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Teacher inservice in critical thinking.

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Teacher Inservice in Critical Thinking

A Dissertation Presented

by

Judith Collison

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ABSTRACT

TEACHER INSERVICE IN CRITICAL THINKING

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This dissertation presents a model for a series of teacher inservice workshops in critical thinking. The model is one of infusion of thinking skills into curricula, for the teaching of thinking skills is a necessary component of all instruction. The workshops are organized around some basic pedagogical needs: 1) The need for making connections throughout the curriculum, by setting unified goals. 2) The need to change the relative importance of information in the educational process. Gathering and clarifying information must become an aspect rather than the end of learning. 3) The need to teach the use of information in the process of reasoning. 4) The need to infuse creativity into all aspect of teaching. 5) The need to ensure that teachers possess the skills that allow them to be actively involved in reorganizing their curricula.

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INTRODUCTION

During the past few years much has been written about critical thinking. Some of the publications dealt with theory only. Others, dealing with practice or applications, present no unified approach, no criteria for deciding what skills are to be taught, in what order and to what end, in specific classroom situations. None of the prescribed programs or applications require teachers to think critically about their teaching.

This dissertation presents a model for an inservice workshop in critical thinking for teachers. The purpose of the workshops is twofold. They aim at making teachers better thinkers, and they aid teachers in incorporating thinking skills into their curricula. In these workshops, I present to the teachers a single, unified model for infusing critical thinking into their teaching. The purpose of this model is to aid teachers in recognition of connections between information, inference and the imagination. The model also helps in reorganizing curriculum.

These workshops do not represent a course in logic, for the problems dealt with are not logic problems, they are pedagogical ones. This point was crystallized in a recent conversation with a philosopher colleague. He repeated the oft-heard complaint, that the task of teaching philosophy is nearly impossible, because students do not understand long or complicated words. "If they were only forced to learn to read difficult text, they would be able to handle or become interested in philosophical prose". This conception of the problem is inverted. We can not expect the words to create interest in ideas. The ideas should move us to learn the words. Analogously, the study of thinking skills

does not move us to examine or improve our teaching, but a desire to improve our teaching can lead us to study and use skills of analysis, synthesis and relevant criticism. Educational theory is important, but it should not constitute a large part of inservice education. Discussion of pedagogical theory has two major purposes: 1) It is useful in initiating thought on the subject, it often helps overcome intellectual inertia. In this function the use of theory must be defined and limited by interest. Some examples of appropriate materials for this purpose are C. S. Pierce's essay "Never Block the Way to Inquiry" (1940), which deals with some common, but commonly ignored ways that we stop or fail to initiate inquiry, or Richard Paul's essay: "Critical Thinking: Fundamental to a Free Society" (1984), which discusses reasons including teaching students to think critically in our society.

2) Theory can and should be a guide to practice. It can provide a framework for curriculum development. Time available for inservice workshops is limited, thus exposition must be brief and to the point, and connection to practice must be constantly kept in mind. An extensive bibliography should be provided to enable teachers to further explore ideas.

More important than mastery of theory, is the teacher's ability to change instruction and curriculum so that students learn to think with the material taught. Typically, in the twelve-year course of a student's education, there is no conscious effort to involve the students' thinking capacities. Most of the knowledge that the students are supposed to gain is about subject matter outside of their minds, and the development of mental capacities is often no more than accidental carryover from the activity of information gathering. (Goodlad, 1983). For most people, information is equated with knowledge, and the gathering of

facts seems the goal of education. In fact, facts or information are just the building blocks of knowledge. Without the ability to use these building blocks, to make them adhere to each other in a practical and imaginative way, they are unused, therefore useless raw materials.

Traditional pedagogic belief holds that the various disciplines, by virtue of their organization, will teach that organization; that learning about ideas will result in the ability to think in terms of those ideas. These beliefs are largely unfounded, and report after report on the state of teaching and learning demonstrates that despite continuous exposure to logically organized disciplines, most students are not capable of logical, or independent thought. (See Chapter 1) Transfer of the skills of logical organization and sequencing and of reasoning does not usually or reliably occur. Obviously, a new approach to education is needed, for it is vital that students learn how to think clearly, how to make connections between ideas and concrete reality, how to generate new ways of looking at ideas, problems, and the world in general, how to make decisions with a clear understanding of the purpose and consequences of these decisions, and how to realize their ownmost intellectual capacities. These are the general goals of critical thinking instruction .

The most recent predecessor of critical thinking instruction was the pre-college philosophy movement. Its proponents believed that philosophy should be included in the curriculum, most typically as an elective course for advanced students, in order to provide a component in education that deals with intellectual development. In adding a philosophy course or courses into an already crowded curriculum there was a clear danger that the above skills would still be taught indirectly, i.e.,. with the hope that in learning about

philosophy, students would become philosophers. Thus, the addition of philosophy courses suffered from two problems. On the one hand, transfer of the skills of the philosopher could not be assured, on the other hand, even if philosophy courses could be instrumental in making students better thinkers, their benefits would be limited to those who elect to take these courses. Perhaps the greatest obstacle faced by school systems that tried to introduce philosophy into the curriculum, was the lack of teacher preparation. Typically, teachers have no background in philosophy and have no idea how to include philosophical content in their instruction. thus in the absence of teacher education in the area of philosophy, the success of the efforts was wholly dependent on the dedication and pioneering work of a few exceptional and exceptionally educated teachers.

Lipman's (1980) program in teaching philosophy to children addresses some of these problems. Teacher education in philosophy and in the use of philosophical material precedes the introduction of his program into any school system. All students in a school are exposed to the philosophical material, not just a selected group of talented ones. The question of transfer and of long term effect still remains a problem even in this approach.

A parallel problems face proponents of critical thinking instruction. If courses in reasoning or critical thinking skills are introduced into the curriculum, application of these skills to specific disciplines is not assured , i.e.,. transfer is not guaranteed. The addition of courses in reasoning or thinking skills is difficult, and as is the case with philosophy courses, makes such instruction available to only some of the students, whereas all students need to possess these skills. The changes in the curriculum have to be qualitative rather than quantitative. Rather than expanding the curriculum, the

traditional disciplines ought to be taught in such a way that they include, self consciously, the teaching of thinking skills. Here I am not arguing that critical thinking skills can not be conceived of outside a discipline as McPeck (1981) or Adler (1986) would claim, for I do believe that it makes sense to talk of specific skills of thinking or reasoning without embedding such discourse in a subject other than thinking itself. I am simply saying that pedagogically it makes more practical sense to embed the teaching of thinking skills in the subject matter to be taught. The lack of appropriate teacher education is still the major obstacle to infusing critical thinking into the curriculum.

The essential first step in teaching students to think critically is the education of teachers, after all, teachers themselves received an education largely devoid of critical thinking instruction. Teachers need to become critical thinkers, they need to look at their teaching in light of thinking skills and they need to explore ways of incorporating thinking skills into the form and content of their presentation. While it is true that students preparing for the teaching profession need to have such learning incorporated into their program of studies, it is just as important for teachers already in the schools to receive education in critical thinking. Moreover, teachers with experience in the classroom have a special understanding of the problem involved in getting students to think.

The typical and most practical form of further education for teachers already in the profession is through attendance of inservice workshops, provided by their school systems. In designing teacher inservice in critical thinking I have examined research in staff development to arrive at the most effective format.(Chapter 3)

In the workshops I introduce teachers to currently available curriculum materials in critical thinking. There are numerous very fine and useful programs and approaches, and teachers need to know what is available. Some of the time in the workshops is spent in reviewing and learning some important reasoning skills, using available programs and materials. My model is not, however, based on any of these programs. Rather, it is guided by what is conspicuously absent in all of them. Even after learning critical thinking skills and becoming familiar with the instructional materials and programs promoting critical thinking in the classroom, teachers still face a serious problem, one that is not addressed in any of the critical thinking literature. There is no framework or organizing principle that could help teachers structure critical thinking instruction. My model gives teachers a framework for reorganizing their instruction in such a way that it teaches thinking skills through and within the curriculum.

CHAPTER I

CRITICAL THINKING IN EDUCATION

A) Statement of Need for Critical Thinking Instruction

In 1892 The Committee of Ten, a group of leading educators was appointed by the National Education Association. The group was headed by Charles W. Eliot, the president of Harvard University. The task of the committee was to come up with a set of recommendations for standardizing college entrance requirements, and correspondingly, standardizing the high school curriculum. The major goal of the curriculum was to provide "...intellectual disciplining, training in reasoning, memory and expression". These were seen as "the best training for life and for college". The Cardinal Principles of Secondary Education, published by the NEA in 1918 included the development of thinking skills and moral judgment among its main objectives. Subsequent documents of the various committees of the NEA: Education for All American Youth (1944), The Committee on Life Adjustment Education (1951 & 1954) all included statements about the need for the development of critical and moral thinking. Most explicit were the recommendations of the Committee on the Central Purpose of Education (1961):"... the development of rational powers, and the processes of recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, and deducing and inferring were to be the central purpose of the schools". In spite of these forceful recommendations, none of the reports suggested ways in which these lofty goals

could be accomplished.

Recent studies of the American schools reaffirm the need to teach students to think, but they go further than the earlier documents. The shortcomings of the educational system are blamed on the absence of any instruction in thinking skills, and suggestions for educational improvement or reform invariably include ways of making the teaching of critical thinking explicit. Since 1980 a number of major reports have been published concerning the status of secondary instruction in America today, together with proposals to improve the quality of education at this level.

