1993

The Illinois Studies in Inquiry Training: A Critical Review

James Edward Cleland
Loyola University Chicago

LOYOLA UNIVERSITY CHICAGO

THE ILLINOIS STUDIES IN INQUIRY TRAINING: A CRITICAL REVIEW

A THESIS SUBMITTED TO

THE FACULTY OF THE GRADUATE SCHOOL

IN CANDIDACY FOR THE DEGREE OF

MASTER OF ARTS

DEPARTMENT OF CURRICULUM AND INSTRUCTION

BY

JAMES EDWARD CLELAND

CHICAGO, ILLINOIS

MAY 1993

PREFACE

In September 1970, a high school student in north suburban Chicago, Illinois opened two textbooks, one dealing with American history--the other a textbook in biology. These books were to leave a lasting impression on the student; these books did not attempt to reveal previously determined and accepted truths about U.S. history or the study of biology. Rather, these books, along with the environment the teachers of these two courses attempted to create, considered the student to be an integral part of the search for knowledge.

The student's own experiences, inferences, and conjectures were allowed to thrive in this new educational setting; learning was not the result of a transmission from teacher and textbook to student, but learning was an inquiry into theory building; the student as well as leading historians and biologists of the day together were undertaking the search for knowledge.

Unbeknownst to him, an educational methodology movement which took form in the late 1950s was having an effect on this student in the 1970s.

As the editor of his history book mentioned the difference underlying this new appoach to history, so did the editor of his biology textbook underscore what he believed to be the objective to this new inquiry-based learning:

> This is a new kind of textbook... (The text and the accompanying materials) have been chosen with great care. They have been designed so that you will not merely memorize facts and generalizations; you will identify problems,

> develop hypotheses, or tentative answers to questions, and draw your own conclusions from factual evidence. Throughout this course in American History you will be challenged to think for yourself and to make up your own mind.[1]

> For years, many of our better teachers have been expressing dissatisfaction with the tools with which they have had to work. They wanted to teach modern biology in an imaginative, investigative, and inquiry-oriented fashion...[2]

The above excerpts were cited to indicate the philosophy of this new inquiry-based learning. The work of several top educational researchers who were pioneers into inquiry-based learning convinced this high school student that better ways of teaching and learning were being sought; that to ignore the innumerable experiences of each student as he undergoes the high school experience is tantamount to educational heresy; that the finest motivational ploy to use in getting students to think productively and with an ever-increasing acumen is to allow the student to inquire on his own. This thesis is a culmination of twenty years of interest in inquiry-based learning in general; the work of the University of Illinois at Urbana-Champaign's Illinois Studies in Inquiry Training is the principle focus of this thesis. To the men and women of ISIT this is dedicated.

1. Edwin Fenton, gen. ed., *A New History of the United States* (New York: Holt, Rinehart and Winston, Inc., 1969).

2. *Biological Science: An Inquiry into Life*. William Mayer, Director, Biological Sciences Curriculum Study, (New York: Harcourt, Brace and World, 1968).

ACKNOWLEDGEMENTS

Assistance rendered by the director of the committee, Dr. Robert Cienkus, as well as by the other committee members, Dr. Barney Berlin and Dr. Steven Haymes, all of the Department of Curriculum and Instruction at Loyola University Chicago, is gratefully acknowledged.

Dr. Terry Denny of the University of Illinois at Urbana-Champaign offered a plethora of sources for me to consult as this thesis evolved. It was he who guided my historical quest.

Dr. Ted Manolakes of the University of Illinois at Urbana-Champaign was invaluable to me as I spent the summer of 1992 tracking down members of the original Illinois Studies in Inquiry Training.

Dr. Joseph Novak of Cornell University added considerable insight into the potential of Inquiry Training when the Suchman method was allowed to undergo modification.

My understanding of the mechanics behind the original proposal for ISIT was enhanced by an in-depth discussion with Dr. J. Myron "Mike" Atkin at Stanford University.

Dr. Jim Fejfar of the University of Nebraska at Lincoln, gave me much support, enthusiasm, and considerable information of the day-to-day workings of the

ISIT team. Dr. Fred Wilkin of National-Louis University took me step-by-step through the in-service procedures of Inquiry Training.

Any historical essay is dependent upon considerable library assistance. This thesis would not have been possible if it were not for the Reference and Research Librarians at the Julia Deal Lewis Library of Loyola University Chicago who gave me their time, expertise, and support. Michelle McConnell at Loyola University Center for Instructional Design also contributed her editing expertise and helped to make this thesis possible. In addition, the University Archivists at the University Library of the University of Illinois at Urbana-Champaign, Mr. Maynard Brichford and Mr. Bob Chapel, assisted me in my historical trek through memorandums and agendas of countless ISIT and NDEA meetings as well as in my understanding of Suchman's departure.

Finally, I wish to express my gratitude to my wife, Natividad, for supporting this effort from its inception.

May 1993

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Amidst the clamor of American educators wailing over the impressive gains achieved by Soviet scientists in the launching of the artificial moon Sputnik on October 4, 1957 one American educator looked to the natural inquisitiveness of a young child. A child's curiosity could unlock mysteries much more significant than the hurtling of hardware into space by means of a rocket propellant.

This American educator was not willing to throw away recently achieved gains in structuring inductive learning even though there were many in the field of education who wished to direct America's schools into a European inspired essentialist philosophical base. This base, they would argue, would put renewed emphasis into science and mathematics. This base would be the foundation on which rigid subject-centered curricula would nourish the intellectually-starved children of America and allow America to take its place at the head of all democracies and to counter the threat from the Soviet-led Warsaw pact nations behind the Iron Curtain.

While the essentialists prepared to provide structure anew in America's schools, Joseph Richard Suchman sought a return to America's progressive roots. Suchman wished to incorporate the existing inductive learning tenets surfacing in the 1950s into a learning environment dictated autonomously by the child as the child begins to seek knowledge.

Other educators espousing innovative learning methodologies pursued their dreams through the university based research venues or as professors of educational methodology addressing graduate or undergraduate students. Suchman, on the other hand, watched young children at work in elementary schools and marvelled at the thought that if education could truly address a child's needs, an entire lifetime of cognitive skills acquisition necessary for growth, maturity, happiness, and yes, building a better America, could be fostered.

This is the story of Joseph Richard Suchman and the work he sponsored while at the University of Illinois at Urbana-Champaign.

The significance of Suchman's Illinois Studies in Inquiry Training (hereinafter referred to as ISIT) lies not only with the research and development which produced Inquiry Training itself as an educational methodology, but also with the implementation of a strong network of development centers which would make the research available to elementary school teachers throughout the United States in meaningful, well-structured workshops.

Inquiry Training, in its concept, sought to facilitate active participation by students in the learning method which was, itself, based upon a modification of the Scientific Method. As a result, school children would be encouraged to act as scientists as they empirically studied their world. Children would understand concepts through successful questioning, and the resultant hypothesis-formation and hypothesis-testing would serve to lead the child on a heuristic adventure.

This paper will pursue the ISIT team from its early days conducting pilot

studies, through its days where it shared attention with the United States Department of Health, Education, and Welfare and on to the days when replicated models allow us to view the phenomenon of the self-correcting method of science as it came to grips with the empirical shortcoming of Inquiry Training.

A review of the literature will serve to pinpoint flaws in approaches; this will be corroborated by a look at shortcomings with the domain of quantitative analysis. Bright points will also surface in this review, particularly when the author shares some anecdotal information about his own replication of Inquiry Training at Loyola Academy in Wilmette, Illinois.

Key sources to be examined in the critical review include the ISIT documents; observations of those who attempted to replicate Inquiry Training, including this author as he taught a three-dimensional design class; comments from ISIT team members themselves; and comments from those who worked in unison with the ISIT team.

This paper will provide an ex post facto look at ISIT as a case study with considerable ramifications for American educators today in the 1990s. It will be posited that had not Suchman and his team blazed their trail in inquiry-based learning, thus keeping alive the hopes of Bruner and Piaget before them, the current constructivists might not be experiencing the success they enjoy today.

Suchman's modification of the scientific method has been found to be quite innovative. Witness the many forms of inquiry-based learning springing from Suchman's work, each attempting to foster a love in children for that particular

discipline and having as a goal the child's duplication of efforts of actual professionals in that field: historians encouraging children to seek an understanding of history as an historian would, and biologists fostering a love of biological science so that children seek out systems and make comparisons and contrasts as would the biologists.

Not only did Inquiry Training produce inquirers, it also encouraged the inquirers to reflect on those newly-discovered questioning techniques for the expressed purpose of improving their own analytical capabilities so that ever-increasing sophistication and effectiveness would result when later questions needing answers arose. An example of this questioning format is as follows:

> One morning, as Mrs. Harrison's fourth grade class is settling down to their arithmetic workbooks, she calls their attention. As they raise their eyes toward her, a light bulb directly over Mrs. Harrison's desk blows out, and the room darkens...
>
> Mrs. Harrison unscrews the light bulb and holds it up. The children gather around, and she passes it among them. After she receives it, she says, 'Well, why don't you see if you can develop a hypothesis about what happened?'
>
> 'What's inside the glass?' asks one of the children.
>
> 'I'm afraid I can't answer that,' she replies. 'Can you put it another way?'
>
> 'Is there air inside the glass?' one questions.
>
> 'No,' says Mrs. Harrison.
>
> 'Is there a gas inside?' asks another.
>
> 'No,' says Mrs. Harrison. The children look at one another in puzzlement.
>
> Finally, one asks, 'Is it a vacuum?'

'Yes,' nods Mrs. Harrison.

'Is it a complete vacuum?' someone inquires.

'Almost,' replies Mrs. Harrison.

'What is the little wire made of?' asks another student.

'I can't answer that,' says Mrs. Harrison. 'Can you put it another way?'

'Is the little wire made of metal?'

'Yes,' she agrees.

Asking questions such as these, the children gradually identify the materials that make up the light bulb and the events that took place. Finally, they begin to venture hypotheses about what happened. After they have generated four or five of these, they search through reference books in an attempt to verify them.[1]

Children from higher socio-economic levels were the initial target populations for the ISIT team. It is with great irony that this paper will note that later replications of Inquiry Training gained widespread acceptance from children of lower socio-economic backgrounds as well as from children with handicapped and learning-disabled backgrounds.

Be that as it may, the major problematic concern, one echoed by several experts who have been consulted, is that empirically Suchman could not count on quantitative analysis, as practiced in the 1960s, to demonstrate the methodological veracity of Inquiry Training. True, statistical tests could demonstrate increased interest among the elementary school children and learning equal to the content-based learning in traditional essentialist-run classrooms, but it could not be proven that the question-asking format devised by Suchman specifically led to better insights and a

more profound grasping of subject matter.

The unsuitability of traditional quantitative analysis to validate the planks of the Suchman platform of Inquiry Training could only hurt the acceptance of the ISIT and Inquiry Training as the inquiry-based model of choice in the 1960s and 1970s.

Had quantitative analysis techniques along the lines of a naturalistic and participant-oriented manner been acceptable standard operating procedures in the 1960s, perhaps the Suchman model could have been provided with the sorely needed authentication to allow it to flourish in thousands of classrooms rather than forcing it to languish in a relatively short time in only hundreds of classrooms.

The entire lifespan of ISIT has been lived and can be studied. We are able to stand in judgement of its outcomes. We are able to analyze the major fruit of ISIT research: Inquiry Training.

This critical review will look into the independent variables of the research design: a discrepant initial event causing widespread dissonance in the elementary school classroom but also providing a problem each child is eager to solve. Indeed, the child must solve it to be able to place this new knowledge within the conceptual framework of its experience. The next independent variable is the use of a questioning format quite conventionalized so as to permit questioning along the lines of the scientific method without necessitating extensive laboratory time within the school day. Another independent variable would be any tool which the inquiry team felt necessary to provide to the students with clarity as they perceived the problem at hand. (This author uses the model of a geodesic dome. Suchman himself used

equipment necessary to make a model of a deep-sea diver as the diver entered the water.) A videotape camera would also be helpful to allow the children to view their own questioning strategies in the classroom as part of the evaluative stage.

This paper will look into the dependent variables: both the inquiry produced by each child as well as the knowledge (or perhaps insight is a more appropriate term) gained when the child is cognizant of how he or she does indeed ask questions.

Inquiry Training has, as its focus, a strikingly different rationale from its inquiry-based competitors of the day: it is not content-based but works exceedingly well in fostering respect for content in any number of practical curricular applications ranging from economics and physics all the way to training military policemen!

