	Mean Gain	Standard Deviation	F-Value	*Sign
Experimental Group	88	.3409	4.248	1.67	.0075
Control Group	95	1.5474	3.287		

*a = .10 level of significance

Table 15 shows an analysis of mean gain scores for the experimental students and the control students by sex. There were more males in the experimental group than in the control group. The 48 experimental male students had an average loss of .6875 points from their pretest to their post test. The 32 males in the control group scored 2.1875 points higher than the experimental group males.

The females in the experimental group improved .8936 points from the pretest to the post test. The female control group students gained 1.5714 points. This gain was .6778 points greater than the experimental group females. Thus, it can be seen that the females in the control group scored a little more than a half point higher than the females in the experimental group.

Table 15

Analysis of Mean Gain Scores for the Experimental and Control Group Students by Sex

(N = 190)

Variable	Student Group	Number	Mean Gain	Standard Deviation	F-Value	*Sign
Male	Experimental	48	-.6875	5.821	2.43	.005
	Control	32	1.5000	3.733		
Female	Experimental	47	.8936	2.547	1.45	.0940
	Control	63	1.5714	3.068		

*a = .10 level of significance

From this post hoc analysis, additional information became evident. Even though the teachers in the experimental group made a significant gain in their critical thinking abilities from the pretest to the post test, their post test mean percentile of 74.0211 was 13 percent lower than the control group teachers' mean test score of 86.5085 percentile. This data indicates that the control group teachers critical thinking abilities may have influenced their students inductive learning test scores, since their inductive thinking abilities were higher than those of the experimental group teachers.

When analyzing the mean gain scores of students in the experimental and control groups by sex and grade level, the results showed a gain for the control group males of 1.5000 and for the females of 1.5714 points. However, the experimental group females gained .8936 points on their post test, but the experimental males lost .6875 points when they took the post test. Taking a closer look at these results, it was observed that the experimental males were the only group of students in either group not to improve on the post test. It could also be seen that the seven ninth graders (all male) were the only group by grade level who did not improve on the post test. Thus, the ninth graders did influence the lower mean gain score of the experimental group. When these seven students were removed from the analysis, the mean gain score for the experimental students improved but not sufficiently for a change in the research results.

CHAPTER 5

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND REFLECTIONS

Summary

Hilda Taba's inductive learning strategies, developed during the 1960's, guide learners through the mental processes of categorization, generalization, and inference. Taba's model for inductive thinking was used as the basis for the Inductive Learning Strategy taught in the VIDEOS Workshop. The VIDEOS Project was funded by the Vocational Education Division of the New Mexico State Department of Education.

The VIDEOS Workshop was designed to present vocational teachers with a set of teaching strategies that would increase the critical thinking skills of their students. The Inductive Learning Strategy was one of these teaching strategies.

The purpose of the present study was to measure the educational impact of the Inductive Learning Strategy on secondary, vocational students. No standardized measurement had previously been used to evaluate the change in ability levels of teachers or students after exposure to the VIDEOS strategy.

The findings from this study are important to the future evaluation process of the VIDEOS Workshops. Assessment of the present procedures used to evaluate success will be reviewed in light of these findings.

The teachers and students involved in this study were from secondary, vocational classrooms. The sample was formed by the

voluntary participation of 29 vocational teachers across South Central Michigan. Each teacher selected one of her or his vocational classes to use in the study. The experimental group consisted of eight vocational teachers and 95 students, and the control group was made up of twenty-one teachers and 243 students.

The 95 experimental group students were matched as closely as possible with 95 students from the control group. Out of the 243 control group students, 95 students were selected that matched the experimental students according to pretest score, age, sex, grade level, and vocational subject area. This matching procedure was prioritized, with the pretest score having the highest priority and the vocational subject area the lowest. Table 1 in Chapter three indicates the close match achieved between the two groups of students by pretest score.

The experimental group teachers and students were exposed to the Inductive Learning Strategy. The control group teachers and students had no special instruction. These teachers were asked only to pretest and post test one class of students and to take the Critical Thinking Appraisal, Form ZM, at the end of the study.

The eight teachers who comprised the experimental group were involved in a two-day workshop on the Inductive Learning Strategy. The workshop sessions were held one week apart by the researcher. The workshop format and presentation were identical to all VIDEOS Workshops. The workshop design used for this study follows:

First Session: Introduction to critical thinking and the strategies approach.

Presentation of Inductive Learning Strategy. (Involves teachers as learners.)

Review of Inductive Learning Module. (Designed to assist teachers with the use of the strategy.)