The Commission on the Humanities of the NEH (1980) in its report noted the deterioration of American secondary education. It is the opinion of this commission that the schools fail to foster "insight, perspective, critical understanding, discrimination and creativity". To teach people ways of making "moral, spiritual and intellectual sense of the world", this commission recommends instruction in critical thinking, as well as the creation of opportunities for professional development of teachers.

The Report of the Carnegie Foundation on the Status of the High School (1983), prompted by some shocking statistical data gathered by the National Center for Educational Statistics, the National Assessment of Educational Progress and the College Entrance Examination Board, showing a dramatic drop in various quantitative measures of high school and college students, in reading comprehension, writing effectiveness, competence in mathematics and social studies. Also of concern was the poor showing of American students in a twelve nation comparative study of performance of high school age students in seven basic subject areas. The authors of the report called for a new orientation

of educational goals in the high school. They were adamant that an essential goal of education is teaching students how to think critically, and that a strong writing curriculum should be central to achieving this goal. These goals also need to be reflected in the education of new teachers and in the continuing or further education of teachers already employed in the profession.

Recent publications of the American Federation of Teachers (1985,1986) cite some of the evidence giving cause for concerns of the effectiveness of the teaching profession:

•"Many high school students do not possess higher order intellectual skills we should expect of them: 40% cannot draw simple inferences, 80% can not write a persuasive essay, 66% cannot solve a math problem requiring several steps.

•95% of standardized test questions are devoted to recall and memorization and neglect the higher level thinking processes.

•On the New Jersey test for reasoning the mean scores of college freshmen are less than one point above the mean scores of sixth graders.; the basic repertoire of the adult is relatively unchanged from that of the sixth grade child.

•A major study using 100,000 U.S. school children found that although students at each age level had little difficulty making judgments about what they read, most lack the problem solving and critical thinking skills to explain and defend their judgment (not a cognitive inability of students, but a lack of exposure to critical thinking tasks).

•A recent report of the Association of American Medical Colleges criticized the lack of critical-analytical skills on the part of today's medical students."

The AFT also urges educational reform, with focus on critical thinking

instruction.

Reports of the Paideia Group (1982), The Twentieth Century Fund (1982), The National Commission on Excellence in Education (1983), all recommend the development of a systematic program for the improvement of students' thinking skills. In a later publication,(1986) Adler, the force behind much of the Paideia Groups' ideas, flatly rejects the notion that critical thinking skills are teachable. He promotes a use of the Great Books in a discussion format for teaching thinking. A publication of the National Science Board: Educating Americans for the 21st Century (1983) urges a renewed emphasis on teaching thinking and understanding. "We must return to basics. But the basics of the 21st century are not only reading, writing and arithmetic. They include the thinking tools that allow us to understand the technological world around us."

Ernest Boyer,(1983) the president of the Carnegie Foundation for the Advancement of Teaching summed up the challenge faced by the American educational community:

> "The nation must deepen its commitment to the belief that a human mind is a terrible thing to waste. We must renew our commitment to public education. To me this means establishing a clarity of goals in education, restoring language to a central place in the classroom, developing a coherent curriculum, and reaffirming the centrality of teaching."

In each case the push for educational reform is coupled with a realization that teacher education is a necessary prior step, echoing John Dewey: "All educational reform begins and ends with the classroom teacher."

B) How the Educational Community is Meeting this Need

The need for teaching critical thinking is being recognized widely, as is the need to bring about changes in order to remedy the deficiencies in the educational establishment. Changes are occurring at all levels, kindergarten to adult education.

The American Federation of Teachers (1986) conducted a fifty state survey of State Departments of Education regarding the role of critical thinking. Of the 28 states responding, 27 claimed they were taking positive steps to include critical thinking skills in curriculum revision on all levels, and in the reorganization of teacher education. All respondents expressed their conviction that the teaching of thinking is a major function of the schools. Some concrete examples of reform in the educational community are:

California has instituted a graduation requirement in critical thinking at the college level. In the elementary and secondary schools a series a reforms have been initiated to include critical thinking in teaching, which include revision of textbooks, curriculum and staff development. State-wide testing programs are being revised to test for thinking skills.

In Connecticut, the Department of education is developing mastery tests for the elementary grades focusing on reasoning skills. They have enlisted the aid of Robert Ennis and Edys Quellmaltz, both authors of critical thinking tests, in this project.

New York (1984) adopted an action plan for changes in instruction, which is to "ensure that all students are learning to think logically and creatively, and to apply reasoning to issues and problems an all subjects and at all grade levels".

The South Carolina legislature passed an Education Improvement Act (1984), requiring that "all schools and districts shall emphasize higher order problem solving skills in curricula at all levels".

North Carolina has two major, state-wide programs promoting critical thinking. Based on the Paideia model (1984), under Mortimer Adler's direction, over 100 school systems participate in a program of weekly discussion seminars. The discussions make use of the Great Books and the Socratic method. Teachers and administrators undergo extensive training before instituting the program in their particular school system. The Consortium for the Development of Thinking for Learning (CDTL) takes a different approach. The task of this group of educational, business and community organizations is finding and backing means of developing student thinking in, and out of school. It is a collaborative effort to provide support, training, methods and materials to teachers. (Rud, 1987)

The state of New Jersey has recently (1987) made a formal commitment to state-wide curricular reorganization. A Center for Critical Thinking has been established at Montclair State College. This group is to work on curricular reform in pre-college and teacher education. The Institute for Advancement of Philosophy for Children is also located at Montclair State College.

A number of conferences on critical thinking have been held nationwide, and have developed into regular events. The yearly conference on critical thinking hosted by the Center for Critical Thinking and Moral Critique at Sonoma State University in California will be holding its eighth meeting this summer. The Critical Thinking Conference sponsored by the Center for Critical

Thinking at Christopher Newport College in Newport News, Virginia is in its third year. The American Association of Philosophy Teachers has devoted many of the sessions of its biennial workshop conferences to teaching thinking at both the college and pre-college levels. Sessions at all divisions of the American Philosophical Association have dealt with issues of teaching thinking skills. This is also true for conferences of the National Education Association and of the Association for Supervision and Curriculum Development.

Unfortunately, teacher education lags behind intentions and directives. At this time the only graduate program in critical thinking is at the University of Massachusetts in Boston. This highly successful program offers a Masters Degree in Critical and Creative Thinking. Summer institutes are also held in Boston both for degree and non-degree students, mostly teachers, in critical and creative thinking. Harvard University's School of Education has held summer institutes in critical thinking for educators. The new center at Montclair State hopes to establish a graduate program in teacher education in the near future. For the most part, teacher education in critical thinking has been in the form of fragmented, sporadic in-service workshops, with little or no follow-up.

CHAPTER II

PROGRAMS AND DEFINITIONS

A. What is Critical Thinking?

Educators, educational theorists, policy makers and administrators all endorse the teaching of critical thinking. They agree that the very notion of education must contain, entail or imply critical thought; that critical thinking is necessary if education is to fulfill its purpose: bringing about learning. The purpose and goals of all the proponents of critical thinking are, by and large, the same. What is different is the emphasis and specific content of the proposed programs. They range through formal-logical approaches, the teaching of informal logic and fallacy hunting, criterion and hypothesis testing, problem solving, argument generation and analysis to merely creating a critical attitude - a sceptical mindset. The reasons for teaching critical thinking vary, as do the proposed forms of instruction.

Richard Paul, one of the most active proponents of critical thinking instruction believes that critical thinking is "fundamental for education in a free society." He distinguishes between "weak sense" and "strong sense" critical thinking. Critical thinking in the weak sense is clear and logically correct thought, necessary but not sufficient to make one into a critical thinker. Critical thinking in the strong sense involves a merciless scrutiny of one's beliefs.

Michael Scriven sees critical thinking instruction as "survival training": .."the task of preparing human beings for survival in the more hazardous moments of normal life, moments when the wrong decision can mean injury or

long term commitment to a disastrous form of life, such as addiction or criminality or resented parenting...".(1985) As such training, critical thinking instruction must be characterized by the key features of other instances of survival training: "a) careful supervision of coping efforts, so that the dangers are absolutely minimal; b) constructive demonstrations and suggestions on how to handle the problems of survival; c) enough reality so that some transfer of coping skills to the real case - should it ever arise - can reasonably expected." As a precondition to this survival training is the acceptance by the schools of the idea that free inquiry is critical to survival. For Scriven, skills of reasoning represent an important aspect of critical thinking: the vocabulary for dealing with arguments, their truth and validity, and decisions. It is then important to apply the logic of argumentation and reasoning to dealing with large families of issues. and decision making strategies.

Matthew Lipman (1984) also talks of reasoning equipment as a cognitive tool kit. It is the responsibility of the schools to teach children how to use this equipment. Children who enter schools with cognitive deficiencies need to have these diagnosed and corrected, otherwise they will carry these deficiencies to their mature reasoning. Philosophy for children, all children, is offered by Lipman as the way to provide children with this tool kit, i.e.,. with reasoning and inquiry skills. Although the greatest emphasis in Lipman's approach is on the development of logical reasoning, he wishes philosophy to be taught as true humanities discipline at the elementary level: "... a discipline that helps students develop their personal perspectives and discover broader ranges of meaning in their lives." To enter the educational process, philosophy has to change its image of itself, much as teachers need to change their image of

philosophy.