It does so in a radically new way. It does not fit within the context of what Thomas S. Kuhn, the radical science historian, would call "normal science."[2] It does not serve to be an end in itself but rather the vehicle by which to transport the child to any number of wonderful searches to resolve puzzling--yet challenging--situations. Suchman was fond of quoting Archimedes' "Aha!" as the response most appropriate when a person resolves a confounding situation by means of one's own cognitive capabilities.

This author witnessed the "Aha!" experience in the high school classroom over thirty years after the pilot studies were developed. And for this reason, ISIT methodology can now be viewed and scrutinized through the clarifying lens of over thirty years of elapsed time.

ISIT's brilliant beginning, meteoric rise, sudden collapse, and rebirth through

interesting replications throughout the 1970s, will serve to give the reader a breathtaking look, as Kuhn would posit, at one major paradigm destined, as all are eventually, to die out, leaving in its wake other critical thinking viewpoints to take center stage. If Kuhn is right, all discovery of major import will necessitate major reworking of accepted paradigmatic thinking, as Suchman's once did, and as other's work eclipsed ISIT.

As science (and concomitantly, education) advances, it does so at the expense of what can be called conventionally-accepted wisdom. After all, is it not possible--even probable--that within the domain of physics the unified field theory is now in danger of foundering? Yet, even so, few physicists would question the benefits derived from the unified field theory paradigm in explaining previously confounding phenomena. So, too, did Inquiry Training seek to clarify the process of inquiry.

Issues for the reader to consider at the conclusion of the research should fuel healthy debate and thoughtful consideration, otherwise that body of research has existed in vain in terms of adding to mankind's storehouse of knowledge.

While other educators sought to lay blame with the progressives for America's educational deterioration in the 1950s, one educator shed light on the importance of the child finding its own way and in time to lead others to the joyful search for knowledge. This knowledge would possess an immediacy and an authenticity so electrifying so as to encourage the child to seek ever more complex solutions to ever-more confounding problems.

Joseph Richard Suchman did not wish for the schools to impart knowledge but

for each child to autonomously invent knowledge.

1.Bruce Joyce and Marsha Weil, *Models of Teaching* (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1986), pp. 55-56.

2.Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1970).

CHAPTER II

REVIEW OF THE LITERATURE

First and foremost, a review of the literature of the Illinois Studies in Inquiry Training must explore the paradigm developed by Dr. J. Richard Suchman.

Keeping in mind that his method is not an attempt to teach the content of science but rather the method of science, the reader is readily drawn to the fundamental difference between this type of learning and the more traditional one most of us grew up with: "...(W)e must prepare them to inquire productively, combining bold, creative thinking with the rigor of logical analysis."[1] Suchman's bold attempt to make children active in their own learning had a precedent in the work of Max Beberman while both were at the University of Illinois at Urbana-Champaign.[2] Beberman indicated discovery as being a powerful tool for a child's education. Suchman agreed, and he ardently believed that the utilization of this discovery variable alongside student inquiry could ignite America's educational recovery.

America was then doubting itself as a nation capable of achieving parity with the Soviet Union which had, in October of 1957, launched the world's first artificial moon, Sputnik. This extraordinary achievement drew the world's praise as just how far the educational system of the Soviet Union had progressed since the days of the

Russian Revolution, only forty years earlier.

American doubt centered around the Progressive Movement of John Dewey and this country's preference for the method of learning taking preference over the content of the subject matter itself. There were many in the educational field who would have supported Vice-Admiral Hyam Rickover, a leading proponent of content-based learning, in abandoning the Progressives and seeking a return to a rigorous national curriculum based upon strict adherence to the tenets of each academic discipline.

Not that a rigorous regimen in curriculum development was anathema to Suchman--far from it--but Suchman sought a rigorous regimen internally within each student. Indeed, not only should each student seek discipline from within, but the basis for the acquiring of knowledge as well as the testing of the efficacy of that very knowledge must come from the student.

It took a great deal of courage for this young Ivy League-trained professor to suggest a retrograde maneuver to a belief system firmly rooted in John Dewey's empirical method now out of favor with many in American education.

Inquiry Training begins with the premise that the need to know will overcome initial cognitive confusion. So much so, that in fact a student will not want to leave a problem until the student knows precisely why some event happened for which there was no previous explanation available that successfully could explain such physical behavior. Such a physical event causing cognitive confusion Suchman called a discrepant event.

This discrepant event could be a light bulb burning out for elementary school children. It could be, in the case of high school seniors this author teaches, an engineering model of a geodesic structure collapsing for no immediately understandable reason.

This phenomenon is able to excite the learners in the classroom: they don't want to leave until they know why the event happens. In addition, they want to determine the cause rather than have a teacher tell them the cause.

And for a teacher to be suitably equipped in this educational adventure, the teacher must know how to cognitively assist the children in their own understanding of the answer. This assistance comes to them in the form of Inquiry Training.

A series of questions are asked by the children; the children expect the teacher to readily provide them with an answer. But in an approach unique to Inquiry Training, the questions are redirected to the children.

The teacher can only answer "Yes" or "No" thereby limiting the initial questioning to one concerned with the determination of the boundaries of the problem to be solved.

The specific goal of this initial stage, dubbed by Suchman the Episode Analysis, is to identify, verify, and measure all that is needed in the explaining of what, indeed, happened in the discrepant event.

To analyze the episode, the student must first describe it in a logical and scientific manner. To do so, the student must utilize certain categories; these categories provided the basis for a logical construct in which each element has a

demonstrable relationship to the other elements.[3] Each episode-analysis consisted of the following categories:

Objects, including two or more objects which together make up a system. This system has a property that each component therein did not. Suchman cited a beaker of water as such a system.[4]

Properties, the predisposition of an object to act in a predictable manner under a certain set of conditions.

Conditions, which are observed or measured and deal with the state of objects or systems.

Events, which are changes in the conditions of objects or systems.

The student utilizes the above categories in the framing of questions in an inductive manner.[5]

The child collects data and then organizes it. Suchman was careful to explain the need to avoid perceptual Gestalts, those ways of thinking whereby new events and situations are perceived as total patterns. These Gestalts, unless accepted for what they are, can cause problems in the correct inductive processing of the objects, events, and conditions of the interaction.[6]

As an example of the perceptual Gestalts, in a two-dimensional design class which the author instructs, high school students can typically misunderstand how a geodesic configuration can be formed using glass tubes. If the student can observe other geodesics, the student can make the mistake of falling prey to a Gestalt truism which leads the student to constructing the entire geodesic with a mixture of

congruent pentagons and hexagons. The mistake comes in the failure to realize that the pentagons, as well as the hexagons, may need to be truncated so that the hemispherical configuration, and not a quasi-cylindrical configuration, will result. "A thorough and orderly assessment of the objects, conditions, and events of an episode increases the probability of gathering all the significant data."[7]

In the second stage, the Determination of Relevance, the student's assessment must be necessary and sufficient to explain--and later to replicate--the episode's events.[8]

Suchman called this the determination of criticalness.[9] As Suchman conceived it, this stage was to be an empirical solution to the understanding of the causation.[10] Yet, it is essential for the reader to understand what, in this case, Suchman considered to be "empirical." The reader is reminded that, although the tenets of Inquiry Training could be utilized in a traditional laboratory setting, Suchman's focus was on elementary school children who were <u>not</u> in a laboratory setting. The "experimentation" thus considered was to be of a semantic nature. Questions directed to the reader for a verification or nullification were to take the place of testing in the laboratory. It was hoped that the student could, indeed, determine what was relevant to the student's understanding of the components of the event(s).

The third stage, the Education of Relations, allowed the child to formulate and test those constructs which could allow for a replication of the event in another setting.

Experimentation, again, is the venue by which to determine relationships

between objects, properties, conditions, and events. A difference from the earlier stage would be that in the third stage, each semantic experimentation serves to test the veracity of a student-generated hypothesis, not just to test possible relationships having a bearing on the observed event. Quoting Suchman: "(The child) learns that the value of any rule he constructs is a function of (1) its validity within a specified realm of applicability and (2) the scope of this realm."[11]

Suchman spelled out the optimum criteria with which to implement Inquiry Training. Class size would be no greater than thirty: ten children would be engaged in the Inquiry Training, and the remaining twenty children, in two groups of ten, would evaluate the progress of those undertaking the experience. Each training session (he later regretted the naming of the methodology as "training") would last one hour and be held once weekly, although he allowed for revision of that requirement in later studies.[12] Each training session consisted of the three-pronged objectives of practice, corrective feedback from the observers and instructor, and exposition.

After the presentation of the discrepant event, the children would begin the inquiry procedures. In the aforementioned questioning, children either ask questions to verify the existence of knowledge or to question in what this researcher calls the "semantic experimentation." Inferences are derived by the child and based upon the empirical data the child found. The Inquiry Training process is completed in one of three ways:

1) The student has successfully explained the event and his/her knowledge has

achieved the necessary "criticalness" so that the discrepant event could be replicated

2) Time runs out for the Inquiry Training in the allotted time for the procedure

3) The children's conceptual development has not reached the stage necessary for comprehension, thus effectively nullifying its efficacy.

Suchman admitted that the second way, time expiration, was the result of many attempts at utilizing Inquiry Training in the early 1960's.[13]

The critique is begun at the conclusion of the learning experience. In a modification of his earlier study, Suchman felt that immediate feedback would be more beneficial than the use of playing back tape recordings of the session. In addition, he agreed with those who suggested that the teacher could provide stronger suggestions for improving the children's inquiry at the teachable moment and not after the session has ended, thereby reinforcing the likelihood that the student would, indeed, retain that piece of criticism.

At the heart of the critique Suchman hoped for each student to accept the fact that his particular attempt to inquire could be improved, thereby making his/her next application of Inquiry Training much more productive. Less time would be spent on needless verification of observations, and hypothesis testing could be more accurately targeted.

To assist the student in making the learning more likely to result in discovery Suchman outlined the manner in which Inquiry Training would assist the student in processing his data.

The following processes were deemed as having the most to offer in terms of facilitating discovery: analysis, comparison, isolation, and repetition.

In the analysis process the component parts of data are systematically derived. In the comparison process those parts deemed similar are linked together to form similarities or they are counter positioned against contrasting parts to clarify the differences. In isolation, important, yet minute, variables are isolated so as to be intensely scrutinized. In repetition, the data are configured so that every possible relationship may be seen.

Once the actual discovery is achieved, that discrepancy or dissonance, as Suchman called it,[14] would be overcome by a cognitive act. This cognitive act could be the result of careful analysis; it could be the result of matching two concepts[15] by similarities between patterns of data with patterns previously experienced. Conceptual shift, the ability for the learner to "make" (author's quote) new knowledge due to the inadequacy of the learner's previous storehouse of experiences to explain or account for the discrepant event, could also result in this cognitive act.

Suchman, interestingly enough, left the door open to a much more complex possibility for researchers to examine: the attempt to teach students how to create their own conceptual systems. But this lay outside the scope of Inquiry Training at that time. Rather, Suchman directed the then-current level of Inquiry Training to focus on the efforts of analysis and the comprehension of relations as the best means by which to facilitate the cognitive act.

Suchman's Inquiry Training was only one of several efforts to identify

inquiry-based learning.

Geisinger stated that Suchman's approach was "...(T)he general approach with a particular purpose..."[16] while Maw's was "(T)he particular approach with the general purpose..."[17] and that Beberman's was "(T)he particular approach with a particular purpose."[18]

"Thus Suchman envisioned his treatment as useful for a general purpose--autonomous inquiry--but used it only in the particular area of physics."[19] (This, of course, is a reference to the pilot study of 1957. Further applications of Inquiry Training would be seen in economics, geology, and even in military police study.)

Continued Geisinger: "Maw's treatments were designed to create a particular ability, but a test of general ability was the criterion. Beberman's treatments were designed to produce the ability to solve mathematical problems, and were tested for this particular purpose."[20]

Glenn Robert Linnert provides the reader with a most comprehensive description of the various inquiry-based learning methodologies. In his dissertation[21] Linnert quotes Schwab's definition of teaching science as inquiry; Massialas pronounces the role of students and teachers in inquiry in the same dissertation; additionally, Postman and Weingartner are quoted in their identification of the components involved in teaching in an inquiry manner. This author will excerpt from the above as this is quite pertinent to our understanding of Suchman's slant on inquiry-based learning. The reader is invited to make conjectures as to how the

competitors to Suchman differed in their approaches.