Video tape sample of a teacher and students using the strategy.

Instructions for practice session.

Second Session: Each teacher presents an Inductive Learning Strategy lesson to peers. The lesson is video taped and replayed in part. All teachers offer suggestions for greater effectiveness of the strategy lesson.

Research instructions given and testing schedules discussed with teachers.

All of the students to be involved in the experimental group were pretested before the workshop was completed. Teachers were instructed to use the Inductive Learning Strategy four times over a six week period of time with one experimental group of students.

In order to measure the impact of the inductive strategy on teachers and students, two measurements were selected. The Watson-Glaser Critical Thinking Appraisal (1964) was chosen to pretest and post test the teachers. This appraisal measured the teachers' abilities to make inferences, recognize assumptions, make deductions, intrepret data, and evaluate arguments. These are some of the mental abilities used in the process of induction. The use of this measurement gave the researcher an indication as to the predisposition teachers had to the inductive thinking process and the change in the experimental teachers' ability to think inductively after exposure to the strategy.

The STEP (Sequential Tests of Educational Progress), Series III, Study Skills Test, Level J, (1979) was used as the student pre- and post test. Only one form was used for both pretesting and post testing. The test focused on the mental skills of data interpretation and categorization. A test to measure a student's ability to generalize and infer was not available for students at the secondary level.

Following is the order in which the research events occured:

Identification of teachers for the experimental and control groups.

Pretesting of the experimental and control group students.

Inductive Learning Strategy Workshop:

- Pretesting of experimental group teachers.
- Instruction in the Inductive Learning Strategy.
- Practice of strategy by teachers.
- Instructions for research study.

Use of Inductive Learning Strategy by teachers four times over a six week period of time.

Post testing of experimental and control group teachers.

Post testing of experimental and control group students.

Experimental group teachers send strategy lesson plans to researcher.

Data was collected through the pre- and post testing of the teachers and students in the experimental and control groups. This data gave the researcher information concerning the following research questions and hypothesis.

Research Question 1: What are the differences between the experimental group and the control group students in age?

The experimental group students range in age from 14 to 18, with 15.8 percent of the students 15 or younger. The control group students range in age from 15 to 19, with five percent of these students at 15 years of age. Eighty-three percent of the experimental group students were ages 16, 17, or 18. Eighty-nine percent of the control group were 16, 17, or 18 years old. Thus, the experimental group was younger than the control group.

Research Question 2: What percentages of males and females are represented in the experimental group and the control group?

Fifty-one percent of the experimental group students were male, and fourty-nine percent were female. Sixty-six percent of the control group students were females, and thirty-four percent were males. Thus, an equal number of males and females made up the experimental group; while, the control group had a larger number of females than males.

Research Question 3: What are the differences in grade level for students in the experimental group in comparison to the students in the control group?

The experimental group consisted of 43 percent twelfth grade students, in comparison to 41 percent twelfth graders in the control group. Twenty-nine percent of the experimental group students were in the eleventh grade; while fourty percent of the control group were eleventh grade students. The experimental group had 20 percent sophomores, and there were 19 percent control group students who were sophomores. Seven percent of the experimental group were in the

ninth grade in comparison to no ninth graders in the control group. Overall, the students in the experimental group were in lower grades than the control group students.

Research Question 4: How do the vocational subject areas of the students in the experimental group compare to the vocational subject areas of students in the control group?

Fourty-seven percent of the experimental group and fifty-four percent of the control group were made up of Business and Office Education students. Applied Technology was represented by 28 percent experimental group students and 25 percent control group students. Twenty-four percent experimental group students were from the Human Services area, and twenty-one percent of the control students were from Human Services. Business and Office Education was, therefore, represented to a greater extent than the areas of Human Services and Applied Technology in this study.

Null Hypothesis: There will be no significant difference between the mean gain score of the experimental group students and the mean gain score of the control group matched students at the .10 level of significance.

The control group students increased their mean score an average of 1.5474 points from the pretest to the post test. The experimental students increased their mean score an average of .0947 points from the pretest to the post test. There was a significant difference, at the .001 level, in the mean gain scores between the experimental and the control group of matched students. Thus, it can be observed that the control group students performed significantly better on the measures in inductive learning than did the experimental group students.

Conclusions

The following conclusions were drawn from the results of this research effort.

1. The students in the study were approximately equal in ages; however, the experimental group students were younger than the control group of matched students.

2. The experimental group students had an equal representation of males and females; while the control group was made up of a greater number of females, with 66.3 percent females and 33.7 percent males.

3. The grade level distribution showed that the control group students were in higher grade levels than the experimental group students.