> "Against its conception of itself as a discipline which could be formulated in the most technical of terminologies, philosophy had to throw aside the comforts of a mysterious nomenclature and express itself in the ordinary, everyday language of children. The grim forbidding text had to be replaced by novels, and the cerebral sobriety of the text had to be replaced by conversations often charged with feelings and occasionally bubbling with humor. The pretensions to wisdom also went by the boards, and in their place came institutionalized naivete and a sense of wonder at things in the world normally taken for granted and at the world itself."(Lipman: 1985)

It is this sense of wonder or "puzzlement" that Gareth Matthews takes as the ground for his philosophy for children. The problem is that adults and the educational establishment have shortchanged children by failing to validate their reflective activity. Matthews regards both "puzzlement" and "conceptual play" of children as important philosophical activities. He also believes that reasoning is not the domain of older or precocious younger children. Children do reason, but are given little or no opportunity for trying out or developing their ideas through interaction . "In fact," Matthews writes, "for many young members of the human race, philosophical thinking - including on occasion subtle and ingenious reasoning - is as natural as making music and playing games, and quite as much a part of being human."

Harvey Siegel (1987) talks of critical thinking as a life long learning process involving skills as well as a critical attitude, which we bring to all new situations. He objects to the image of the critical thinker as a "bloodless reasoning machine". Siegel contends that : "The critical thinker has a rich

affections make-up of dispositions, habits of mind, values, character traits, and emotions which may be collectively referred to as the critical spirit."

McPeck (1981) refers to a "propensity" for thinking critically as necessary in addition to an ability to reason correctly. Critical thinking must include "..the active engagement of the mind as well as the assessment of statements", and must be done within specific subject areas. He feels that it makes no sense to talk of critical thinking skills as such, because they are "necessarily linked with specific areas of expertise and knowledge."

Robert Ennis' definition of critical thinking also includes rationality and the scrutiny of belief structures: "Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe and do." (1985). Critical thinking has three dimensions: the logical, the criterial, and the pragmatic. The logical deals with the mechanics of reasoning, the criterial, with the subject specific aspect of what is thought about, and the pragmatic with problem resolution and decision making processes. Ennis (1962)

Israel Scheffler (1973) believes that critical thought should characterize the form and content of all educational activities. By critical thought, he means rationality as a "unifying perspective, relating theory and practice".

The philosophical controversy surrounding the proper definition of critical thinking goes on. All attempts do have something in common. They all stress the role of reason, but none see rationality as the sole aspect of good thinking. The development of the individual mind for belief formation is at least mentioned by all proponents of critical thinking instruction. The relative importance of personal decision making and belief formation in the various approaches varies.

The programs for critical thinking instruction vary correspondingly, in their emphasis on teaching reasoning skills (logic) and methods of questioning and clarifying beliefs.

B. Programs and Approaches for Teaching Critical Thinking

The programs developed for teaching critical thinking have been categorized according to their focus and emphasis. Nickerson et AL. (1985) arrived at a five -fold classification.

1) The cognitive operations programs.

These programs treat thinking as a set of skills, operations, or processes, such as classifying, observing and reasoning (i. e. logic). It is believed that refining these skills, operations, and processes will result in better thinking, therefore in better education. The emphasis here is clearly on objectively identifiable skills. Skills are identified, for the most part, independently of content. These programs assume a developmental framework and concentrate on "enabling skills" at earlier, and formal skills at later stages. The ability to make decisions and formulate beliefs is to be an indirect, rather than a direct goal of these programs. The following are examples of this approach:

The Instrumental Enrichment Program (IE) developed by Reuven Feuerstein seeks to develop the intelligence of students through realizing their potential for learning. The "instruments" are sets of exercises designed to correct cognitive deficiencies. This program has been most successful with students whose environment or abilities did not provide intellectual stimulation: disadvantaged or handicapped students.

Science... a Process Approach (SAPA) was developed by the Commission

on Science Education of the American Association for the Advancement of Science and the National Science Foundation (1967). The program emphasizes learning about scientific processes through discovery and experience. Instruction focuses on eight basic processes of science: observing, classifying, using numbers, measuring, using space/time relationships, communicating, predicting, and inferring. The program is individualized. It was the hope of the developers of this program that students will come to have a better understanding of science, and that this understanding will contribute to intellectual growth in other areas.

Think About is series of videotaped programs developed by 40 American and Canadian state and provincial Education Departments, with the Agency for Instructional Television (1977). The programs are organized around thirteen basic general reasoning skills, and sixty five subject specific skills in mathematics and language arts. The ultimate goal of the program is to make students independent thinkers and problem solvers. Here we find both content free and content dependent aspects, but they do not form a complex system, but are, rather treated separately.

Building and Applying Strategies for Intellectual Competencies in Students (BASICS) Was developed by the Institute for Curriculum and Development in Cora Gables, Florida (Ehrenberg & Sydelle, 1980). Eighteen thinking /learning strategies are identified, some dealing with data gathering, others with interpretation.

Project Intelligence was a cooperative venture of Harvard University and the Venezuelan Ministry of Education from 1979 to 1983. The basic instrument for the project was a set of six lesson series, each dealing with some aspect of

thinking. The six areas were: foundations of reasoning, understanding language, verbal reasoning, problem solving, decision making, and inventive thinking. Teachers were supplied with carefully and fully developed lesson plans.

2. Problem Solving or Heuristic Approaches.

These approaches emphasize problem solving methods, models or strategies as the way of improving thinking, thus learning. The major goal is the structuring of activities of 'information processing'. The idea of treating learning as problem solving is not new. Dewey's inquiry method is based on the same idea.

The Polya Model is perhaps the most widely known and used approach to structured problem solving. It is based on Polya's book How to Solve It (1957), where he outlines ways of approaching, setting up and solving problems, testing alternative solutions, and generalizing learning from the process. The later heuristic approaches and programs are variations and elaborations of this model. Among these are: Patterns of Problem Solving, developed by Rubenstein at UCLA (1969), Schoenfeld's Heuristic Instruction in Mathematical Problem Solving (1982), A Practicum in Thinking developed by Wheeler and Dember at the University of Cincinnati (1979).

The Cognitive Studies Project of Wimbey and Lochhead (1979), introduces some innovations that broaden the scope of problem solving. Most important is the use of team, peer or pair problem solving. This method considers the learner a part of the process of problem solving.

Other heuristic models incorporate creativity and experiential learning into problem solving strategies. The Productive Thinking Program of Covington et AL. (1974), the CoRT Program of DeBono (1968, 1970), and the Problem Based Self-Instruction in Medical Problem Solving of Barrows and Tamblyn (1980) are examples of more complex conceptions of heuristic programs.

3) Formal Thinking Approaches;

These approaches are largely based on the Piagetian model for cognitive development. the central assumption is that students can be helped in progressing through their cognitive developmental stages to become formal operational. Once at this most advanced stage, they can be taught to maximize their capacity for formal thought, i.e.,. they can learn to deal successfully with formal processes and abstract concepts.

The programs reviewed by Nickerson et AL. (1985) have all been developed for college students, in response to concerns that many were not able to function well academically, because they lacked the ability to deal with abstractions. These programs include : ADAPT (Accent on the Development of Abstract Processes of Thought), a program developed at the University of Nebraska, for integration of teaching formal reasoning into the content of courses, in order to move pre-formal students to the formal operational stage. The goals of DOORS (Development of Operational Reasoning Skills) at Illinois Central College, COMPAS (Consortium for Operating and Managing Programs for the Advancement of Skills) at the community colleges in Illinois, SOAR (Stress on Analytic Reasoning) developed by the mathematics and science departments at

Xavier University in Louisiana, and DORIS (Development of Reasoning in Science) at California State University at Fullerton were all similar.

4) Thinking Through Language and Symbol Manipulation

These programs hope to enhance thinking skills through the manipulation of complex systems such natural or artificial languages, rather than through refining discrete skills. They use the reading and writing of essays, stories, arguments, and computer languages as vehicle for teaching thinking.

These approaches attempt to make use of personal experiences and abilities that students already bring to situations.

There are numerous programs that attempt to teach thinking though developing skills of writing - programs that do not teach of writing in a "mechanics first" approach. These tend to use "writing as occasion for thinking", or "writing as a means of thinking". The basic assumptions here are, that :1) writing demands thinking, 2) writing is a vehicle for thinking, and 3) writing reflects thought. Therefore, examining the process of writing could yield insights into the nature of thinking, and writing instruction is useful content for teaching thinking. (Easterling & Pasanen, 1979; Bereiter, 1980: Perkins, 1981; Bruce et AL., 1983: Scardamalia & Bereiter, 1985).

James Moffett's Teaching The Universe of Discourse seeks to reform education by introducing a student centered arts and reading program K-12. His is a departure from the other reading and writing based programs for teaching thinking, in that he sees the occasion for thought not in the writing or reading of the individual, but in the interaction of students with each other. The idea is not new. It is at least as old as Socrates. It is the same idea that Clyde

Evans (1976) used in his appearances as "philosopher-in-residence" in various elementary schools. The role of the teacher is that of facilitator and Socratic guide of discussions. The verbal is then translated into writing. Teaching thinking using Moffett's model is more a method than a program. This is also true of Meichenbaum's "Modelling Inner Speech and Self-Instruction as Means of Teaching Thinking" (1977). Meichenbaum uses inner speech in problem resolution and for cognitive behavior modification. He believes that 'inner speech' including language as well as images, comes closest to one's understanding of problems at hand. If inner speech can be modified, internal cognitive structures are likely to follow. Lochhead (1987) uses a similar idea in his pair problem solving format. A crucial step in this process is the articulation, or restatement of the problem by the "solver" to the facilitator. Such re-statement can reveal misunderstanding or lack of understanding of the problem, and can be corrected. Without this step, the source of confusion can remain hidden.

The use of artificial, rather than natural language, in teaching thinking skills is another instance of language and symbol based instruction. The best example of such an approach is the use of the computer language LOGO in teaching thinking skills. Seymour Papert, in Mindstorms (1980) and On Logo (1986), describes the use of LOGO, more specifically of Turtle Geometry, in teaching cognitive skills. The vocabulary that LOGO translates in not that of verbal thought, but of physical intuition. Papert's is basically a Piagetian framework, using the representational as bridge between concrete and abstract reality.