> (From Schwab in a 1963 study)
> ...(K)nowledge arises from the interpretation of data.
> ...(T)he analysis of data and even the search for data proceeds on the basis that concepts and assumptions change as our knowledge grows.
> ...(B)ecause certain concepts and principles change, knowledge changes, too.
> ...(T)hough knowledge changes, it changes for a good reason--because we know better and know more than we knew before.[22]

> (From Massialas in a 1969 study)
> The roles (of teachers) are as follows: the teacher as planner, the teacher as introducer, the teacher as questioner and sustainer of inquiry, the teacher as manager, the teacher as rewarder, and the teacher as investigator.[23]

> (From Postman and Weingartner in a 1969 study)
> He (the teacher) has persistent aversion to anyone, any syllabus, any text that offers the Right Answer. He is interested in students developing their own criteria of standards for judging the quality, precision and relevance of ideas. He rarely summarizes for...he assumes that one is always in the process of acquiring skills, assimilating information, formulating and refining generalizations.... He measures success in terms of behavioral changes in students: the frequency with which they ask questions, the frequency and conviction of their challenges to assertions made by students, teachers, or textbooks.[24]

In the *Merrill-Palmer Quarterly*, Dr. Suchman explores the theories supportive of his unique approach to inquiry. Keep in mind that there were at that time several good educational methodologies that utilized inquiry-based learning: Schwab's 1965 Biological Sciences Curriculum Study; the Social Science Curriculum Project of Lippitt, Fox, and Schaible, (1969); Social Science Inquiry of Massialas and Cox (1966); as well as the time honored Deweyian approach of Group Investigation most cogently put into a model by Thelen in 1960 and, most recently, by Sharon and associates in 1980.[25]

In addition to models specifically dealing with inquiry one need be aware of similar educational methodologies of this time period which also dealt with inquiry without using inquiry itself as the focus. The Inductive Learning approach of Hilda Taba (1966) comes to mind as does the concept attainment model of Bruner, Goodnow, and Austin (1967). The work of Suchman's University of Illinois colleague, David Ausubel, and his 1963 landmark Advance Organizer model, also deals indirectly with motivational aspects of discovery. Whereas Dr. Ausubel ended his model with students attaining concepts, Suchman uses this as a point of embarkation to an autonomous and joyous discovery for the student; an upward "spiraling" of inquiry refinement.

J. Richard Suchman's version of inquiry does away with the use of a laboratory setting. His "audience", so to speak, is of elementary school age. He does not want precious student time gobbled up with laboratory methodology. Rather, students ask questions which are answerable in simple "yeses" or "nos", thus allowing for student-generated data-gathering which inevitably leads to student-generated inferences. These inferences, or hunches, are then "tested" and the resultant validity or invalidity dealt with by the teacher heuristically.

He is, so to speak, taking the laboratory out of the science, but not the science out of the curriculum. As a matter of fact, he is challenging educators to implement inquiry training in "...every other curriculum area that requires the performance of empirical operations, inductive and deductive reasoning, and the formulation and testing of hypotheses."[26]

Suchman goes on: "Inquiry will not occur in a vacuum. The autonomous attainment of new meaning and comprehension--the unification of diverse experiences through the discovery of principles and generalization--this is what inquiry holds for those who learn to use it productively."[27]

Ironically, Inquiry Training is not predicated on a firm research basis. Curiosity and the resultant quest for satisfying curiosity can't be explained in traditional motivational theories.[28] Suchman preferred the studies of R. White over Hullian and Freudian paradigms as a way to explain this cause-effect relationship between curiosity and its satisfaction. In other words, humans seek truths because of intrinsic rewards in the search itself. (Incidentally, Suchman casts a great shadow over those educators who favor grades and rewards as prime motivations!) Suchman quotes Bruner's belief in "intellectual potency" which the student accrues through successful self-discovery:

> In short, what White, Bruner, and Dewey are saying is that concepts are the most meaningful, are retained the longest, and are most available for future thinking, when the learner actively gathers and processes data from which the concepts emerge. This is true (a) because the experience of data gathering (exploration, manipulation, experimentation, etc.) is intrinsically rewarding; (b) because discovery strengthens the child's faith in the regularity of the universe which enables him to pursue causal relationships under highly frustrating conditions; (c) because discovery builds self-confidence which encourages the child to make creative intuitive leaps; and (d) because practice in the use of the logical inductive processes involved in discovery strengthens and extends these cognitive skills.[29]

In addition to White, Dewey, and Bruner, I should add the names of Barbel Inhelder and Jean Piaget to the list of major influences on the young Suchman. While the former stressed the need for inquiry-based learning, the latter delved, in

considerable depth, into the process of learning. Young children, those said to be "pre-operational" in Piagetian terms, are not capable of extrapolating effects from causes. Once the "operational" level is reached the child is capable of cursory attempts at making order out of chaos, more accurately, making theoretical constructs with which to allow attempts at predicting and controlling events.

This type of learning places considerable demands on the teacher. Suchman succinctly mentioned the transformation required of a teacher in an inquiry-based mode:

> The teacher must abandon his traditionally directive mode and structure an environment which is responsive to the child's quests for information... The educator should be concerned above all with the child's process of thinking, trusting that the growth of knowledge will follow in the wake of inquiry.[30]

An aside is called for at this point in the paper. The State of California took the lead in the dissemination of the techniques of Inquiry Training as well as in the actual implementation in its public school system as early as 1961. This was a remarkable happening in that the pilot study for ISIT was initiated only five years earlier! Although the focus of this paper is on the ISIT team, a look at the wide scale curricular inclusion of Inquiry Training may give the reader an idea of the hopes of many in the educational field for the success of this bold innovative methodology in its attempt to revitalize post-Sputnik American education.

Conferences, county-wide meetings, and local institutes were the sites for Inquiry Training workshops. As many as six regional associations and even a state-wide council were formed to promote Suchman's ISIT research.

According to the ISIT team's newsletter from December 1964, the following

people were instrumental to the end of establishing Inquiry Training as an accepted method in California's public schools: Charles Lavaroni, Assistant Superintendent of the San Jose District, Marin County; Mary Durkin, Elementary Consultant, Contra Costa County; Ben Strassner, Science Consultant, Los Angeles County; Lydia Kraus, Assistant Superintendent, Madera County; Louis Beck, Elementary Consultant, Riverside; Eugenia Bernthal in Pasadena, California.[31]

Dr. J. Richard Suchman, Dr. Rosslyn Suchman, and Mr. Charles Lavaroni at San Francisco State College conducted a four-week summer institute at which forty-eight participants enrolled. This program was co-sponsored by the San Francisco State College, California State Department of Education, and the U.S. Office of Education.

The newsletter mentions that Dr. Rosslyn Suchman was a former psychological consultant to ISIT who served as a Research Assistant Professor of Psychology at UCLA, and who, in 1964, was an Associate Professor in the Office of Psychological Research at Gallaudet College, Washington, D.C.

> Most of the teachers worked with have shown interest in finding out about new approaches, particularly when these are accompanied and followed by interpretive comments that show why each step or strategy in the teaching stems from some consistent theoretical structure. If the theory is understandable and acceptable to the teacher and the results of the methods are desirable and clearly observable, the teacher is usually willing to undertake some kind of in-service training in order to become proficient in it.[32]

The in-service mentioned above by Dr. J. R. Suchman called for a person capable in the utilization of Inquiry Training who could spend time with the teacher as a mentor. This mentor could provide useful criticism.

Suchman, however, did not intend this to be one teacher imitating another who was experienced in this approach, but rather one teacher providing assistance to another as he/she sought to make, and refine, his/her own "brand" of Inquiry Training.

As Suchman pointed out, "Without learning why the new approach has desired effects, the teacher cannot adapt it to fit his own style of teaching. If the approach is learned only as a 'method', an externalized set of rules, it may never become part of the teacher's total mode of operation and may therefore have no lasting effect."[33]

This in-service training had three target goals: (1) demonstration (2) interpretation and (3) guided practice.

The demonstration served to showcase the wide variety of Inquiry Training episodes. The interpretation dealt with the every day application of Inquiry Training as well as the theoretical grounding. The guided practice consisted of the institutes which sought to train, assist, and guide those who would implement Inquiry Training in their own classrooms.

> By preparing a group of inquiry training specialists and providing them with special materials to facilitate demonstration and interpretation on a continuous basis, the objective was to reach a significant number of teachers with a program of curriculum change that will have an immediate impact and permanent effect on curriculum organization and teaching methodology.[34]

Suchman saw a short-term and a long-term goal for these so-called Demonstration Centers. The former was to introduce this methodology to some school districts. The latter was to replace much of the "teacher-programmed learning."[35]

The Demonstration Centers were also begun in the State of Illinois, although a bit later than in the State of California. Some comments from participating teachers should serve to provide the reader with a random look at professionals on the cutting-edge of educational methodology:

> Most students took readily to the problems and remained interested as long as problems seemed puzzling... Economics worked best since students hadn't been taught this in school. A few students progressed to the point where they were distinguishing between various levels of theory.[36]

> Mr. Reick tried inquiry training with one sixth grade gifted section, two eighth grade fast sections, and two eighth grade slow sections. He found, somewhat contrary to his expectations, that it worked very well with the slow sections.[37]

1.J. Richard Suchman, "The Elementary School Training Program in Scientific Inquiry," U.S. Office of Education Reports, 1966, p.i.

2.Mr. Bob Chapel discussed this point with the author in the University of Ilinois Urbana-Champaign Archives, Oct. 23, 1992.

3.J. Richard Suchman, "Inquiry Training in the Elementary School," *Teaching: Vantage Points for Study,* ed. Ronald T. Hyman, p.477.

4.Ibid., p.477.

5.Ibid., p.478.

6.See the work of the Hanover Institute for exciting developments in the understanding of Gestalt phenomenology.

7.J. Richard Suchman, "Inquiry Training in the Elementary School," *Teaching: Vantage Points for Study*, ed. Ronald T. Hyman, p. 478.

8.Ibid., p.478.

9.Ibid., p. 478.

10.Ibid., p. 478.

11.Ibid., p. 479.

12.Ibid., p. 479.

13.Ibid., p. 481.

14.J. Richard Suchman, "The Elementary School Training Program in Scientific Inquiry," U.S. Office of Education Reports, 1966, p.17.

15.Ibid., p. 18.

16.Robert Willis Geisinger, "Inquiry Training: Results in Tenth Grade Students of Complex Heuristic Treatments" (a doctoral dissertation, University of Pittsburg, 1964), p. 6.

17.Ibid., p. 6.

18.Ibid., p. 6.

19.Ibid., p. 6.

20.Ibid., p. 6.

21.Glenn Robert Linnert, "The Effects of Inquiry Training on Fifth and Sixth Grade Teachers Who Differ as to Basic Belief Systems" (a doctoral dissertation, Purdue University, 1976).

22.Ibid.

23.Ibid.

24.Ibid.

25.Bruce Joyce and Marsha Weil, *Models of Teaching* (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1986), pp. 5-11.

26.*Merrill-Palmer Quarterly*, p. 168.

27.Ibid., p. 168-169.

28.Ibid., p. 151.

29.Ibid., p. 148.

30.Ibid., p. 151.

31.The Illinois Studies in Inquiry Training Newsletter, University of Illinois Urbana-Champaign Archives. December 1964.

32.J. R. Suchman, Principal Investigator, "Demonstration Center: Part II--Elementary School Programs in Scientific Inquiry for Gifted Students," U.S. Office of Education Reports, March 1968. p.5.

33.Ibid., p. 5.

34.Ibid., p. 7.

35.Ibid., p. 7.

36.Ibid., p. 40.

37.Ibid., p. 42.

CHAPTER III

PROBLEMATIC CONCERNS OF INQUIRY TRAINING

Manusov, in his dissertation for Temple University, sought an examination of Suchman's criteria for the classification concerning his questioning categories. Manusov also takes an in-depth look at Suchman's views on causality, which is integral to our understanding of Inquiry Training. Manusov takes a dim view as to Suchman's claims for clarity in the eleven questioning categories and, in addition, finds fault in the schematic development of the types of questioning that elementary school children should be expected to undergo.

Manusov does agree that at the conclusion of the sessions, the school children did ask fifty percent more questions than did a control group; however, he would ask us to look at the questions in a very discriminating light. Children use all senses when learning.[1] Can't it be argued, I can imagine Manusov asking, that we are channeling a child's response into a very narrow tunnel when we ask the child to draw conclusions based upon viewing a film of scientific occurrence rather than manipulating all facets of the environment while experiencing the experiment firsthand?