4. The control group students had a higher representation from the Business and Office Education area; while the experimental group had a greater number of students from the areas of Human Services and Applied Technology.

5. The test for significant differences between student post test minus pretest scores indicated that there was a significant difference in the mean gain scores of the experimental group students and the control group students. The mean gain score was higher for the control group students than for the experimental group students. When the data was analyzed by grade level, the results indicated that the higher the grade level of the students the more significant was the difference in their mean gain scores.

6. The experimental group teachers did show a gain in their inductive thinking abilities from the pretest to the post test. This increase in ability was an average of 12.6 percentile. This gain was statistically significant at the .000 level.

7. When the control group teachers' inductive thinking abilities were tested, they received a higher mean score than the experimental group teachers earned on either their pretest or post test. This indicated that the control group teachers were more competent in the areas of inductive thinking than the experimental group teachers, even after the experimental teachers were exposed to the Inductive Learning Strategy. This lead the researcher to question the possible influence that the vocational education area might have on teacher ability. A breakdown of the experimental and control group teachers by areas indicated that there were four experimental group teachers from the Business and Office Education area in comparison to eight control group teachers from this subject area. Human Services was represented by two teachers each in the experimental group and the control group.

The Applied Technology area had two experimental group teachers and three control group teachers represented. Thus, the greatest concentration of control group teachers was in the area of Business and Office Education. This data may indicate that inductive thinking abilities are inherent or more often used in this vocational subject area.

Recommendations

The following recommendations are made as a result of the study and its findings:

1. A study should be conducted where the experimental group teachers are allowed to teach the Inductive Learning Strategy for a longer period of time before an evaluation of student learning is completed. It would be important to determine whether the amount of time a person is exposed to a thinking process is a major factor in developing the mental skill.

2. A matching procedure that uses the teachers' pretest scores as a variable when matching students should alleviate the teacher influence on student learning abilities.

3. A standardized test specifically designed to measure the inductive learning abilities of inference and generalization for secondary, vocational students should be developed. The researcher found the measurement used for the students to be insufficient to evaluate the impact of the strategy. A measure of the higher levels of inductive thinking is needed.

4. A standardized test specifically designed to measure the inductive thinking abilities of inference and generalization for vocational teachers should be designed. Without an accurate measure of these specific mental skills, the actual learning which results from the use of the Inductive Learning Strategy cannot be measured.

5. Further study should be conducted to determine the level of inductive thinking that teachers learn through their college course of studies, their daily lives and through the practice of teaching in general and specific to their vocational area of instruction. It would be helpful to learn where individuals learn to think inductively. Identification of these learning sources would assist in the planning of teacher education and inservice programs.

6. Further research should be done to determine if specific vocational education programs foster a higher level of inductive thinking ability than other vocational education programs.

7. Research should be initiated to determine if there are certain personal innate thinking abilities which contribute to the level of one's inductive thinking ability. If certain innate abilities do influence other thinking abilities, would training in inductive mental skills be more effective for the one whose innate thinking abilities did contribute to the learning of others?

8. Research should be conducted to determine the reason for the increased significance in the difference between the inductive thinking abilities of students as their grade level increased. The results could suggest the best time to introduce or practice the Inductive Learning Strategy.

9. A follow-up session should be made available to teachers who have participated in the VIDEOS Workshops as a check on the teachers' effective use of the strategies. This follow-up session would allow for assistance with questions or difficulties experienced by teachers with the strategies. Also, it would serve to restimulate teacher interest in the teaching of mental skills.

10. A student test for inductive thinking skills should be included as a part of the teachers materials. This student measurement could be used by the teachers to determine the change in their students' abilities to think inductively after several exposures to the Inductive Learning Strategy. This would give the teachers a better idea of how effective their use of the strategy has been. A student test to measure the other teaching strategies which are a part of the VIDEOS Workshop should also be developed and included to measure the students' change in the mental skills taught by each strategy. Greater accountability for the VIDEOS materials would be achieved with the addition of these evaluation devices.

11. A section which stresses the importance of teaching mental skills should be added to the learning modules. This section should give a rationale that teachers could use with their students to explain those mental skills essential to cope with life in the twentieth century. A rationale of this type may increase the students' willingness to learn the various processes of thinking, such as induction.

Reflections

This researcher was not fully aware when the study began of the importance of measuring the abilities to make inferences and form generalizations when trying to measure inductive learning abilities.