5) Thinking About Thinking

These are approaches that are based on reflection and introspection. The assumption is that thinking is basic to the human mind, and that children can learn to think well if encouraged and provided with opportunity and guidance.

Matthew Lipman's Philosophy for Children is one such program, with curriculum materials and teacher handbooks developed for use K-12. The definition of philosophy and of critical thinking that Lipman works with is quite simple. Philosophy is "thinking about thinking". Children read short novels about their contemporaries, written for their age group. For example, Kio and Gus, is written about and for children at the pre-school level; Pixie is for 7 year olds, and Lisa (1976) for the junior high school age students. Novels for the secondary level address specific disciplines: Mark (1980) deals with issues social science; in Suki (1978) children sort through the differences between scientific writing and literature. Through reading, discussing and understanding the content of these novels, and with the guidance of their teachers, students are able to discover rules of reasoning. They can also form their positions on several philosophical issues.

The basic assumptions of this program, and similarly of Gareth Matthews' (1976), is that: 1) children are natural philosophers, and ought to be taken seriously; 2) reasoning skills can be taught at a very early age; and 3) discussions are very helpful in developing children's reasoning abilities. These assumptions directly contradict the Piagetian contention, that children are incapable of abstract thought at such an early age. In the same vein, writing about teaching science to children, Osborne (1985) recommends that we pay attention to students' intuitive ideas about scientific concepts, and use these, not the scientists polished formulations, as the springboard for teaching new

material.

Courses and books on argument analysis and informal logic also fall into this category. These are, for the most part, aimed at college students. Examples of texts dealing with the anatomy of argument are Beardsley's Thinking Straight (1966), Toulmin et AL. An Introduction to Reasoning (1984), Michael Scriven's Reasoning (1985), Howard Kahane's Logic and Contemporary Rhetoric (1984). The content of these texts is informal or non-symbolic logic.

Another informal logical approach consists in analyzing fallacies. Some interesting and innovative work has been done in this area in recent years, representing a definite departure from the traditional treatment of fallacious arguments. The works of Edward Damer (1987), and John Hoaglund (1987) treat fallacies not merely as ends in themselves, but make use of them to throw light on sound argumentation.

These classifications are helpful, but far from exact. There is a great deal of overlap. Some programs could easily fit into several categories. For example, the formal thinking approaches incorporate the ideas of cognitive operations, but organize instruction in a temporally (or developmentally) hierarchic fashion. Thinking about thinking is a formal operational approach without the Piagetian framework, and the entire classification can easily fall into the category of language manipulation. The language manipulation approach makes use of cognitive processes and logical sequencing. Problem solving methods and strategies are used by all programs, with varying degrees of emphasis.

Siegal et AL. (1985) offer a slightly different classification of the available programs and texts. Programs considered are classified into three broad categories.

1) Programs whose goal is the acquisition of knowledge in the form of acquiring information from texts. Some concentrate on learning strategies: MOAN (Matrix Outlining and Analysis) and CMLR/LS (Chicago Mastery Learning Reading Program with Learning Strategies), while other programs deal with improving reading and writing skills.(Segal: 1985)

2) Problem solving models, whose goal is the structuring of activities of 'information processing'. This category has basically the same content in both classificatory schemes.

3) Development of intelligence and reasoning. Lipman's Philosophy for Children falls into this category, as do the Instrumental Enrichment program (Feuerstein) and the various informal logical approaches. This category combines some of the programs subsumed under cognitive developmental approaches as well as others in the "Formal thinking" classification. The central idea here is that students become capable of dealing with abstractions at some stage of their cognitive development. Until such time we need to concentrate on teaching 'enabling skills', or lower order thinking skills. Examples of this approach are California's Project Impact, and the H.O.T.S. (Higher Order Thinking Skills) program developed by Edys Quellmaltz (1984).

The proliferation of instructional materials for critical thinking is at the same time a blessing and a curse for the teachers. There is now available an ever growing pool of ideas and strategies for use in the classroom. That is the blessing. The curse is that there are no guidelines or criteria for assessing the usefulness of in specific circumstances. At the end of their book, Nickerson, et AL. (1985) admit: "Our review of specific programs has not left us with a strong conviction that any of these approaches is manifestly superior, or inferior, to all

the others. testing has not been sufficiently extensive to permit firm conclusion on that issue."

If we take the points of agreement as a point of departure, that teaching critical thinking is desirable and possible, the problems remaining for the teacher can be, and often are paralyzing. Where does one begin? Which are the right approaches for a specific student population? How does one choose? Once the choice is made, how is the innovation to be evaluated?

CHAPTER III

PREFERRED FORM OF TEACHER INSERVICE

Since the inservice workshop is the most practical and most readily available form of further education for teachers, designing the appropriate form and content of inservice workshops in critical thinking is a necessary first step. in order to arrive at the most effective format for my inservice workshops, I examined the relevant research on the various forms of inservice teacher education, also referred to in the literature as "staff development". This chapter summarizes results of that research, and outlines the preferred form of inservice workshops implied by the research.

During the past twenty years considerable volume of research has been done on the effectiveness of staff development or inservice teacher education in improving the quality of education. These studies were attempted to evaluate the various forms of staff development, the most desirable content, and the special needs and concerns of teachers as students. The following is a list of some of the most significant findings.

Inservice should recognize the special attributes and needs of the adult learner Hendrickson (1966) by:

1) Recognizing the teachers' need for involvement.
2) Recognizing the adults as a prime teaching resource.
3) Recognizing the concreteness and immediacy of adults' goals. (For the younger students goals are not always clearly formulated, and application is not close to the learning.)

4) Taking into account the learning speed of adults.

5) Recognizing physical and mental fatigue.

In considering the needs of educators as learners, M. M. Worth(1986) concluded that:

1) There is a need for individualization, therefore needs assessment is essential. Those with like needs could work as a group.
2) Depending on the need, other teachers, administrators or support personnel can act as instructors.
3) Since staff development is a vital activity, it should be subject to change to coincide with the needs that arise.

Evaluation of a program of cooperation between public schools and colleges, Parkay (1986) found that:

1) Teachers felt that their creativity was encouraged.

2) Teachers felt their sense of professionalism was enhanced through the following ways:

a) sharing materials across the curriculum,

b) developing long term collegial problem solving groups at their own schools,

c) being treated as professionals,

d) acquiring new research based materials,

e) extending their understanding of why students learn or fail to learn

f) clarifying instructional goals and objectives

g) receiving encouragement and support for trying new things and

growing professionally.

Ruth Wade's (1985) analysis of research in inservice education concludes that there is no magic formula for best inservice programs, but there are some practices that tend to make these programs more effective. These are:

1) Programs in which elementary and secondary school teachers work together.
2) Teachers are encouraged to participate in federal, state or university programs.
3) Incentive for participation is offered
4) Instructors set clear goals and take major responsibility for design and teaching.
5) The use of instructional techniques as alternatives to lecture is encouraged.

A national study of staff development programs conducted by J. C. Thompson and V. E. Cooley (1986) showed that 94% of teachers and administrator in all types of school districts (urban, suburban and rural), see staff development as important and effective in bringing about educational improvement. All stressed the need for teacher involvement in the planning and development of new programs and curricula. They also believed that the development of objectives greatly enhanced instruction.

In summary, these findings indicate that in order to be effective, inservice workshops need to have the following general characteristics:

1) Teachers must be active participants in their education.
2) Goals of instruction need to be clarified.
3) New methods, materials and techniques to revitalize instruction.
4) No specific method of instruction stands out as universally superior.

Method of instruction should represent the individual teacher's strength.

5) Teachers should be treated as professionals.

In addition to these general attributes, workshops in critical thinking have requirements specific to them.

1) Critical thinking workshops should model critical thinking instruction.

2) Teachers should have a good working understanding of the concept of critical thinking.

3) Teachers should have usable instructional materials as a result of having attended these workshops.

I had these general and specific criteria in mind in designing my inservice workshops in critical thinking.

CHAPTER IV

WORKSHOPS IN CRITICAL THINKING: A MODEL

In this chapter I describe the overall form and content of the workshops I designed.

A. Introduction to the Workshops

The focus of these workshops is the improvement of teaching. The workshops introduce teachers to new ideas, materials and methods, and to the results of the latest research in critical thinking instruction. As part of the workshops, teachers devise a way that they can continually share ideas with each other. They also have to look beyond the scope of the present workshop to determine what they need to learn about in future staff development sessions. Teachers must be active participants at all levels, for the success of the workshops is determined by the results achieved by teachers in the classroom.

The definition of critical thinking that I am using is akin to Lipman's definition of philosophy: it is thinking about thinking. (Lipman:1980) It involves both attitudes and abilities. It is true that thinking is always thinking about "X", and this variable "X" is replaced by critical thinking, thinking about teaching, in the course of our considerations.

1)Thinking about "critical thinking":

We review the current status of critical thinking in education, with summary of research done on the various programs claiming to enhance

critical thinking skills. Teachers are asked to examine their teaching for the ways they already attempt to teach these skills, and to compare the results of researchers with their own results or impressions.

2) Thinking about thinking:

A look at some important aspects of organizing thought and reasoning processes. This is a preliminary look at some of the issues in reasoning and logical organization. Questions are raised at this point. Later, a more detailed treatment of these issues becomes necessary. Topics include:

Continuity: within the subject, between subjects, between students' learning in school and his/her daily life and level of cognitive development;

Definitions: the purpose of defining, and the type of definitions appropriate for this purpose.