Also, what type of response are we seeking if it is the practice to elicit positive responses from the teacher? Manusov himself states "...(T)here is no good

and sufficient reason for classifying student's questions into one category over any other. The categories are not consistent, certainly not clear and, by definition, not mutually exclusive categories."[2]

Suchman initially considered over one hundred variations in the structures of questions.[3] After careful analysis (can we assume the ISIT team utilized the same attack on problem-solving that it espoused for elementary school children?) the over-one hundred number was pared down to eleven categories, compartmentalized into the following categories:

(1) Questions of verification: questions used for the comprehension of the discrepant event and included herein were categorical as well as analytical verification

(2) Questions of implication: questions used in the search for relationships between variables and included herein were considerations of abstract-conceptual, concrete-inferential, and concrete-conceptual.

If the teacher could understand the types of questions utilized by the learner in the classroom setting, then the learner could reveal much of the method behind the learning and, with increasing exposure to corrective evaluation, the learner could utilize more successful questioning aimed at seeking workable hypotheses to test without much of the unnecessary dependence upon the abstract-conceptual questioning.[4]

In the case of this researcher who utilized Inquiry Training questioning techniques in a class of twelve high school design students, the hoped for transition

from abstract-conceptual questions toward questions of an inductive nature is evident.

The discrepant event was a failed geodesic dome model made of plastic tubes and florist wire. When the class was exposed to this the following comments were heard:

"It's supposed to be a semi-circle dome..." (Student B is helping out Student A whose dome collapsed. Student B is indeed verifying the geometric concept of "dome" as being a necessary piece of knowledge needed to complete this project correctly. He is also making a further clarification by mentioning that this dome must be hemispherical, his reference to a "semi-circle dome.")

(Pointing to what Student A had built, Student B says the following): "This is a cylinder." (Again, he is grasping a geometric concept which is necessary in the identification of the mistake and also is necessary prior to the correction of the error.)

"Take a bathroom towel thing." (That is, the cardboard tube used to anchor tissue paper.)

"Stick it up and attach the triangles and work it down." (That is, place the top of the failed dome at the top of the cardboard tube and work downward when constructing the geodesic.)

(Student B is now actively engaged in problem-solving. He has mentioned the conceptual flaws to Student A and now is inductively suggesting a more successful construction technique.)

Manusov makes a powerful point when he suggests that an answer to a

question of causality is in the form of "yes" or "no."[5] Manusov also drives another powerful wedge into Inquiry Training when he deals with the particulars of this type of inquiry--physical science inquiry--over social science inquiry or life science inquiry. I would like to spend some time on this as this is an area of interest that I have, and it should address the concerns of the different foci that Suchman's Inquiry Training has over, for example, Massialas and Fox or Schwab, et al.

When one deals with teleological definitions of reality one is concerned with scientifically valid explanations which can be replicated in the laboratory under proper conditions. However, the world of social science or even economics (an area dealt with by Suchman towards the end of Inquiry Training) must, of necessity, deal with the world of generalizations of social or economic observations. These are not any less important for the scientist to study but exceedingly more difficult to replicate. Can we, for example, reproduce the social, economic, and political undercurrents of 1861 America and produce another Civil War? A bit far-fetched, perhaps, but precisely the point Manusov is trying to make. Different branches of science necessitate far different questioning and work towards different ends.

In Suchman's effort to make inquiry just like the scientists do--a heuristic goal for school children--he takes the very essence of scientific inquiry out of the inquiry, so might argue Manusov. He might, therefore, invalidate that which he is trying to replicate at a simplified elementary school level.

Manusov states in no uncertainty: "What is important is the recognition that causal chains represent only one class of scientific generalizations."[6] And Suchman

does not deal with different levels of truth-seeking and theory stating. One child's simplistic theory may not be as neat and precise as another's yet it may very well be right on target.

My eleventh and twelfth grade Three-Dimensional Design students, who were confronting a failed geodesic dome model made of glass tubes, stated the following explanations (theories?):

---(When one builds a geodesic this way) "You are really making a cylinder--it goes all the way up; it really isn't a geodesic." This is a statement of what was done improperly.

---"He has to alternate hexagons with pentagons so that the top gets more scrunched up and pounded-off like a dome." This is a statement of what should have been done to properly construct the model.

Both statements are true--and scientifically valid theories. One, however, (the latter) allows for the replication of a geodesic another day in another classroom. Is that explanation any more valid in the "physical science" sense than the former?

Manusov does indeed strike a damaging blow to the credibility of this classroom exercise in causation-finding and causation-testing.

Glenn Robert Linnert has done exhaustive research into the various types of inquiry training which were espoused in the 1960s and 1970s. Chief among them was J.J. Schwab's (1963) teaching of science as inquiry. Others included Massialas (1969), Postman and Weingartner (1969), DeVito (1975), Sund and Trowbridge (1967), Voss and Brown (1968), and Romey (1968). Taba's landmark work (1966),

as well as Bloom's masterpiece of cognition (1956) and all the others, receive their inspiration, in part, from John Dewey (1903) and his seminal study of inquiry in the Progressive mode.

Of all the types of inquiry training, it could well be the work of Dr. Joseph Novak at Cornell University which, at one and the same time, formally changes the direction Suchman's team was taking and gives inquiry training the long-needed and desperately hoped-for proper scientific basis.

This "guided" approach to inquiry takes what was the best of Suchman's work and transforms the model into one with set parameters for both the teacher and the pupil.

Professor Joseph Novak at Cornell University has followed closely the Suchman experiment in inquiry. He uses the words "enormously capable and energetic" to describe Dr. Suchman but adds that there was considerably more "zeal than theoretical foundation" in the direction the ISIT was following. David Ausubel, with whom Novak has worked, was also in a "friendly dialogue" with Suchman while both were at Illinois. Novak suggests that Ausubel found the inquiry learning path to be unproductive. "(Suchman's) work was a reaction to behaviorism; cognitive learning theory came out of behaviorism....Suchman was following Dewey's work in the early 1900's."[7]

Professor Novak has taken inquiry training and placed it within a "guided" methodological format. Joseph D. Novak and D. Bob Gowin flesh out this "guided inquiry" in their book *Learning How to Learn*[8] and in the book make reference to a

singularly pivotal work inspiring both of them, the work of David Ausubel (1963, 1968)[9] whom we have already cited. Ausubel was keenly aware of Suchman's work. Novak also seeks to steer the course away from laboratory-verified pieces of knowledge towards a clear and broad focus on Ausubel's six fundamental components of constructing meaning.[10] Suchman's inquiry learning is here inferred as having been well-intentioned towards leaving rote learning by advocating autonomous discovery but, unfortunately, doing little to increase the meaningfulness of school learning.[11]

Concept-mapping and the Vee diagram (heuristic) are cited by Novak as two tools readily available to any student (these requiring only a piece of paper and a pencil) which will serve the pupil in organizing knowledge as only the student can by utilizing one's own experiential base and, eventually, incorporating that knowledge into the student's very being.

In defense of Suchman's Inquiry Training, I proffer that this incorporation, too, was the aim of Suchman; its undoing was in the existence of the forty-five minute high school or elementary school class which served to severely constrict the likelihood of meaningful autonomous discovery.

Suchman's approach, suggests Novak, fostered a random search inquiry. A great amount of knowledge is needed by the teacher who will use an inquiry teaching mode; there's the problem. At the elementary school level most teachers have a poor foundation in their own disciplines and the classroom exercise in inquiry training becomes a "random search."[12]

In summing up that which I have discovered from Dr. Novak it seems clear that the ISIT Inquiry Training methodology came to the proverbial fork in the road when a weakness in its theoretical foundation was left unattended. This weakness necessitated the consideration of concluding ISIT or moving ISIT into a new, more guided format--one which would make use of empirically valid conclusions verifiable with acceptable means of quantitative analysis.

George Ivany illustrated what he believed to be the flaws inherent to Inquiry Training. He began with concerns over Suchman's limiting the elementary school student to inquiring via verbal questions and not kinesthetically experiencing the initial event. Also, much as Joseph Manusov, Ivany had serious doubts about the use of assigning questions to the Suchman categories. Ivany mentioned his own study (Ivany 1965) made as part of a dissertation at the University of Alberta wherein "pure" questions were seldom found to be of the specific type sought.[13] Rather, maintains Ivany, the students' questions were more likely to combine several categories at once. Ivany was troubled by the Suchman regimen of eleven classes of questions. "Thus a question assigned to the category of 'verification by comparison of conditions' should have a function in a child's inquiry analogous to the function served by this category in the logical analysis of inquiry. In the study already mentioned it was often thought that such was not the case."[14] He continues:

> ...Such questions suggested that the logical function assumed by assigning them to certain categories of the Suchman model is rather unimportant as the child's motive for asking them. The disposition of students toward approval, the tendency to minimize risk of participation, and the subordination of intrinsic motives may well be more important considerations.[15]

Ivany continued his broadside into several of the fundamental tenets of Suchman's Inquiry Training. After raising doubts about the efficacy of an introductory film recording the discrepant event as opposed to having the children see the actual event unfold in front of them, he next challenged the Suchman evaluative test, the so-called Questest. With the Questest, ISIT hoped to evaluate different student inquiry styles. But, as Ivany cogently suggested, a test requiring close to thirty minutes per pupil would be quite cumbersome to administer if, for example, a class of thirty students needed to be accommodated. Ivany proffered a test which could be administered to the entire class, not only to individuals, thus freeing the teacher's time.

Another study from 1969, a bellwether investigation into the discrepant event, gave serious thought to older children and their inquiry. It was analyzed after having been used at Purdue University for research. The author, Kenneth Collins, suggested that for a high school freshmen accelerated geometry class with a homogeneous grouping, inquiry training could be said, once again, to promote high class participation, knowledge of the heuristics involved, demonstrable success in reaching the solution to a posed problem of logic error (the treatment group reached its conclusion in 20% less time than the control group),[16] and the ability to use valid laws of implication.

Collins: "...(T)he confrontation for the experimental group generated cognitive dissonance in each student that had to be resolved. This encouraged a hard attack on the problems an(d) aggres(s)ive analysis for flaws."[17]

The Elefant study with hearing disabled young people provided another fascinating application of ISIT research.[18] Remember, Suchman initially designed Inquiry Training for elementary school-aged children who were relatively predisposed toward success. Now with Collins and Elefant studies, older children and hearing impaired were the subjects, and beneficiaries, if we are to accept the findings.

Suchman's team demonstrated a doubling of the fluency of inquiry, increases in the use of the techniques of analysis, and a reduction in the use of random approaches to inquiry.[19]

Suchman aimed at freeing the child to conduct his own autonomous search for knowledge, collecting data and processing it, learning to infer relationships, and finally, to construct theories and then evaluate them.[20]

Feeling justified in continuing the development of Inquiry Training due to its proven efficacy in stimulating inquiry, the team embarked on the establishment of a demonstration center, a report of which appeared in March 1968.

Dissemination of the methodology of Inquiry Training as well as the requisite materials was the purpose of the demonstration center. Implicit in the undertaking of Inquiry Training is the need to instill in teachers the belief in, as well as the rationale for, Inquiry Training. Teachers must see the approach as well as the outcomes; they must understand the philosophy and theory; they must work through the nuances of the approach before taking it to their classrooms under the tutelage of an Inquiry Training supervisor; teachers must be encouraged to fit the model within their own style of teaching.[21]

Let's return to the paradigm of the original study on Inquiry Training and then look at problems which are presented when a statistical analysis is undertaken.

The inquiry and control groups were chosen from the same school building. Teacher effects were basically uncontrolled: there was no matching nor any statistical manipulation from a control standpoint. Suchman admitted this as being a major, but unavoidable, weakness. After all, "The teacher effect is a complex phenomena that is extremely difficult to assess. The personality and behavior of the teacher is probably more important than the method he uses."[22] It is here that Suchman hoped something approximating randomization of variance would come to his rescue with a more or less equal number of positive teacher qualities being washed out by an equal number of negative teacher qualities.

A standardized test was administered to measure intelligence and the scores were used as a control variable when the P.C.E. underwent a covariance analysis. Another test, initially created to provide control for science knowledge, was later rejected because the P.C.E. performed the same function.