It has become apparent that a measure of one's abilities to interpret data and process information is an inadequate measure of inductive thinking. Data interpretation is a necessary first step in the process of induction, but it is not unique to that mental process. The skills needed when interpreting data are most likely learned through many circumstances and are not an effective criteria for determining a student's ability to think inductively. A measure of the abilities to make inferences and form generalizations would perhaps be a more accurate evaluation of inductive learning skills.

There may be a relationship between the vocational area which the students come from and the amount of inductive thinking that the students are asked to perform. It is possible that certain vocational subject areas practice more problem solving as a part of their curriculum than other vocational areas. Thus, a certain amount of practice with inductive learning skills may already be a part of specific vocational classes.

This research effort did not ask the teachers for any background information concerning their education preparation for teaching. In vocational education, teachers often have quite varied backgrounds. A teacher may have a bachelors degree in elementary education or perhaps psychology and yet be teaching a class in auto body repair. Some vocational instructors are under an annual authorization from the State Department of Education which allows them to teach in their specific area of occupational training. This wide range of educational backgrounds may influence the inductive thinking abilities of vocational teachers.

The design of this study did not allow for any control or observation of the teachers' use of the strategy. When doing a study to determine the impact of a specific technique or strategy on learners, this researcher would in the future build in an observation check point(s) during the study. This would be used to insure the correct and effective presentation of the teaching strategy. During this study, the researcher had no way of knowing if the teachers were using the strategy correctly, or if they were using it as often as the research design required.

It is possible that the experimental students were in a confused state of problem solving due to the introduction of the inductive thinking process. Taba (1964) suggested that since students are more familiar with the expository, deductive approach to information processing and problem solving, learners generally go through a confused state while learning to think inductively. Students seem to necessarily go through a period of overgeneralizing and greater risk taking before they function effectively with the new inductive approach.

This researcher did not expect to find the following results from the study:

1. The lack of cooperation received from school administrators and teachers was a surprise to this investigator. I did not expect to meet so much resistance to research conducted in the classroom. From over 200 teachers, only 28 teachers were willing to test one class of students and 12 teachers were willing to become personally involved in the learning. My admiration goes out to the teachers who took part in the experimental group for their dedication to professional development and to the advancement of educational knowledge. This researcher realizes that teachers are busy, overworked professionals. Therefore, the teachers who assisted with this research study are appreciated. Most of the high

school teachers I spoke with were not willing to do anymore than their regular duties. Teachers do not have an easy job, and I respect this fact. I was, however, truly affected by the lack of concern so many teachers felt toward increasing our knowledge of how students learn.

2. An underrated influence on this study was the time of the school year. The researcher realized that the Spring term would be the least desirable time for introducing a new learning technique; but I also believed that, with motivation low at this point in the school year, a new approach would increase the students' interest in learning. I did not think that the students and teachers would be so disinterested in school and learning as early as March. One teacher explained that "as soon as the snow melts, the students have mentally begun their Summer vacations."

3. Lastly, the researcher did not anticipate a situation where the control group students would show a greater increase in their inductive thinking abilities than the students in the experimental group. It has been the researcher's experience that students exposed to the Inductive Learning Strategy have become highly motivated toward learning as a result. Vocational high school students have expressed their views on the teaching strategies to the researcher and on evaluation forms. Some students believed they could function better in all phases of the learning process because of the mental skills they developed through the VIDEOS strategies. Other students felt that their performance had improved in the particular vocational class where these strategies were integrated. With so much positive feedback from students and teachers over the last five years, the researcher believed that the students in the experimental group would perform at the same level or higher than the control group students on the inductive learning post test.

The following ideas represent those procedures I would change as a result of the experience derived from this research effort:

1. If the ideal could be achieved, I would plan a research study which would begin in the Fall (pretest in October) and end no later than March (post test in early March).

2. Equivalent forms of the same test or two separate tests would be used when pre- and post testing secondary students. The students did not like taking a post test which was given to them as a pretest. Several students simply refused to test-retest and only filled in the blanks on the post test answer sheet in a haphazard way.

3. All teachers in the study would be pretested to determine their prior knowledge in the area of inductive thinking. Then, if possible, teachers in the experimental group could be matched

with teachers from the control group that had similar pretest scores. Only these teachers' students would be measured for a change in their inductive learning abilities. This matching of teachers would remove the influence the teachers' previous knowledge had on the students test results.

4. A student test would be identified or developed that would measure the learner's abilities to make inferences and form generalizations. I believe this would be a more accurate measure of a change in inductive thinking abilities as a result of the Inductive Learning Strategy.

5. A longer time span would be used for teachers to learn the strategy and then transfer it to their students. The researcher would review any available research which determined the most appropriate length of time for internalizing a thinking process and a teaching strategy.