Reasoning: Types of reasoning used in different contexts, the difference between deductive and non-deductive forms, the ways of making logical connections, with special emphasis on the use analogies.

Justification: the effects of point of view, rules for the evaluation of evidence, distinguishing between relevant and irrelevant information.

3)Thinking about teaching:

An examination of the goals of instruction in general, individual topics and lessons in particular in light of the topics discussed in thinking about thinking. Are the goals characterized by unity and continuity? Are they clearly defined? Are appropriate connections made? Are methods of evaluation consistent with the goals? What works i.e.,. is a successful strategy, and why? What does not

work, and how is the teaching approach in this case similar to or different from that of the successful lesson? How is transfer of skills and ideas to be achieved?

At this stage of thinking about teaching, the teachers provide much of the material for discussion. Teacher input is very important here. It allows us to deal with problems that are actually present in the classroom, connecting the workshop to day-to-day teaching. Using their actual experiences, successes as well as failures, in the classroom, we can begin to answer some of the questions raised, and identify problem areas.

We use my model for resolving the problems as they are identified by the teachers. The model has four major components:

1) Setting goals:

In order to create a coherent approach to teaching and an awareness of the role of the subject taught in the intellectual development of the student. The goals to be recognized are the problems or deficiencies of specific students as seen by their teachers.

2) Study of a schema for organizing the teaching of critical thinking skills:

The purpose of this organization is to ensure that information acquisition is only an aspect, not the end of education.

3) Study of critical thinking skills:

Specific skills associated with information acquisition, implication and inference are studied, along with the programs and techniques currently available for teaching these skills. The list of skills may be generated during the introductory section of the workshops, it could be those listed in

the curriculum materials the teachers wish to try out, for example, Lipman's suggested list of goals in his novels, Richard Paul's in his Guidebook (1987), or Robert Ennis' (1984) list of "Goals for a critical thinking/reasoning curriculum", just to name a few. I provide notes and worksheets on the skills studied. Examples of such worksheets are included in the Appendix.

4) Reconstruction of curriculum:

Instruction is reorganized using my critical thinking schema, and goals and skills appropriate for specific curriculum. The scope of reorganization varies with the needs of particular teachers. Some wish try out the process on single lessons, others organize an entire year's work according to the model.

The following sections are the elaboration of the components of the above outlined model.

B) Setting Goals

Before deciding to use any of the curricular ideas or materials, teachers need to examine and clarify their goals in their own situations. Naturally, these goals can not be set in a vacuum. They must have a context. Inquiry into the aims of teaching must begin as does all inquiry: with a problem. (Dewey: 1945) In 'setting goals' teachers focus on this problem: the deficiency or desired developmental outcome for students at the appropriate level in the study of particular subject matter. Thus, the goals of instruction represent the interdependent and mutually defined problems of teaching and learning. It is only in light of these goals that intelligent decisions about the appropriate choice of approaches or techniques can be made.

The most important theme in formulating or setting goals is that of making connections. Ideas that are connected are learned faster, retained longer and are understood better than those with arbitrary connections with each other and independent of the experience of the learner. This idea is not new. An experiment in classical cognitive psychology has shown that learning is faster and retention is greater of words that are in some way connected than of those that are nonsense or unconnected. Moreover, the greater the connection, the better the retention and faster the learning. John Dewey's idea of 'continuity' takes the need for connections further in insisting on a connection between the personal experience of the student and the content of education. The major ideas of this component of my inservice are :

1) The goals should be organized around one or a few germinal ideas. Information or concepts with internal connections are easier to learn than unconnected material.

2) Learning must be put in perspective to provide continuity with history of ideas, educational history of students and personal experiences of students.
3) Curriculum must be geared to encouraging independent and creative thought.
4) Goals of instruction need to be clearly stated to the students.

In a workshop on setting goals for a course or a unit, we do not merely discuss the importance of such connections. Teachers are asked to recreate the results of that classical experiment in cognitive psychology. (Appendix: Worksheet on making connections). The need for making connections emerges from these experiment in several ways:

1) Familiarity with vocabulary is essential. Words that are understood are learned faster than those that are not, and it is easier to establish connections between words that make sense. The impact of this idea is especially great in bilingual education, where lack of a common vocabulary can seriously hinder learning.
2) Internal connection of ideas facilitates memorization and recall, thus teaching of units, courses and indeed the entire curriculum is easier and more successful when a connecting thread is established.
3) Knowing the sequence or pattern of relationships enables one to generate information that is forgotten, or never memorized. In case of the numerical examples in the experiment, members of a sequence do not need to be memorized if the rule or pattern governing the sequence is recognized. Without such a pattern learning is sheer memorization.
4) In presenting information or ideas we can not assume that the same

connections are made by all people. The examples calling for individual associations clearly show the need to verify students' understanding of instruction. It also becomes clear that teachers have to understand the context of their students' associations.

Once the need for making connections is established, the next step in the workshop is establishing connections through setting goals. Teachers are asked to arrive at one or few germinal ideas around which all instruction in a course or unit can be organized. (Worksheet on Goals: Appendix). One of the teachers in my course on critical thinking made an interesting comment. "Every year" she said, "I write up my goals and sequence of lessons for the administration, and then teach by staying one week ahead of the kids." It is important that this organization of the subject matter be done by the teacher with an understanding of the value of it.

Connection with the experience of students is established by putting the materials to be taught in perspective. (Appendix: Worksheet on Perspectives). Teachers are to examine how the material to be presented fits into the educational experience of students and how it is or can be related to the personal experience of students. Justification for the teaching and learning in particular course should be in terms of the intrinsic value of the material and the intellectual needs of the particular student. For example, the oft heard reasons for signing up for courses "It is required" or "It will look good on my transcript" are just not appropriate or sufficient.

Finally, teachers are asked to review their curricular organization, by completing the worksheet on synthesizing. The questions here are aimed to look

back at the process and to look forward to the actual implementation of the goals set.

C) A Model for Organizing the Teaching of Thinking Skills: Information, Implication, Inference, and Imagination

There is a need for a unified, structured approach to teaching critical thinking, but one that is at the same time open ended, i.e.,. does not stop the process of inquiry. Most approaches to critical thinking instruction suffer from fragmentation. There are some fine programs that promote the teaching of specific skills outside of the context of the process of thinking. The problem with this type of approach to teaching critical thinking skills is that there is no common tangible goal, but only goals specifically associated with the learning of each skill. The entire process of reasoning or decision making has to be the context for teaching specific skills.

The approaches based in cognitive developmental theory fragment thinking skills through time, through the life of the student. The underlying assumption is that since higher order thinking is not done at early stages of development, that it is useless to teach the entire spectrum of thinking skills at all stages of the child's intellectual development. Thus, skills dealing with information gathering and sorting are taught exclusively at an early age. The skills of questioning, hypothesizing, and making connections are reserved for a later stage; reasoning is not tackled until students are believed to be formal operational. (E.g.,. PROJECT IMPACT). The flaw here is that children do not wait to reason until they are developmentally ready to do so correctly or elegantly. Reasoning is done by even very young children, who are far from

formal operational stage (Lipman, Matthews). They may lack sophistication, they may reason incorrectly, but the form or structure of reasoning is present even at a very early age. It is this structure that needs to be made the framework of all critical thinking instruction. The process of inquiry may be represented by this framework, and through its use, criteria for good thinking can be developed for all cognitive levels.

The framework I am proposing is implicit in most instruction. It is one that leads the learner from information to inference, through an understanding of the connections implied and questions raised by the information. It is not a hierarchical model, but one that characterizes the reasoning process at all levels. Dealing with facts or information is not seen as a lower order concern than is making connections or inferences. The level of each component has to be appropriate to the specific student population; the format is the same. Even though this format is characteristic of the organization of most subjects, it is not used as a tool in teaching. Proofs in geometry present the most obvious example. Even in this subject students are rarely made aware of the value or structure of the subject.

Table 1. represents my proposed structure. Once goals for specific subject and grade level are established, teachers need to develop a program for implementing these goals. Before describing how the model is used, let me clarify the way I use the terms in the model.

Information :

Deals with determining what ideas, or data are relevant to lesson or course under consideration, and with clarifying and gathering ideas and data dictated by the goals. Activity at this level is descriptive. Items of 'information' whether

ideas or data are the raw materials for the process of inference.

Implication:

Deals with recognizing connections among items of information, examining the questions raised and problems posed by the information, and with arriving at appropriate hypotheses or conjectures based on the information.

Inference:

Refers to the process of reasoning. It is at this point that connections present are used in drawing conclusions, answering questions, verifying hypotheses, problem solving, and predicting. Logical skills are needed at this stage.

Skills:

Operations or processes necessary for enabling students to carry out goals of lesson. Critical thinking skills associated with each aspect of this reasoning process are chosen in such a way that they are appropriate to grade or age level and to the subject. For example, listening skills are appropriate in a music class, while examining criteria for evidence is more appropriate in a history class.

Activities:

Methods, materials or lessons designed to teach or reinforce the skills chosen.

Imagination:

Creative ways of extending each level beyond the scope of the unit or subject. This extension may be in the form of asking unusual questions, setting up analogies based on visualization or fantasy, or finding innovative and/or interdisciplinary applications of what was learned.