The dependent variables were the P.C.E. and the Questest Product Tests which helped to determine the yield of inquiry under standardized conditions. The information yielded concerned principles, necessary conditions, and parameters of the problem; the Questest Process Analysis yielded frequencies of questioning types which acted as windows to the minds of the student-inquirers who were conducting the search for cause. It is at this juncture that Suchman hoped that Inquiry Training could find its empirical validation as "The differences between the inquiry and control

groups with respect to these frequencies provide the best indications presently available of the effects of Inquiry Training on the process of inquiry."[23]

All statistical tests serve to assist us with the justification of inference-making. The ISIT team, for its statistical testing, computed the t-values for the difference between the mean pretest score and the mean posttest score. Using that as its justification, the team stated that the inquiry group, as well as the control group, "improved significantly over the 24 week period ($p < .001$)."[24]

However, the difference between the inquiry groups and the control groups on the so-called gain scores was not significant when the analysis of covariance of the gains in the P.C.E. scores for both groups was calculated, and this was true even with the variable of intelligence controlled for.

For statistical purists, it must be mentioned that only two schools were utilized whereby complete randomization of the assignment of subjects was accomplished. The ISIT team concluded that on the basis of these two schools the Inquiry Training group's gains were greater than the control group's, although the control group also experienced improvement; the level of significance was short of .05.[25]

> To summarize the effects of Inquiry Training on conceptual growth, there is some evidence that learning through inquiry is superior to expository teaching when this growth is measured by the P.C.E. The emphasis on the development of process of Inquiry Training does not apparently detract from (and in two groups it actually enhances) the learning of physical principles.[26]

In terms of the three dimensions of productivity, each was analyzed separately with inferences suggested.

In the co-variance analysis of the shifts of the pretests and posttests (the pretest

scores were controlled) the differences between the two test groups' scores were insignificant.

The end result, or inference to be drawn, of the Product Test A was that the children receiving Inquiry Training did not demonstrably indicate in their questioning a mastery of the science principles seen in the film of the discrepant event.

Likewise, a disappointing inference which was drawn by the ISIT team indicated another lack of verification of Inquiry Training's efficacy: Product B testing the children's understanding of the necessary conditions for the filmed event. A t-test of the two teaching methodologies indicated a lack of statistically significant improvement in the learning of the Inquiry Training children over the learning achieved by their counterparts in the control group. The control group, you will recall, was instructed in a traditional methodological environment.

In the Product Test C of the children's knowledge of the problem episode's parameters (which sought to measure the children in their object identification, condition identification, and event identification) the t-test indicated, again, a lack of significant differences between the experimental and the control groups when Test Film I was analyzed; when Test Film II was taken into account, in one of the six schools represented in the analysis the difference was significant with $p < .05$.

"To summarize the Product Test C analysis, there is no evidence that Inquiry Training has any effect on the child's ability to identify correctly in the 'Questest' any of the parameters called for in Test C."[27]

What, then, could the ISIT team point to as justification for the use of Inquiry

Training in America's classrooms? Please consider the following points:

---Inquiry Training group was found to ask over 50% more questions than did the control group.

---In an analysis of covariance performed on the question-type frequency (with fluency controlled) it was determined that the mean number of questions which were asked by the Inquiry Training group and which fit the "verification" category, was over twice the amount asked by ISIT's control group; (however, when fluency was controlled-for, the use of such questions was only determined to be equivalent.)[28]

---Inquiry Training group, at lower levels of fluency, were determined as having asked more implication-type questions; however, at higher levels the students in the control group asked a larger number of implication questions.

---Suchman mentioned the problems associated with the administration of the Questest: teacher training time was not sufficient to allow him to use much of his data, two schools experienced serious bias in the assignment of subjects to the two groups, and the unfortunate problem of the Questest being unable to accommodate children of low verbal ability due to its very nature as a verbal testing tool.[29]

---In two of the schools studied, those that learned with Inquiry Training scored higher than did the control groups, and it was the control groups which experienced a greater emphasis on content.[30] Suchman obviously held out the possibility that this could indicate the potential of Inquiry Training: "Apparently Inquiry Training is accompanied by conceptual growth that is equal, if not superior, to that achieved under the traditional expository methods of instruction."[31] Indeed, Suchman

suggested that teachers could expand the amount of data presented to their students by utilizing the searching over the expository method. He goes on to say that the Inquiry Training groups also utilized more questions which could be categorized as being analytical in nature, and analytical questions tend to be the most productive of data. ---Suchman admitted that ISIT did not demonstrate the critical elements of Inquiry Training empirically;[32] however, he and they agreed upon the following elements as being crucial to the successful implementation of the method in America's classrooms: problems of a concrete nature to facilitate the specific parameters of the problem; freedom to gather data within an autonomous-inducing classroom environment; a teacher able to answer data-gathering questions; and the elimination of awards which get in the way of the learner's love of learning for its own sake.

1.Joseph Manusov, "An Analysis of Questioning Categories in J. Richard Suchman's 'The Elementary School Training Program in Scientific Inquiry'" (a doctoral dissertation, Temple University, 1971), p. 29.

2.Ibid., p. 59.

3.J. Richard Suchman, "The Elementary School Training Program in Scientific Inquiry," U.S. Office of Education Reports, 1966, p. 73.

4.Ibid., p. 75.

5.Joseph Manusov, "An Analysis of Questioning Categories in J. Richard Suchman's 'The Elementary School Training Program in Scientific Inquiry'" (a doctoral dissertation, Temple University, 1971), p. 59.

6.Ibid., p. 65.

7.Dr. Joseph Novak in a telephone conversation with the author on September 27, 1992.

8.D. Bob Gowin and Joseph D. Novak, *Learning How To Learn* (Cambridge: Cambridge University Press, 1984), p. 9.

9.Ibid., p.7.

10.Ibid., p.7.

11.Ibid., p.7.

12.Dr. Joseph Novak in a telephone conversation with the author on September 27, 1992.

13.George Ivany, "The Assessment of Verbal Inquiry in Junior High School Science," *Science Education* 53 (1969): 287.

14.Ibid., p. 287.

15.Ibid., p. 287.

16.Kenneth Collins, "The Importance of a Strong Confrontation in an Inquiry Model of Teaching," *School Science and Mathematics* LXIX (January 1969): 616.

17.Ibid., p. 616.

18.Emily Elefant, "Deaf Children in an Inquiry Training Program," *The Volta Review* 82 (1980): 279.

19.J. Richard Suchman, Principal Investigator, "Demonstration Center: Part II--Elementary School Programs in Scientific Inquiry from Gifted Students," U.S. Office of Education Reports, March 1968, pp. 3-4.

20.Ibid., p. 1.

21.Ibid., p. 6.

22.Ibid., p. 87.

23.Ibid., p. 90.

24.J. Richard Suchman, "The Elementary School Training Program in Scientific Inquiry," U.S. Office of Education Reports, 1966, p. 90.

25.Ibid., pp. 90,93.

26.Ibid., p. 93.

27.Ibid., p. 99.

28.Ibid., p. 105.

29.Ibid., pp. 116,117.

30.Ibid., p. 117.

31.Ibid., p. 117.

32.Ibid., p. 127.

CHAPTER IV

A LOOK AT RICHARD SUCHMAN

To the researcher, Joseph Richard Suchman remains an enigma. J. Myron Atkin, currently at Stanford University, formerly of Illinois at Urbana-Champaign, mentioned the difficulty of doing a history on the man. He valued his privacy: his work was much more important than his reputation.[1] Suchman was born April 14, 1927 in New York City and died April 21, 1991, at the age of 64 of pneumonia and Alzheimer's Disease.

J. Richard Suchman's high school education was in Newark, New Jersey at Newark Academy. He then served in the U.S. Navy from August 4, 1945 through August 25, 1946. As the claims folder holding more detailed information was destroyed in a major housecleaning,[2] specific information as to the place of service as well as the nature of service is missing. It is known that at the Great Lakes Naval Training Center young Suchman received service training. Suchman received the Victory Medal and was discharged honorably after having provided service to his country as a Seaman First Class V-6 USNR. In a discussion this author had with a Congressional aide about this matter, it was conjectured that Suchman could very well have seen a bit of active service as it was customary to shorten tours of duty to those seeing active combat.[3] He saw no foreign or sea service in World War II.

What little is known for certain includes his studies and his first teaching position. J. Richard Suchman received his A.B. degree in 1949, his A.M. in 1950, and his Ph.D. in 1953, all from Cornell University in Ithaca, New York. The Human Resources Department could not release employment records without written permission of the employee, so Cornell cannot verify that his first position in teaching was indeed at that campus. However, another source maintains that at Cornell, Suchman worked with the faculty in the Child Development Department. His stay was to be short-lived; he left, among other reasons, because of what he perceived to be an anti-Semitic environment.[4]

Suchman entered the College of Arts and Sciences at Cornell University and was a secretary of Pi Lamda Phi and an officer of the Psychological Society. In addition, he was a member of the Octagon Club.

Cornell University must have been a formative experience for the young Suchman. Besides having the status of being in the Ivy League, Cornell could boast of a unique organization certainly impressing upon its students the strengths inherent to innovation: its seven undergraduate schools supported either by the state or through private endowments. The seven undergraduate schools featured curricula developed by the faculty, and science programs among the most sophisticated in America, with research being on a very high level. All of the prerequisites to the attainment of a very sound education in the sciences were there for Suchman to take advantage of.

It would be no wonder, therefore, that Suchman held lofty goals for himself with his transfer to the University of Illinois at Urbana-Champaign. It can be

suggested that for a relatively new professor to request several leaves of absence from Urbana to work for the U.S. government is a bit presumptuous. However, the University acquiesced to his requests, and Suchman benefited from the resources of both.

The University of Illinois at Urbana-Champaign became home for J. Richard Suchman and there he joined Professor Queenie Mills in, of all departments, the Department of Home Economics.

According to the Board of Trustee Report for 1954-1956 Dr. Suchman worked at the University of Illinois as an Assistant Professor of Child Development. Child Development, interestingly enough, was as that time under the auspices of the Department of Home Economics; the Department of Home Economics, in turn, belonged to the School of Agriculture. Perhaps Dr. Suchman's environment caused him some restlessness, for only two years later he would resign from the Department of Home Economics as an Assistant Professor of Home Economics to join the College of Education as an Assistant Professor of Education. He was promoted to Associate Professor of Education in 1958. As his work began to take up the summer sessions by this time, it conflicted with his position as a Student Counseling Bureau counselor. In addition to these responsibilities, the Board of Trustee Report of 1958-1960 mentioned his work in the Graduate College as a part-time employee.

It wasn't long, however, before Suchman found his niche at Illinois. Sources indicated to me that he frequented the Curriculum Lab of Max Beberman where, it might be assumed, he experienced much of the "heady times" described by Dr. Terry

Denny, who would become his chief assistant researcher with ISIT. Dr. James Fejfar, who would join Suchman, also worked with Beberman in the area of discovery teaching. Both men knew of the effects of student patterning on the formation of generalizations.

These times included much development of educational methodology in the wake of the famous assemblage of educational personalities at Woods Hole on Cape Cod in 1959. One legacy of Woods Hole was the belief in teaching science to young people as both content and method.[5] This so-called discovery learning had a marked effect on Suchman as he was one of four University of Illinois professors who were invited to the ten-day meeting sponsored by the National Academy of Sciences, Suchman himself being invited personally by Dr. Jerome Bruner.

In remembering the Woods Hole Conference memory can, indeed, be fleeting. This researcher wanted to "set the scene" in terms of the American educational scene immediately after the Soviet Sputnik changed the world forever. In understanding this time period, it would be hoped one could understand the fervent claims of each educational methodology.

However, major participants in ISIT appear to disagree as to who was invited to Woods Hole by Dr. Jerome Bruner. Dr. James L. Fejfar remembers, "Dave Page was invited to the conference. Suchman was not but he went anyway and I think he got Page to bring up Suchman's ideas at the conference. I remember Terry (Denny) and I working on a chart and assembling materials for JRS to take with him. This was over the Labor Day weekend in 1959."[6] Dr. Lee J. Cronbach, however, saw

the situation quite differently:

> Indeed, I met Suchman for the first time at Bruner's Woods Hole Conference in 1960 (sic). Suchman had been at Illinois for at least a year by then, and I had not (yet) heard of him or his project. As I recall, Bruner heard Suchman talk at the 1960 (sic) meeting of the American Psychological Association and invited him to come to Woods Hole on short notice.[7]

With his Inquiry Training now being sampled by the members of Bruner's panel, it would only be matter of time before Suchman would spread the word to the public at large. He held a special affection for the National Science Teacher's Association, and through this organization Inquiry Training would have its "bully pulpit."