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APPENDICES

APPENDIX A

Inductive Learning Strategy Flyer

TIRED OF SCHOOL??

Have You Used All Your Innovative Techniques?

Here's A Way To Add Some ZEST To Your Teaching

TAKE PART IN A MINI-WORKSHOP DEVELOPED AT THE UNIVERSITY OF NEW MEXICO

WHERE YOU CAN

- develop and increase students' intellectual abilities as well as basic skills.
- learn techniques for data interpretation.
- improve your questioning styles.
- learn a strategy that will assist you in placing the learning in the "hands" of your students.
- "bridge" the generation gap between you and your students by seeing subject matter through the learners' eyes.
- use a strategy that helps learners make generalizations and inferences based on cause and effect relationships seen between groups of items they have identified.
- take part in a strategy that is easy and takes little time.

This is an INTRODUCTORY OPPORTUNITY offered FREE for the first time in Michigan. The workshop cost is generally $200 per teacher. If you are interested in attending this two-session workshop, call Carol Geer to guarantee your reservation. The Mini-Workshop will be held at the College of Education, Michigan State University.

Workshop Dates: & Times — March 22, 9:00AM to 1:00 PM
and
March 29, 8:00AM to 12:00 PM
1:00PM to 5:00 PM

APPENDIX B

Letter to Experimental Teachers

April 17, 1980

Dear

I thought I would write to say hello and offer assistance if you need any. You understood the strategy so quickly that I feel certain you are doing well with it. There are approximately five weeks remaining before the post testing must be done and of course, the end of the school year. I'm sure you feel the pressure of time passing as much as I do. I really hate to see the weeks speed by.

By this time you will have already taught your first strategy lesson and perhaps a second. Using the strategy a second time is much easier, and you probably felt more in control of it. With each use of the strategy, your confidence and expertise will increase.

It would be wise to plan to use the Inductive Learning Strategy once a week during these next three to four weeks. It is essential that the students be exposed to the strategy at least four times before the post testing. If you have not selected the week you wish to post test your class, please let me know. You are the most important group to be tested and I want to make it as convenient for you as possible. Post testing should be done as late in the school year as possible, but I understand that many schools release seniors around May 20th. Therefore, we could post test your class as early as May 12th. Let me know what is best for you. Also, be sure to send your lesson plans as you teach them. This will help me to approximate your schedule.

Your part in this research study is extrememly important and sincerely appreciated. You are using a teaching approach that will benefit you and your students as well as learners across the United States. The results of this study will be used to encourage learning in the critical thinking processes.

Thank you for the dedication you have shown to your profession and for your personal commitment to this project. I am very grateful for this opportunity to work with you.

Sincerely,

Carol R. Geer

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APPENDIX C

Letter to Control Group Teachers

May 10, 1980

Dear

The research study that you and your students are a part of is progressing very well. I sincerely appreciate the care you took with the pretesting. All the tests were completed promptly and accurately.

Now the post testing has begun. The study involves over 600 students and more than 40 teachers. The purpose of the study is to measure the students' abilities to process information and to see if a specific teaching strategy will have an impact on this skill. Related to the student's ability is the teacher's capacity to interpret information and draw conclusions. In order to gain an accurate picture of the effect the strategy has on teachers and students, it is extremely important to measure this skill in both. Thus, the teachers in the experimental group were pretested before receiving instruction in the strategy. To measure the effect the strategy has had on these teachers, I need your help. Enclosed with the student post tests is a Critical Thinking Appraisal. It is an interesting way to find out your strengths in the area of information processing. The Critical Thinking Appraisal will give you an idea of how well you understand inferences, make logical deductions, recognize assumptions, and evaluate arguments.

Your test score will be part of the control group which will form the basis for a comparison between teachers who have used the strategy and those who have not. The Critical Thinking Appraisal takes between 30 to 50 minutes. When you complete it, send the answer sheet back to me along with the student tests and answer sheets. You may keep the test booklet. I will send you your results with any corrections so that you will know which areas are your strongest. The results of your Critical Thinking Appraisal will be kept <u>Completely Confidential</u>. The teacher test scores will be studied as a group. Individual scores will not be used. Your score will be shared only with you.

As you can see, you are an important part of this study. You were not told about this testing earlier because it would have changed the results. You are needed in this study to show teachers' skills in using information without specific training. Thus, it was essential for me to ask you to assist me at this time without prior knowledge of the test. I truly appreciate your efforts toward making this research study a significant contribution to our knowledge of student-teacher learning.

Sincerely,

Carol R. Geer