Grade Level _____
Subject _____
Goal: _____

Critical Thinking
Instructional Planning Table

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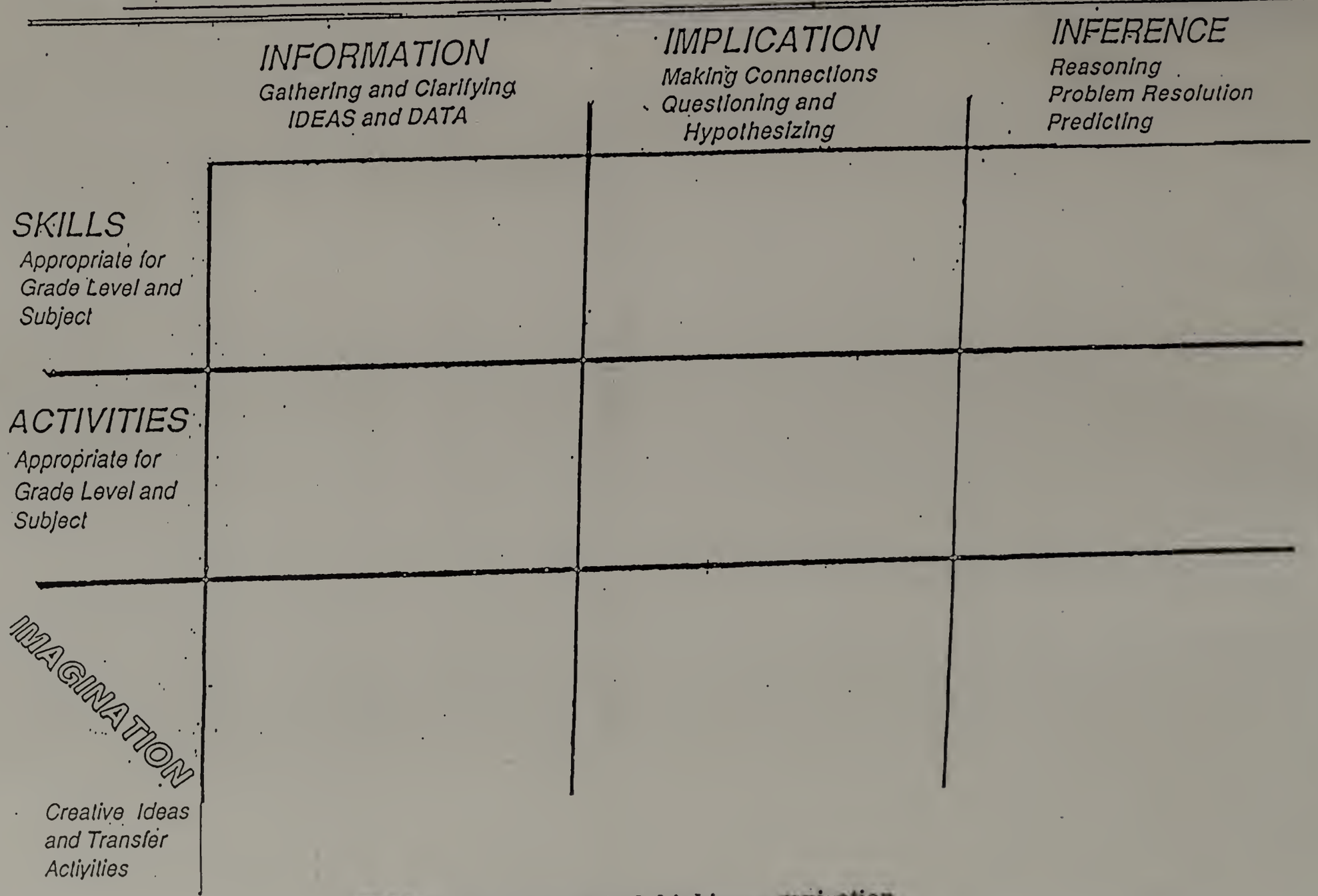

Table 1. Model for critical thinking organization.

The goals to be accomplished by conforming to this structure are:

1) Overcoming the fragmentation of effort by creating a unified format. The various methods suggested in the literature for learning or refining specific skills, such as skills of observation, analogical reasoning or analyzing fallacies, can now be viewed as parts in the process of reasoning, not apart from it.
2) Eliminate the exaggerated and sometimes sole emphasis on information. Teaching is most typically seen as providing information, and learning as the passive intake or memorization of information. (Goodlad:1983; Oakes & Schneider:1984). Facts are usually taught in isolation from thinking skills. (Kneedler:1984). Dealing with facts or information, is important, is only a part of the process of learning to think.
3) Habituate the use of complete reasoning process in both teaching and learning. If the model is used consistently, teachers will not be content to present information alone, and learning will be more effective as result of a greater involvement of students in their own education.
4) Give teachers a framework for decision about appropriate skills to be taught and approaches to be taken. Teachers can look at their goals and decide what skills in each category need to be taught or refined. It is important that teachers be familiar with the materials and programs available for improving various thinking skills. They also need to be critical thinkers themselves.
5) The addition of the fourth step, 'Imagination', is intended to ensure that each instance of learning points beyond itself. One of the most important requirements of an approach to critical thinking instruction is that it should not stop or hinder inquiry. It is therefore essential that each unit or lesson

make connections with some ideas outside of it.

6) The framework also provides a structure for evaluation of students' work. Evaluation of student writing and thinking is a difficult task and is often ignored by students because they see it as merely subjective, opinions of the teachers. This schema gives teachers a powerful tool in understanding and diagnosing students' efforts, and problems. Grading can follow the categories in the chart. It is a fairly easy task to determine if a paper shows acquaintance with relevant information, makes implied connection, draws reasonable inferences and whether it looks at these aspects in a creative light. Thus grading can become an objective, yet non-mechanical process, one that can be explained by the instructor to the students without reference to so called 'personal' or 'subjective' judgment.

An important function of exams is diagnostic. While it is important to know what students learned, it is at least equally as important to find out what they did not learn. The model can be used to find the gaps in students' understanding, and thus it can aid in the improvement of teaching.

In some sense, this model is not new, for it has been the informal organizing principle in teaching, especially in courses such as logic. The subject matter is naturally so organized that it follows this format very closely . Students are asked to learn new definitions, operations, and symbols. (Information) The next step is learning rules of inference, or ways of connecting the information.(Implication) Finally, using what has been learned: information and implication, they are expected to draw inferences and attempt to prove arguments. (Inference) Making use of argumentation in actual

situations follows naturally. (Imagination).

Problem solving strategies can be seen as applications of this model. For example, steps of the Polya model of problem solving follow the same sequence: define problem (Information), choose a plan (Implication), execute plan (Inference), verify results (Inference), identify other, like problems (Imagination).(Polya, 1959)

In his pair problem solving strategies recommended for students with a history of weakness in mathematical problem solving, Lochhead (1986) sets up a structure where one student is the solver, the other is the giver of the problem. The problem giver pushes the solver to examine and articulate the information contained in the problem (Information), to ask the appropriate questions (Implication) and then to plan and carry out strategy aimed at the solution (Inference).

(See Appendix for applications.)

D) The Study of Specific Critical Thinking Skills

The question whether critical thinking skills are general or subject specific must be addressed here. McPeck (1981) claims that "...to teach critical thinking in the abstract, in isolation from specific fields or problem areas, is muddled nonsense; thinking of any kind is always 'thinking about X'..". "Thinking, then, is logically connected to an X." I will concede that thinking is logically connected to an 'X', but if that 'X' is thinking itself, then critical thinking is possible as abstract activity. In fact, logicians have been doing just this kind of abstract critical thinking about the 'laws of thought' for quite some time. At the same time, some thinking skills are subject specific, and the applications of critical thinking skills differ with and are dictated by the disciplines. For example, the logician finds it relatively simple to articulate standards of clarity. These standards are not universal, and do, in fact vary with the discipline. An excellent example of this is the variation in standards of clear writing across the disciplines. Williams (1985) points out that cross disciplinary agreement on evaluation of writing style is virtually impossible. For example, the painstaking clarity of legal documents escapes most of us, even as we put our signatures to them, attesting to our comprehension. The brilliantly clear and distinct philosophical treatise may simply prove to be excruciatingly dull to the uninitiated. The goal of teacher education in critical thinking is tho treat these skills in both ways: to teach reasoning as such to teachers and also to prepare them to adapt and apply these skills appropriately for their specific contexts.

Thus, it does make sense to talk of critical thinking skills without reference to subject matter, while keeping in mind that applications of these skills may vary with the disciplines. Some have to do with ways of gathering

information, some with ways of making connections between items of information, others deal with the way we make inferences, and still others allow us to use our imagination to see beyond what we have learned. The following is a list of some of the skills in each of these categories. Obviously, this just one possible list. Others can be generated according to the requirements of a particular situations.

Information	Implication	Inference	Imagination
Observing	Connections:	Types of certainty	*Any instance*
Focussing	comparisons	Types of inference:	*of reasoning*
Defining	analogies	deduction	*should be*
Describing	ordering	induction	*open-ended,*
Point of view	Supposing	analogical	*and point*
Bias	Hypothesizing	statistical	*beyond itself.*
Examination of	Questioning	Generalizing	*Connect all*
evidence	Rules of inference	Predicting	*learning with*
Fact/opinion	Quantification	Guarding against	*other ideas*
Assumptions	Converses	sophistry	*or with the*
Premises	Consistency	Fallacies of	*students'*
Fallacies of	Part to whole	relevance	*experience.*
ambiguity	relationships		

Table 2.

I have come across very few teachers with any background at all in formal or informal logic. Although critical thinking is not identical with logic, familiarity with the elements of logic is essential for the teacher who is involved in the development of students' critical thinking skills. Much of the program

has to be devoted to teaching aspects of reasoning and their application in the various disciplines.