Dr. Fejfar remembered Suchman inviting Dr. Bruner to visit the University of Illinois.

During the years 1962-1964 the University of Illinois spent a large sum of money, $103,355,00 (sic) on Suchman's project of the Science Concept Development in the Elementary School Through Inquiry Training. This project was with the United States Department of Health, Education, and Welfare and cemented a strong relationship between Suchman and HEW.

Suchman later submitted a request for a leave of absence, without pay, for one year (1964) so that he could work with the United States Office of Education; another request for a leave of absence soon followed for the 1965-1966 academic year in order to continue the work begun there.

His final resignation from the University of Illinois at Urbana-Champaign was tended effective September 1, 1966 from the College of Education as a Professor of

Elementary Education. In the resignation letter he stated that he enjoyed eleven happy years at the University but that it was time to move on.[8]

J. Richard Suchman made many moves in his career as well as many moves from one career to the next.

His educational career spanned the better part of two decades at three top-drawer American institutions of learning, Cornell University, University of Illinois, New Mexico State University, and even included a stint taken at Courtland State Teacher's College in New York to acquire his teaching certificate.

His services would be offered to the United States Government, two private universities, one public university, and professional organizations such as Association for Curriculum Development and Supervision, National Science Teacher's Association, and The Educational Research Association which would benefit from his research and relentless drive. His own organization, the Human Resource Organization, first located in Alexandria, Virginia and later moved to Monterey, California, would become his own Esalen, in the words of a trusted associate.[9]

From his early days as a Graduate Assistant at Cornell to his happiest and most productive days at the Office of Health, Education, and Welfare in 1965 as a Curriculum and Instruction expert, Suchman's energy did not wane. Nor did his faith in Inquiry Training. Whatever the statistical shortcomings, time, as well as his relentless drive, would prove him right and his critics wrong.

Whether the subject be economics, physics, geology or, even as unbelievable as it might seem, military policing, there were no limits to Inquiry Training. After

all, he was not teaching a subject; he was allowing students to inquire about a subject in the manner that would be considered acceptable to a practicing member of that subject in his/her field.

As his days at both the University of Illinois as well as his days at HEW ended, Suchman joined the Science Research Associates. A colleague of Dr. Suchman's while both worked at Science Research Associates (then located in Chicago, Illinois) remembers a particularly vital discussion between Suchman and two other science educators while all three were conducting an in-service workshop at a Leyden Township school (in suburban Chicago).

Paul Saecker found it incredible that at a discussion with three advocates of cutting-edge science education, the teachers in attendance walked out at precisely three o'clock when they believed their school day to have come to an end.[10] Perhaps it is wise to remember Dr. Novak's admonition concerning teachers and professionalism.

Saecker continued to remember "Dick" Suchman fondly; he particularly remembered Suchman's entrepreneurial spirit and his dedication to being an effective consultant. Suchman was, in Saecker's words, a "major science author" who, even while he was seriously ill, was sought out by a manufacturer of computer software to produce an inquiry-based computer program.[11]

Indeed, Suchman was so much the epitome of science while at SRA that Saecker felt it necessary to explain to this author that the "S" in SRA referred to behavioral science and not laboratory science as Suchman would have preferred.[12]

Suchman moved from Urbana-Champaign to Alexandria, Virginia, where he established his Human Resource Organization. His next move with this organization was to Monterey, California. Some work came out of this environment, but without a doubt Inquiry Training had now seen its finest days and hours. What became quite a successful and well-publicized venture petered out as the 1970's came to an end. A small paperback book of geology inquiry ideas published by the Trillium Press was all that remained of inquiry training as the 1980s began.

Suchman developed Alzheimer's Disease and began receiving treatment for it in the mid-1980s. This illness produced as devastating an impact as could be imagined.[13] J. Richard Suchman died April 21, 1991. He died at the Veteran's Admininstration Medical Center in Menlo Park, California after fighting the disease for seven years. His wife, Anne-Marie, was with him throughout his fight.

Colleagues use the words "passionate," a producer of "heady times" and quite "energetic." Colleagues enjoyed working with him--and research assistants enjoyed working for him. He enjoyed being around young people: witness his work as a student advisor. The only problematic concern for all involved was the empirical problem, or as Frank Bills concluded in his dissertation, dealing with the fact that school children enjoyed the inquiry session very much, but creativity was not demonstrably enhanced due to exposure to the inquiry training.[14]

If the author may be permitted an analogy at this point, Suchman felt hounded by J. J. Schwab's success in biological inquiry much as Brahms felt hounded by Beethoven. Yes, Suchman was as much a giant in his field as Brahms--and every bit

as vulnerable as Brahms. Both felt that they were in the shadows of giants; both can be said to have been energized by this very situation even as this situation threatened to confine them.

To paraphrase Dr. Denny: Suchman never lost the faith in the methodology even after he quite possibly should have.

Indeed, the ISIT team drew the conclusion that fluency in question formation was improved, but in terms of accomplishing the major goal, of transferring this manner of inquiry in the search for other conceptualizations in the physical, life, and social sciences,[15] only a statistically insignificant increase was registered when an Analysis of Covariance was applied.

This, as well as other statistical failures to validate Inquiry Training, worked to wrench the ideological framework of Inquiry Training. Its future would be cloudy: many teachers, this author included, would use it with considerable success in motivating students, eliciting increasingly greater sophistication in their responses of data-gathering and hypothesis-testing. Without, however, the support of the scientific community in terms of quantitative verification that Inquiry Training could be used in successively more cognitively sophisticated areas of learning with a "carry-over" effect (that is, successful inquiry-led problem solving at one level would carry-over into other areas which needed a solution to a problem), the educational community, at large, would abandon Inquiry Training.

Dr. Lee J. Cronbach on this matter: "The question no one has addressed is why the curriculum movements of the time lost their momentum and their influence.

To some extent, their ideas were captured in dilute form in more conventional texts. But there is a deeper story in the ability of education specialists to drop off a bandwagon; happens over and over."[16]

1.From a telephone interview with the author on September 9, 1992.

2.Correspondence between this author and an aide to Congressman John Porter.

3.Telephone conversation with an aide to Congressman John Porter on December 28, 992.

4.From a telephone conversation with Dr. Terry Denny and the author on September , 1992.

5.Jerome S. Bruner, *The Process of Education* (New York: Vintage Books: 1963), p. ii.

6.From a letter written by Dr. James L. Fejfar to the author on Oct. 23, 1992.

7.From a letter written by Dr. Lee J. Cronbach to the author on Sept. 23, 1992.

8.From a discussion with Mr. Bob Chapel in the University of Illinois Archives on)ctober 8, 1992.

9.From a telephone discussion with Dr. Terry Denny on September 9, 1992.

10.From a telephone conversation between this author and Mr. Paul Saecker of Science Research Associates on December 28, 1992.

11.Ibid.

12.Ibid.

13.Drs. Terry Denny and J. Myron "Mike" Atkin.

14.Frank Lynn Bills, "The Development of Divergent Thinking as a Function of ıquiry Training" (doctoral dissertation, Utah State University, 1970), p. 2.

15.Project #1547, University of Illinois at Urbana-Champaign Archives (also goes nder the title "Science Concept Development in the Elementary School Through Inquiry raining") p. 5.

16.From a letter written by Dr. Lee J. Cronbach to the author on Sept. 23, 1992.

CHAPTER V

DISCUSSION

What is the legacy of J. Richard Suchman and his Illinois Studies in Inquiry Training? To determine an answer to this question, this researcher asks the reader to determine the nature of science and the place of knowledge in man's quest for improvement.

A Research Methodology professor from Loyola University Chicago recently told his class, "I would become discouraged were it not for the fact that the process of science survives if not the content."[1]

Indeed, some professors tell us that the "shelf life" of scientific knowledge today is lucky to last five years.

Inquiry Training, as espoused by Suchman, is a methodology that is now not considered either as "on the cutting edge" of educational methodology or as having been empirically validated. However, some tenets of Inquiry Training were found to be successful, if not, indeed, the entire rationale.

1)inquiry skills in fifth grade children were demonstrably improved over a fifteen-week period in the original 1962 study

2)motivation was found to be contingent upon the desire to seek "criticalness" in the inquirer's search for workable theory-formation; (i.e. explaining why

the discrepant event occurred)

3)although this process was not found to be a substitute for content-based science courses, Inquiry Training could enhance content-based learning by activating the discovery variable.[2]

Suchman provided the necessary link between the 1950's research of Bruner and others in the determining of the existence of the discovery variable and concomitant implementation of testing procedures to try to isolate the discovery variable, all of which happened throughout the 1960's.

Should the search be condemned because that which was sought was not found? Isn't it true that if one knows where not to search then others will benefit by using new search routes?

On a national level, it can also be argued that had Suchman not endeavored to direct American educational efforts toward Dewey-ian empiricism, the nation would rush pell-mell towards a less-than-critical endorsement of the traditional content-based education championed by Vice-Admiral Rickover, thus undermining the effort to allow American children to think autonomously.

Thomas S. Kuhn in *The Structure of Scientific Revolutions* makes a case for his belief that science is not, as commonly assumed, a cumulative venture of knowledge gathering. Rather, he proffers a "hit or miss" approach whereby one theory (he calls it a paradigm) eventually loses a majority of its supporters and adherents as a crisis point is experienced. This crisis point can be a piece not fitting the paradigmatic puzzle: a lacuna eagerly seized upon by proponents of competing

theories. Once a majority of the younger scientists switch allegiance to the new theory, only the older and more reticent followers of the original paradigm are left to either die out, taking their theory with them, or to live on as believers in a paradigm which the rest of the scientific community has abandoned. These persons, posits Kuhn, are now not acting as scientists.

With the aforementioned empirically-based problems of Inquiry Training (Kuhn might call them crisis points) Suchman was left to face his dilemma: to continue to believe in an educational methodology which others have fled or, like them, to accept newer forms of inquiry learning or critical thinking.

Dr. Terry Denny and Dr. Joseph Novak were to "jump ship," Denny mentioning that "(Inquiry Training) just didn't work"[3] and Novak attempting a major paradigmatic overhaul: an overhaul so extensive one could scarcely see the Suchman imprint on it.

To be sure, Kuhn would argue that any theory once removed in such a "revolution" was still to be respected for having worked as well as it had for as long as it had. The new paradigm simply provided the proverbial "better fit." But Kuhn was speaking as a scientific historian with the benefit of gaining such a perspective from quite a great distance from "normal science," as he would call it. Suchman, however, was a trained researcher who had devoted close to twelve years of his professional life developing, nurturing, and disseminating Inquiry Training. To abandon it now would necessitate casting doubt on his raison d'etre. Who among us would willingly undergo that?

It was only seven years earlier that inquiry was at its paradigmatic apogee. Frank Lynn Bills stated: "Science programs based on student inquiry have been so successful that the American Association for the Advancement of Science (AAAS) recently issued a policy statement which advocated that science could best be taught by a procedure of inquiry." (Kessen, 1964)[4] Continuing:

> Inquiry sessions used in the present study (i.e. Bills) proved to be an effective way of presenting problems to students.[5]
>
> ...(E)nough evidence of increased creativity performance is present to merit additional long-term research to determine what the potential of idea production is among students.[6]

Bill reiterates a position much more in alignment with Suchman's when he states: "If a school curriculum can be designed to increase the production of students, then not only would the potential for more creative scientists be present but also training of idea production men in all fields would be benefited."[7]

The State of California was credited by Suchman for having undertaken Inquiry Training in many of its public schools because of a belief in its efficacy.

Doctoral dissertations utilized aspects of the Suchman paradigm if not the paradigm in total, in several highly creative applications including the well-publicized Elefant study with hearing-impaired students.[8]

To truly understand the excitement engendered in children as well as educators when Inquiry Training was utilized, we need to take a close look into the classrooms of those teachers who implemented Suchman's methods in the manner most faithful to the Urbana research.

Two such educators were Fred Wilkin and Robert Altman, both of the Highland Park, Illinois Public School District #108 at the Lincoln School.

Dr. Fred Wilkin, then a Master's Candidate at the University of Illinois at Urbana-Champaign, was involved with ISIT from the start and, according to this researcher, one of the most faithful proponents of Inquiry Training in terms of diligence in application of the tenets inherent to Inquiry Training as well as a true advocate of the proper dissemination of Inquiry Training via in-service programs. Wilkin attempted to keep in touch with several Inquiry Training students from the late 1950s to see how Inquiry Training has helped them throughout their professional careers. Only a "true believer" would do that thirty years after the pilot program. This "true believer" visited Woods Hole, the post-Sputnik mecca for inductive learning in America and became aware of the incredible potential of inductive as well as inquiry learning as practiced by Jerome Bruner and Richard Suchman.

Wilkin took the experimental group (those who would learn via Inquiry Training) while Robert Altman took the control group. Both teachers utilized the bimetallic strip as the focus of the science class discussion.

While Wilkin could only dutifully answer the questions of his students with the necessary "yeses" or "nos," Altman began the discussion with a presentation as to what happened scientifically.

Altman remembered the problems associated with the successful application of Inquiry Training: teachers would really have to know the content of their field to successfully transfer the techniques of inquiry questioning and hypothesis formation

and testing; to successfully inquire and then to evaluate that which was inferred took much classroom time; the interest of administrators was all-important to the practice of Inquiry Training--when administrative interest waned, so too did Inquiry Training; some "star" pupils could monopolize the all-too-limited amount of time and thus thwart the majority of the class from receiving the benefits of Inquiry Training.

Altman, today, is a believer in Inquiry Training. He remembers utilizing the distinctive questioning format at the age of sixty-two, well over thirty years after the famous ISIT pilot study, when asked by the Highland Park Public School District #108 in Illinois to direct an in-service on science educational methodology. And, he hastens to add, "(T)he students were able to explain what happened to the sowbug."[9] The sow bug and its behavior in a soil sample was the discrepant event in 1992; the bimetallic strip or the sailboat/fan event would have been the discrepant event counterpart in the 1957 classroom.

Altman went on to say that Wilkin would get angry with him because in acting as a scientific control Altman was not able to use the unique question and answer format, but he would fall into it because it was so successful in igniting the children's curiosity and love for forming hypotheses.[10]

It is safe to leave the reader with the impression that the one-year study in Highland Park, Illinois made many converts to Inquiry Training: those children who enjoyed learning for learning's sake; those educators, such as Wilkin and Altman, who learned how to answer questions in a manner advocating the autonomy of learning which should reside within each child; and members of the administration

who supported those early post-pilot study attempts at inquiry learning and training conducted by members of the "Dozen"[11] who had participated in an earlier Summer Institute at the University of Illinois at Urbana-Champaign.

Altman suggested to this researcher that there was quite a bit of irony in that a methodology which served to assist the elementary school teacher of science required that instructor to have as strong a theoretical base as a teacher of science at the college level. This was reiterated by Professor Joseph Novak of Cornell University who added that many elementary school teachers knew very little with regard to the theoretical foundations of science and, for that reason, Inquiry Training might be doomed.

The follow-up study of high school students who were part of the 1962 study was conducted by Dr. Fred Wilkin, in part, to find out what had happened to them as a result of Suchman's Inquiry Training. Dr. Wilkin eventually had a booklet of these experiences written entitled "ISIT Inquiry." These experiences were shared by Dr. Terry Denny. A second study of pupils who experienced the Wilkin version of Suchman's Inquiry Training was also conducted. Inquiry, indeed, paid a lifelong dividend.

Dr. Wilkin today teaches at National-Louis University at its Evanston campus. The igniting of children's minds to their own autonomous problem-solving which motivated Wilkin to join the ISIT team and, a short time later, to become its most ardent spokesman, still motivates him today to challenge young aspiring teachers to implement the best of the inquiry modes into their own teaching repertoires.

Says Wilkin: "Indeed, its (the ISIT study) impact and withering fate has always had me pondering about the type of people we have who teach and who seem uninclined to be stimulated to deal with questioning along these lines... (ISIT) should be studied in depth and related to the educational community."[12]

Wilkin looked back at his over thirty years with Inquiry Training and, as did Altman, took the very best of the questioning modes and refined those modes so that they could be utilized in the 1992 classroom and sustain the same intensity of inquiry as they did in Suchman's classroom thirty years earlier. Wilkin's thirty years of "sustaining and evolving 'inquiry' of a type and form that is seldom anywhere in the meaning of too many educators when they use the word"[13] was a holy crusade against teacher-controlled classrooms. This could be a nostalgic return, perhaps, to the best of John Dewey's Progressive Movement where the child was as significant a variable in its learning as any other variable present.

Dr. James Fejfar, the originator of ISIT's P.C.E. Test, had many thoughts to share on the ISIT team effort:[14]

> As a research assistant who was with the project from the beginning, for the first year or so I thought there was a lot of 'muddling through'. The theory was not clear or precisely articulated. A lot of wheel spinning. Although, Dr. Suchman did seem to have a clear sense of direction and a lot of drive.

On Inquiry Training and its incessant dependence on quantitative analysis:

> I am not an expert in quantitative analysis but I thought that the process did lend itself well to quantitative methods. We were trying to force the procedure into a neat package. I thought the PCT Test was pretty well done....

On Suchman's ability to keep the team focused even though the theory was not as

clear as one would have hoped:

> I thought Dr. Suchman was enthusiastic, had a lot of drive and was very ambitious. He did seem to have a sense of direction and it seems to me that when he hit roadblocks he was able to rethink and redirect our efforts so that the project did make progress.

On a possible explanation as to the meteoric rise and fall of Inquiry Training as the inquiry method of choice:

> After thinking about the project after our conversation it seems to me that if we had tried to gain more insight into how children solved problems and put less emphasis on teaching our method, the project might have had much more impact and would have predated the constructivists.

What is the legacy of Suchman's Inquiry Training research? This methodology is currently being taught in educational methodology classes. With the current interest in cooperative learning, it is particularly suited to small group work.

Inquiry Training workshops and presentations are being conducted by Suchman disciples such as Dr. Fred Wilkin and Mr. Robert Altman who feature their own interpretations of the methodology which closely resembles Suchman's format.

University professors extrapolate new methodologies from Inquiry Training. Dr. Joseph Novak at Cornell University is one example. His guided inquiry which featured concept mapping as one strategem for keeping heurism and autonomy in student learning is consistent with the goals of Suchman.

Inquiry Training has evolved into a set of complex applications to specific instructional methodology needs. For hearing-impaired students to the training of military policemen Inquiry Training was modified successfully. From an initial curricular focus in physics to extrapolations in many areas of the sciences and

mathematics, Inquiry Training proved useful and easily applicable. It can be said that Inquiry Training has had an important role to play in the intellectual development of many Americans from widely disparate backgrounds and in many different educational settings.

Dr. Joseph Richard Suchman's Inquiry Training provided an integral link between the unbridled optimism in John Dewey's empirical approach during the post Second World War period and the educational constructivism in wide practice today.

"I remember Dick fondly as a very stimulating person."
Dr. Sidney Rosen
Professor Emeritus of Astronomy
UIUC

"Good luck on the search: it is an important issue."
Harry S. Broudy
Professor Emeritus (retired)
Philosophy of Education
UIUC

"I, too, have wondered what ever has become of him."
Merle B. Karnes
Director
Colonel Wolfe School
UIUC

"He was passionate!...These were heady times!"
Dr. Terry Denny
Professor Emeritus
Educational Psychology
UIUC

"While I had nothing to do with the project (ISIT) I did know Dick and shared instruction in a course with him over several semesters. He was a bright and very likable person."
Theodore Manolakes
Professor
Department of Curriculum and Instruction
UIUC

"I went off into Curriculum Development while Dick worked on Inquiry Training."
Professor J. Myron "Mike" Atkin
Stanford University

(The comparison with J.J. Schwab's Inquiry Methodology was made.) "Yes... he felt the competition..." (However, Dr. Suchman felt) "he was bigger than Massialas."

"I gave up on it. Empirically, it didn't work... When it came time for an insightful leap, no evidence!" (However,) "kids could identify objects and generate hypotheses."

(His moving to California) "was kind of an Esalen."
Dr. Terry Denny

"I was under the impression that all interest in the Suchman project had vanished. I would be delighted in recalling ISST." (sic)
Dr. James Fejfar
Professor of Curriculum and Instruction
University of Nebraska at Lincoln

"As I recall, Bruner heard Suchman talk at the 1960 (sic) meeting of the American Psychological Association and invited him to come to Woods Hole."

"I recall him as lively and collegial..."

"But there is a deeper story in the ability of education specialists to drop off a bandwagon; happens over and over."
Lee J. Cronbach
Vida Jacks Professor of Education, Emeritus
Stanford University

"He was witty--and a bit absent-minded: students had to retrieve a missing briefcase."
Mr. Robert Altman
Control Group Leader
Lincoln School
Highland Park District #108

1.Quote from Dr. Ronald Morgan to his Resarch Methodology class at Loyola University Chicago on September 30, 1992.

2.A favorite term used by Dr. Suchman throughout ISIT.

3.From a telephone interview with the author on Sept. 9, 1992.

4.Frank Lynn Bills, "The Development of Divergent Thinking in Inquiry Training," (doctoral dissertation, Utah State University, 1970), p. 2.

5.Ibid., p. 56.

6.Ibid., p. 57.

7.Ibid., p. 57.

8.Emily Elefant, "Deaf Children in an Inquiry Training Program," *The Volta Review* 82 (1980): 271-279.

9.From a telephone interview with the author on Nov. 6, 1992.

10.From a telephone interview with the author on Nov. 6, 1992.

11.A term used by Dr. Fred Wilkin in a letter to the author on Oct. 16, 1992.

12.From a letter written by Dr. Fred Wilkin to the author on Nov. 15, 1992.

13.From a letter written by Dr. Fred Wilkin to the author on Nov. 15, 1992.

14.From a letter written by Dr. James L. Fejfar to the author on Oct. 23, 1992. All four passages come from this letter.

APPENDIX A

ILLINOIS STUDIES IN INQUIRY TRAINING

--A TIMELINE--

---Pilot project and field studies designed, implemented and evaluated 1957-60

---"Inquiry Training in the Elementary School" is published in the journal *Science Teacher* 1960

---"Making Room for Searching Minds: Prospects for Education Through Inquiry" is published 1961

---"Science Concept Development in the Elementary School" is published 1962

---"The Inquiry Process and the Elementary School Child" is published 1962

---"Creative Thinking and Conceptual Growth" is published 1962

---"Inquiry Training: New Roles and Goals in the Classroom" is published . . . 1962

---The landmark Suchman work is published and becomes the inquiry bell-wether; "The Elementary School Training Program in Scientific Inquiry" is published and the Suchman team is established 1962

Twelve teachers spent eight weeks in Urbana-Champaign at the University of Illinois going through the training (just as they visualized in the pilot program) and then took what they learned to their own schools. The twelve: Warren C. Coffey, John Cunningham, Edward Eaton, Eugene Irving, Frederick Kline, Roland J. McAnulty, John S. Palumbo, Carl Renshaw, Norval Scott, Robert Sheldon, and Fred Wilkin. Apparently, Dr. Suchman was the twelfth teacher.

In addition, seven graduate students from the University of Illinois acted as research assistants. They were: Terry P. Denny, James J. Fejfar, Helene Henry, Kenneth Peiser, T.V. Sathyamurthy, Sheldon Siegel, and Leone Smith.
Sybil Baltis Carlson, an NDEA Fellow, interned on this project during 1961-62, Emanuel Lask, supervised construction of the tests and ran the data analysis operations. Dora Damrin, a Research Assistant Professor in the College of Education, consulted with the team on measurement problems.

University of Illinois faculty who acted as consultants and advisers were: J. Myron Atkin, David P. Ausubel, Harry Broudy, Roger Brown, James J. Gallagher, Orrin Gould, J. Thomas Hastings, Gertrude Hendrix, David Page, Sidney Rosen, Robert Spaulding, and Lawrence Stolurow, from the University of Illinois' College of Education.

Rupert N. Evans acted as an adviser to the project director in preparation of the original proposal.

Charles P. Slichter and James H. Smith consulted with the team on the preparation of the physics content for both the resumes as well as the films.

---Eleven Midwest Demonstration Centers were established 1964

---Suchman addressed National Science Teachers' Convention in New York on April 4, 1966; "Reports on Elementary School Science Projects-II"

---Inquiry Development Program established 1966
Margo L. Fass developed the Idea Book and the Resource Book, according to Dr. Suchman, but this author cannot find documentation to substantiate Suchman's claim that Ms. Fass was initially involved with both the pilot program as well as the 1962 study.

William Guthrie of Rider College in Trenton, New Jersey, contributed to the Resource Book. Aaron Seyvitz, formerly of New College in Sarasota, Florida, served as Physics consultant.