I have found teachers most receptive to an exploration of the following topics:

Definitions and equivocation. For most people defining begins and ends with the dictionary. We discuss the purpose of defining and the mode corresponding to that purpose. I have used Copi's (1986) classificatory scheme here. Purposes of defining are to: 1) eliminate ambiguity, 2) eliminate vagueness, 3) increase vocabulary, 4) explain theoretically, and to 5) influence attitudes. The types of definitions serving these purposes are lexical, stipulative, precising, theoretical and persuasive, respectively. We also look at ambiguous and shifting, or multiple definitions, as the roots of equivocation. Teachers are encouraged to actively explore the types of definitions they use in their teaching.

Types of reasoning: deduction, induction and analogy. A great deal of confusion surrounds these distinctions, and clarification is very useful. Blumberg points out that traditionally arguments have been classified as deductive or inductive only. He says that more helpful is a "deductive/non-deductive" distinction, followed by an exploration of the types of non- deductive arguments. The use of puzzles is very helpful in perceiving and defining relationships and types of arguments, and provide a good "deductive workout" (Walberg:1980, Hoaglund:1986).

Of particular value is a systematic study of the use of analogy. Synectics (Gordon:1961,1976), a Cambridge based group, has developed some excellent materials for the use of analogy in the classroom. My worksheets are based, to some extent, on the format developed by them. Diane Halpern (1984) has done

considerable work on the use of analogies. Her projects included evaluation, which showed substantial gains on standardized tests by students who participated in her program.

The nature of certainty in the various disciplines. A discussion of the nature of certainty is a natural outcome of the study of the types of reasoning. There is also another context for this discussion. I urge teachers to include a historical treatment of the ideas they are presenting. This enables them to show knowledge as dynamic and evolving, not as the static and complete body of information that texts customarily present. The criteria for evaluating evidence are also discussed in connection with the concept of certainty. Perhaps the finest example of curriculum materials using criteria of certainty is the History and Logic Project developed by Kevin O'Reilly (1984). O'Reilly uses multiple, conflicting accounts of historical events to teach American History. Students are to determine which historian to believe. In order to do this, they have to examine the nature of the evidence. They must determine which historian is a more reliable source, least likely to be mistaken or biased in retelling past events.

The nature of implication; recognition and construction of arguments. It is perhaps a modern phenomenon that many students find it difficult to understand contingent relationships. It has been my experience, substantiated by observations of colleagues, that students often seem unable to distinguish between strings of facts and implied relationships. Similarly, in constructing arguments they often "let the facts speak for themselves", they establish no explicit connections between the facts. The sheer volume of information surrounding us almost makes the establishing of connections superfluous. It must be shown that 'almost' is not good enough. My model is particularly

helpful here. It shows clearly that information is but a part of knowledge, and makes it obvious that the types of connections between matters of fact need to be explored before we can draw conclusions based on them. Michael Scriven's (1976) seven-step approach for evaluating arguments is also a useful tool.

Informal fallacies. A study of the most common errors in reasoning is a natural extension of the study of arguments. Identification of fallacies, and their relation to sound arguments is studied. We also look at how fallacies are used to mislead or persuade. Role of advertising is also examined. We try to deal with live issues and examples. Often, textbook examples of fallacious arguments are too contrived and shed little light on actual situations. We also try to determine when a fallacy is not really a fallacy. Often an argument is fallacious in a technical or "weak" (Paul:1982) sense, but our convictions affirm its conclusions. It is important in this case to examine our convictions, and to see if the argument needs to be reconstructed in light of them.

This portion of the inservice program closely resembles a mini-course in informal logic. The important difference is that the application of the skills, not the logic is the goal of instruction, the problems dealt with are not logic problems, they are pedagogical ones.

Each of these skills is studied and then illustrated through applications in different subject areas. (Appendix: sample worksheets) Teachers are asked to generate activities for teaching these skills in their classrooms.

E) Reconstruction of Curriculum

1) Teachers at this point need to make some decisions about the scope and form of the change in curriculum. The most important aspect of this decision must be a change in focus. The focal point of action must become the student. Curriculum must be reorganized in such a way that involves the development of thinking skills for the students, not merely demonstrates comprehension of critical thinking issues by the teacher. The student's mind must be active participant in the educational process. The goals and expectation in the curriculum must be shared by students and teachers. Paolo Friere is correct in insisting that the teachers must "speak a true word" to the students, let them in on the goals and expectation of their education.

2) The first step in the reconstruction of the curriculum is setting goals. The most exciting aspect of this process is the element of surprise. Teachers find that they come up with unexpected ways of looking at the curriculum when they try to impart a quality of unity to it. Even if the decision about curricular reorganization is limited, even if they wish to try out new ideas on a single lesson or unit, this has to be done in light of a clear, internally connecting, unifying perspective.

The role of the "material to be covered" has to be redefined. Typically, teachers see, as the long and short term goals of instruction, the information to be imparted to students within a specified period of time, in a specific sequence, and are afraid of innovation for fear of failing to complete their task. Also typically, the texts used rather inflexibly prescribe the amount and sequence of topics. If teacher are convinced that they will "cover" all information prescribed, and in the process they will teach students how to understand and

use the information covered, they will feel that they can afford to try new methodology. The material to be covered can take on a different role in the teaching process. If information gathering is not the final goal of education, but only a part of it, the texts and other curriculum materials can take on a new function: that of resources to draw on. In this way history texts can become storehouses of information to be used and evaluated. For example, mathematics texts can provide exercises to reinforce skills of understanding information, making connection, and solving problems.

3) With critical thinking skills and propensities, and a unified goal in place, teachers are ready to use the model for reorganizing the teaching units of their choosing.

Steps in dealing with information:

1) Determine what information, i.e.,. data, ideas, descriptions, primary texts, commentaries, etc. are needed for resolution of teaching/learning problem, as set out in the goals.
2) List sources or resources for acquisition of information.
3) Decide what skills are necessary for collection and clarification of information.
4) Devise strategies and activities for teaching the above skills. Use the content of lesson or unit as vehicle for teaching the skills.
5) Consider ways of going beyond the information, to stimulate students' imagination.

For an excellent example of a critical thinking unit on information, please

refer to "Assignment #1: Definitions" in the Appendix. This assignment was designed for a Computer Science course at the secondary level. One unit on information systems uses the study of trends in the stock market as vehicle. The teacher identified two problems in the way students dealt with information. The first had to do with definitions. Many of the technical terms also have non-technical meanings. It is important to know which type of definition is appropriate to different contexts. The second problem was the students' inability to comprehend non-fiction expository writing. The assignments provide activities to address these problems. The last question on worksheet #3 asks the students to rewrite a crucial paragraph in their reading. This question is a fine example of one that requires students to go beyond what is presented to them, i.e.,. to use their imagination.

The same process is followed in dealing with implications and inferences: given a particular context, or body of information, teachers need to choose relevant skills and activities and innovative strategies. It is essential that each occasion of learning point beyond itself. The "imagination" should be developed at all levels.

The successful organization lessons or course according to this model is hard work. It is work that is not done for the teacher, nor is a formula for solving pedagogical problems presented. It would be presumptuous to attempt to provide one. The decisions for "filling in the blanks" with appropriate skills, activities or imaginative strategies will vary widely with subject matter, age and ability level of the students, learning styles, and teaching styles. The person best equipped to make these decisions is the classroom teacher. The model provides a starting point and format. It enables the teacher to organize the teaching of

thinking skills while teaching content. Students learn to think with the ideas and information. The model also enables teachers to follow the course of learning according to a definite but open-ended structure.

CHAPTER V

SOME SPECIAL CONSIDERATIONS

A. Who Should Learn Critical Thinking Skills?

In many school systems, when critical thinking is taught, it is limited students in the "Gifted and Talented" programs, or to students considered capable of grasping higher order thinking skills. This is fundamentally a mistake. Learning to think well is an important educational goal for all students. It is not a luxury that should be available to only an academic elite. In fact, some of the most successful critical thinking programs have been designed for remediation or for children with special needs. For example, Reuven Feuerstein's Instrumental Enrichment program was designed especially for children with learning disabilities, and Wimbey and Lochhead's (1985) course in Analytic Reasoning with pair problem solving is aimed at college students with a deficiency in mathematics. In both cases, considerable intellectual gains follow upon participation in the program.

Bilingual students represent another, pedagogically often misjudged group. Often the ability to reason is masked by lack of vocabulary or shared informational or cultural background. My proposed format can help teachers pinpoint and remedy the problems.

B. The Role of Computers in Teaching Critical Thinking Skills

The greatest single source of change in American education is the introduction of the computer to the classroom. It is a natural question whether computers can be used to teach thinking skills. The answer is a resounding yes. There a several ways that computers can aid in teaching thinking skills. Logical sequencing and proofs are natural to the computer; in fact , the use of the machine, wether in its operation or in programming, demands conformity to laws of deductive logic. In a Piagetian framework the computer can be used to provide a bridge between concrete and formal operations, by having students create an intermediate, representational stage. Seymour Papert's (1980) LOGO curriculum is based on this idea. Using the physical manipulation of the "turtle" by the machine, students learn to solve problems on paper. The process of problem solving in "turtle geometry" can be transferred to other parts of the curriculum, e.g.,. the teaching of writing. (Collison, G.: 1987). Computer simulations of experiments in science, social science and in mathematics can teach the process of inductive inference empirically. (Collison, G.: 1986). The computer has another important role in teaching thinking. By its superhuman or non-human capacity to retain, organize and store information, by its capacity for carrying out mechanical tasks at fantastic speeds, the computer can be used to liberate us from physical and mental drudgery and can provide us with the freedom to engage in those activities that are truly human. The computer can not teach critical thinking in the "strong sense": the merciless scrutiny of our most strongly held beliefs . It can not teach understanding, judgment, or creativity. It can not teach the "critical spirit". Without these essentially human activities and attitudes guiding and directing the use of the computer,

the machine is nothing more than what it appears to be: a passive plastic and silicon box.