Taylor Elementary School in Arlington, Virginia, provided students and faculty time and facilities for the recording of inquiry sessions used in the book.

Problems were tested at Skokie Junior High School in Winnetka, Illinois by Fred Wilkin; at Nichols Junior High School in Evanston, Illinois by Thomas Sinks and Jeremiah Floyd; at Glenview Junior High School by a teacher as of yet unidentified; at Brentwood School in Elk Grove, Illinois by Ethan Janove and Ruth Lang.

The 1966 research program, unlike the seminal 1962 effort, was not a joint effort of the Office of Education of the United States.

---*Demonstration Center--Part II* is published 1968
Report centers on elementary school programs in scientific inquiry for gifted students and features Suchman as Principal Investigator with

Sybil B. Carlson as the preparer of the report.

---*Inquiry Development Program: Evaluating Inquiry in Physical Science* is published by Science Research Associates in Chicago 1969

---Collins' study detailing the need for strong confrontation in the discrepant event is published 1969

---Ivany's exhortations on the verbal inquiry methodology of Suchman's Inquiry Training is published 1969

---"The Ortega Park Teacher's Laboratory" is published in the journal *Instructional Development* 1970

---Manusov's dissertation is written 1971

---J. Richard Suchman establishes the Human Resource Organization, first in Alexandria, Virginia, and later in Monterey, California.

---Rochette's dissertation is written 1975

---*The Development of an Open-Access, Performance Oriented Curriculum for Training the Military Policeman* is published 1975

This is a final report emanating from the Human Resource Organization then located in Alexandria, Virginia. This was a revision of the U.S. Army's Basic Law Enforcement Course (BLEC).

Only minor problems were encountered in the development and testing of this course which gives the Military Policeman student considerable latitude of choice in choosing instructional techniques.

---Schlenker's study highlighting understanding, creative thinking, and skills used for analysis and data gathering is published 1976

---A paper entitled "Heuristic Learning in Science Education" is presented to the 49th annual meeting of the National Association for Research in Science Teaching in San Francisco, California on April 23rd through 25th 1976

---"An Instructional System for Consumer Decision-Making: A Teacher's Manual" is supposedly published by the Human Resources Research Organization in Carmel, California (Another change of address!) and is not available in hard copy due to marginal reproducibility of the

original. This claims to be an instructional system building adult basic education students' competencies in making consumer decisions and featuring a teacher's guide in designing their own decision-making problems for their students. No date found by this author, but being from Suchman's California days it may very well be in the late 1970s.

---A document describing a practicum which produces a unit on critical thinking makes use of Jerome Bruner's discovery-learning method within the curricular requirements of Castleton State College in Vermont. This is for Elementary Education majors. In this document the critical thinking theories of many major theorists are included such as J. Richard Suchman. (The others: Jerome Bruner, Hilda Taba, Benjamin Bloom, David Wright). The document was compiled by Robert F. Forest and entitled: "The Development of Critical Thinking Skills for Elementary Education Majors at Castleton State College" 1978

---Elefant's study acting to resuscitate a floundering educational acceptance of Inquiry Training is published. Sensory handicapped students are demonstrated as benefiting from application of--and experiences with--Inquiry Training 1980

---Concepts for Geological Inquiry Idea Book is published by Trillium Press, Inc. 1981

This idea book appears to be the last book or article published by J. Richard Suchman.

APPENDIX B

DISSERTATIONS INSPIRED BY SUCHMAN'S ISIT

---Blank (1963) Inquiry Training Through Programmed Instruction; University of California at Berkeley

---Geisinger (1964) Inquiry Training: Results in Tenth Grade Students of Complex Heuristic Treatments; University of Pittsburgh

---Mascolo (1967) Key Conceptual Schemes and Inquiry Training and Some Effects on New Learning; New York University

---Collins (1969) See thesis text

---Ivany (1969) See thesis text

---Bills (1970) The Development of Divergent Thinking as a Function of Inquiry Training; Utah State University

---Manusov (1971) An Analysis of Questioning Categories in J. Richard Suchman's 'The Elementary School Training Program in Scientific Inquiry'

---Pixley (1972) An Investigation of the Change in Teacher Attitudes and Behavior Resulting from a Title One In-Service Training Program as Perceived by Students; University of Idaho

---Legenza (1975) Inquiry Training Procedures to Improve Reading and Learning; University of Missouri at Kansas City

---Rochette (1975) "Le rendement en decouverte autonome en fonction de la motivation empirique du modele de J. Richard Suchman"; University of Ottawa

---Linnert (1976) The Effects of Inquiry Training on Fifth and Sixth Grade Teachers who Differ as to Basic Belief Systems; Purdue University

---Amore (1976) Instructional Procedures Using the Joyce-Weil (sic) Inquiry Training Model of Teaching With Teacher Candidates; Columbia Teachers College

---Peterson (1976) An Experimental Evaluation of a Science Inquiry Training Program for High School Students; University of California at Berkeley

---Schlenker (1976) Cited by Joyce and Weil in *Models of Teaching* but this author

researcher cannot locate the work.

---Lakin (1978) A Study of the Relationship Between Conceptual Development and Self-Inquiry Training of In-Service Teachers; University of Minnesota

---Elefant (1979) Behaviors Exhibited by Deaf Students During an Inquiry Training Program; Boston University School of Education

---Voss (1982) A Summary of Research in Science Education; Columbus, Ohio (Ohio State University, perhaps)

APPENDIX C

EPISODE ANALYSIS IN A HIGH SCHOOL DESIGN COURSE LESSON PLAN

Objects and Systems Name/Properties	Conditions and Events Initial Condition/Closing Condition	
1) glass tube (object)	1)initial effort to erect the geodesic hemisphere fails; a cylinder is the result	(1)several pentagons and hexagons are truncated; new configuration results in a true geodesic once the tension is applied
2) floral wire (object)		
(3)floral wire threaded through glass tube (system)		
(4)pentagons created from wire and tube systems(system)		
5)hexagons created from wire and tube systems(system)		

APPENDIX D

NECESSARY CONDITIONS IN A LESSON PLAN IN A HIGH SCHOOL DESIGN COURSE

Necessary conditions for the completion of a geodesic hemisphere:

1)the determination of either a Platonic solid or an Archimedian solid for the configuration

2)the determination to use either a rigid superstructure or a tension-integrity superstructure

3)student must draw to scale the configuration

4)if the geodesic is a tension-integrity structure (i.e. non-rigid) student must know how much wire to use as well as the proper level of tension to apply to the system to facilitate erection of a geodesic hemisphere

5)student must determine if truncation of the pentagon-units or hexagon-units is required to allow for the completion of the polar regions

APPENDIX E

RELATIONAL CONSTRUCTS USED IN AN INQUIRY TRAINING EXERCISE IN A HIGH SCHOOL DESIGN COURSE LESSON PLAN

1)student to determine structural integrity

2)student to determine economy of design

3)student to determine efficiency of design

4)student to be aware of concept of structural fatigue

5)if the geodesic is a tension-integrity design, student will determine proper level of tension to apply to model to allow for successful erection of geodesic configuration

6)optional: advanced student to make comparison between the model and the carbon atom replication of R. Buckminster Fuller

7)optional: advanced student to note difference between pure geodesic and other polyhedral solids

SELECTED BIBLIOGRAPHY

BOOKS

Bruner, Jerome S. *The Process of Education*. New York: Vintage Books, 1963.

Kuhn, Thomas S. *The Structure of Scientific Revolutions*. Chicago: The University of Chicago Press, 1970.

Suchman, J. Richard. *Inquiry Development Program: Developing Inquiry*. Chicago: Science Research Associates, 1966a and 1966b.

Suchman, J. Richard. *Concepts for Geological Inquiry Book*. New York: Trillium Press, Inc., 1981.

Suchman, J. Richard. "A Model for the Analysis of Inquiry." *Analyses of Concept Learning*. New York: Academic Press, 1966b.

ARTICLES, CHAPTERS, REPRINTS

Collins, K., "The Importance of Strong Confrontation in an Inquiry Model of Teaching," *School Science and Mathematics* LXIX (1969): 616.

Elefant, Emily, "Deaf Children in an Inquiry Training Program," *The Volta Review* 82 (1980): 271-279.

Ivany, George, "The Assessment of Verbal Inquiry in Elementary School Science," *Science Education* 53 (1969): 287.

Suchman, J. Richard, "Inquiry Training: Building Skills for Autonomous Discovery," *Merrill-Palmer Quarterly* 7 (1961): 168.

Suchman, J. Richard, "The Illinois Studies in Inquiry Training," *Piaget Rediscovered,* March 1964.

Suchman, J. Richard and Sybil B. Carlson, "Demonstration Center: Part II--Elementary School Programs in Scientific Inquiry for Gifted Students," Urbana: University of Illinois, (ERIC Document #ED041405), 1968.

Suchman, J. Richard. "Inquiry Training in the Elementary School." *Teaching: Vantage Points for Study*. Philadelphia: J.B. Lippincott Company, 1974.

Suchman, J. Richard, "Heuristic Learning and Science Education," *Journal of Research in Science Teaching* 14. 3 (1977).

Suchman, J. Richard, "Inquiry Training in the Elementary School," *The Science Teacher* 26. 7 (1960).

REFERENCE WORKS

ARCHIVAL COLLECTIONS

University of Illinois at Urbana-Champaign, Urbana, Illinois:

Board of Trustee Reports
ISIT Newsletters
Original ISIT Reports
Original ISIT Statistical Analyses
The Elementary School Training Program in Scientific Inquiry. J. Richard Suchman. University of Illinois at Urbana-Champaign. 1966.

DOCTORAL DISSERTATIONS

Bills, Frank Lynn. "The Development of Divergent Thinking as a Function of Inquiry Training." Utah State University, 1970.

Geisinger, Robert Willis. "Inquiry Training: Results in Tenth Grade Students of Complex Heuristic Treatments." University of Pittsburgh, 1964.

Linnert, Glenn Robert. "The Effects of Inquiry Training on Fifth and Sixth Grade Teachers who Differ as to Basic Belief Systems." Purdue University, 1967.

Manusov, Joseph. "An Analysis of Questioning Categories in J. Richard Suchman's 'The Elementary School Training Program in Scientific Inquiry'." Temple University, 1971.

Mascolo, Richard Peter. "Key Conceptual Schemes and Inquiry Training: Some Effects Upon New Learning." New York University, 1967.

PERSONAL INTERVIEWS

University of Illinois at Urbana-Champaign:
Dr. Terry Denny

Dr. Theodore Manolakes
Dr. Maynard Brichford, University Archivist

Stanford University:
Dr. J. Myron "Mike" Atkin

University of Nebraska at Lincoln:
Dr. James J. Fejfar

Cornell University:
Dr. Joseph Novak

National-Louis University:
Dr. Fred Wilkin

Highland Park Public School District #108:
Dr. Robert Altman

The office of Congressman John Porter, 10th District of Illinois, and the San Francisco Regional Office of the Department of Veteran's Affairs both provided access to all documents pertaining to Suchman's government service.

VITA

The author, James Edward Cleland, was born in 1953 in Evanston, Illinois.

In August 1972, Mr. Cleland entered Loyola University Chicago, and in June 1977 he received the Bachelor of Arts degree in Fine Arts with a concentration in Studio Art. With assistance from Loyola Academy's Sister Institution Program, Mr. Cleland was able to complete coursework leading to the Master of Arts degree in the Graduate School of Loyola University Chicago in January 1993.

Teaching and administration have been the occupations of Mr. Cleland since 1981. As Assistant Principal of Notre Dame de Chicago Academy, a Catholic elementary school located on Chicago's West Side, Mr. Cleland was part of an implementation team for a major curricular restructuring at that school. While currently teaching in north suburban Chicago at Loyola Academy College Preparatory School, Mr. Cleland also sits in on the Curriculum Committee and acts as a Semester Course Level Coordinator in the Fine Arts Department as well as contributing to the school's Critical Thinking sub-committee of the Outcomes-Based Accreditation for the North Central Association.

APPROVAL SHEET

The thesis submitted by James Edward Cleland has been read and approved by the following committee:

Dr. Robert Cienkus
Associate Professor, Department of Curriculum and Instruction
Loyola University Chicago

Dr. Barney Berlin
Associate Professor, Department of Curriculum and Instruction
Loyola University Chicago

Dr. Steven Haymes
Associate Professor, Department of Curriculum and Instruction
Loyola University Chicago

The following copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

3/9/93
Date

Director's Signature