Computers also present the educational community with a challenge, that has yet to be fully met. At the moment, the most common educational use of the computer is to mimic the traditional flash-cards or workbooks: providing programs that aid in rote memorization. The challenge lies in finding ways of maximizing the use of the machines in ways that are unique to it.

C. Testing in Critical Thinking

Accountability is an important issue in critical thinking education. Testing for critical thinking skills is a difficult task, because objective evaluation of how mental processes work is not nearly as simple as objective evaluation of information recall. The most commonly administered standardized tests for academic achievement have shifted their emphasis during the past few years. The California Aptitude (CAT) tests used to test skill levels at elementary school level, the Scholastic Aptitude Tests administered to high school students, and the Graduate Records Examinations (GRE) have all been drastically reorganized and rewritten to test for thinking skills, not only for information recall.

Over the past few years a number of tests have been developed specifically for critical thinking skills. (Ennis: 1985) Some of these are general, attempting to cover critical thinking as a whole, while others are aspect specific focusing on selected skills such as stereotyping, assumption identification, fallacies or syllogisms. Most tests are multiple choice in format, and test almost exclusively for deductive reasoning. Two notable exceptions are the Ennis -Weir Critical Thinking Essay Test (1985) the Test on Appraising Observations developed by Stephen Norris and Ruth King (1983). The latter uses pairs of statements based on story lines. Statements have to be compared and evaluated regarding their believability. The manual provides principles for judging statements. The problem here is that the criteria are almost hopelessly complicated, because they are used to evaluate responses that are, at least to some degree unpredictable. The same problem is present in evaluating the essays of the Ennis-Weir Test. Any test that includes original contributions from the students will face the same difficulty.

I believe that using my critical thinking model can facilitate evaluation of original student work. Using the categories of information. implication, inference and imagination as criteria students' work can be judged complete or lacking, correct or incorrect.

At the present, administration of tests for critical thinking skills is somewhat unfair. Most schools still teach information almost exclusively. Long term studies are needed to determine what the best approaches to teaching critical thinking are, and to determine what is the most useful mode of testing these skills.

SUMMARY

Although the entire educational community pays lip-service to teaching children how to think, research has shown that about 95% of the time spent in school is devoted to the presentation and acquisition of information. Education and testing, for the most part is based in soon forgotten recall.

While it true that the gathering of information is not a proper goal of education, it is also true that becoming adept at the skills of reasoning is not sufficient in itself in promoting critical thinking. What is needed is an approach to teaching that incorporates and integrates, at all levels, the major skills required. I propose the following format:

All activities, units or lessons should deal with: **information. implication, inference, and imagination.** Thus the three "R"'s are replaced by the four "I"s.

Information deals with the collection, clarification and classification of data, such as matters of fact, opinion, and observations.

Implication looks at the information and ferrets out all connections, contingencies and consequences.

Inference is the act or process of making claims or drawing conclusions based on the information and the implications contained within.

Imagination forces the study of all three: information, implication and inference to point beyond itself, so that all learning opens the mind to more learning.

Teaching may begin with inference, as it does in science when proposing a hypothesis, in literature in suggesting a specific interpretation. It may begin

with observations or gathering information, or with noticing relationships between facts. Whatever the starting point, all three areas need to be elaborated on, and the connection between them needs to be made explicit.

Teachers who designed and taught units using this critical thinking structure have been excited about the results. Unfortunately, I have no data yet to document the success of a program of this sort. Controlled experiments with pre and post tests need to be run. A long term study of the effect of critical thinking instruction on performance on standardized tests will also have to follow.

It is commonly held that education in America, is in need of renewal. Replacing information with intellectual development as the goal of education is perhaps the best starting point. Critical thinking may not be sufficient, but it is a necessary condition of education.

> "Education is dangerous, of course: it can be used to distort and enslave. At its best it is revolutionary: fostering people's ability to examine their surroundings clearly and accurately leads to some nasty discoveries. But, volatile though it is, education remains the best hope of a free people." (Sizer:1973)

APPENDIX

The Appendix contains materials I created for use in the workshops, notes on thinking skills and examples of teachers' work that grew out of participation in my critical thinking workshops. References are made to these throughout the text. The order of material in the appendix follows the sequence of topics in the workshops.

Worksheet on making connections.

Memorize the following set of words. Record the time for each set.

nonsense	sense	connected	sentence
hrt	**jog**	**eye**	**the**
qma	**gum**	**ear**	**cat**
wgo	**ask**	**arm**	**saw**
ver	**beg**	**leg**	**one**
zug	**fly**	**toe**	**hat**
Time:____	_____	_____	_____

Read each of the following list twice. Test your neighbor's recall by giving the first word of each pair.

Connected	Unconnected
door - knob	**squirrel - table**
wall - mirror	**house - pepper**
child - teen	**tiger - alfalfa**
mother - father	**luggage - candy**
No. correct: _____	**No. correct: _____**

The process is same in the case of quantitative learning:
Read each list of numbers twice. Test your neighbor's recall by giving the first number in each group.

arbitrary	connected
1, 4, 11	1, 3, 5
2, 5, 8	2, 4, 6
3, 2, 7	3, 6, 9
4, 5, 2	4, 8, 12
2, 9, 4	2, 3, 5

No. correct: _____ **No. correct:** _____

Write the first word that comes to your mind when you read each of the words below:

	Connection
snow -- _____	_____
boots -- _____	_____
squirrel -- _____	_____
crane -- _____	_____

When trying to learn in a foreign language, one faces the same difficulties as the person attempting to memorize nonsense syllables or arbitrary verbal or numerical sequences. Vocabulary is essential as a first step. The second step: making connections explicit.

Worksheet on setting goals

1) Name of subject or unit:

2) Grade level:

3) Goals for the rest of the school year:

_____

_____

_____

4) Ideas (or topics) to be covered:

_____

_____

_____

5) Re-group ideas in order of importance:

_____

_____

_____

6) Choose the 2 most important ideas :

_____

_____

7) Why did you make this choice?

_____

_____

8) Can the rest of your ideas on the list be seen as parts of the major ideas? How?

_____

_____

9) Can you organize all the teaching and activities around these two main ideas? How?

Worksheet on perspectives:

1) How does the content of this course fit into the history ideas?

_____

_____

_____

2) Why do you teach this course?

_____

_____

_____

3) What is the role of this course of study in the education of the student? Why should student take this course?

_____

_____

_____

4) What is the connection, if any, between your reasons for teaching and the students' reasons for learning the content of this course?

_____

_____

_____

5) Think of at least two ways in which the student can further learning outside of the classroom. (Try to think of something other than the research paper.)

_____

_____

_____

Worksheet on synthesizing:

1) What is the goal or central idea of your course?

_____

_____

_____

2) What information will you be studying?

_____

_____

_____

3) What are the major arguments you wish the students to consider?

_____

_____

_____

4) How will you use the information to generate the arguments?

_____

_____

_____

5) What interdisciplinary connections can you make between the content of your course and other courses studied by students?

_____

_____

_____

6) What suggestions do you have for students wishing to go beyond material covered in the class?

_____

_____

The following are some examples of curriculum projects organized through setting goals based in connections. Obviously, there are many other possible projects. these represent the ideas that emerged from the workshops.

Project 1

Preschool : The central idea arrived at after considerable discussion and elaboration was "communication". Teachers realized that all their activities and lessons involved, in some form, skills of communication. This realization made it possible to direct activities and learning more effectively. Music, art, sports, play, reading and writing readiness could all be organized around skills of communication. It also made possible a process of evaluation, something that is extremely difficult at this level, without a clear focus.

Project 2

Elementary Mathematics : Mathematical skills to be taught for this age group are very clearly set out in texts and curriculum guides. Concrete examples are then used to practice and reinforce these skills. Teachers found that concrete reality can provide a better context for learning these skills than the chapter-by-chapter organization of the texts. The central idea arrived at here was the rather obvious one of measurement. All mathematical skills can be taught through different types of measuring, and connection to students' personal experiences is extremely easy.

Project 3

Folk Heritage project : This is an interdisciplinary project for grades 4-6 in the Holyoke Public Schools. This project seeks to familiarize students with their

city's history, geography , its musical, artistic, literary and ethnic heritage. The project provides an excellent unified vehicle for teaching all subjects. The most appropriate purpose for this project was seen as the creation of a sense of community among students in a city with a history of influx of various ethnic groups.

Project 4

Third year High School French : This project was organized around the French Revolution. The philosophy, social and political setting, art, music, architecture and literature of the time served as the vehicle for learning about French culture, people and for studying the language. The project incorporates interdisciplinary activities, e.g. joint papers done for French and history classes (both American and European history), demonstration of French cuisine in Home Economics classes.

Project 5

Science: Junior High School Biology : The idea around which this course came to be organized was the natural one: What is life? A self conscious organization that keeps in mind way of answering this question takes the traditional emphasis on classification out of the curriculum. Classificatory schemes of life forms and tissues have a context, they are no longer the end of the course.

Project 6

American History, High School level : Several ideas emerged from discussion as appropriate and useful for organizing concepts for the entire course. Some of these were: democracy, freedom, and property. Changing definitions of these

concepts through time and the consequences of these changes in the social, political and cultural life of the nation provide a fine unifying thread to the course.

Project 7

English literature : A thematic, rather than chronological organization of readings provides a better focus. It also enables students to choose literature related to topics of interest to them. Amherst Junior and Senior High Schools (Amherst, MA) have used this approach for a number of years with great success. Some of the themes used are: Women in literature, Adolescents in the Novel, Science Fiction, Heroes and Heroines, Shakespeare.

Worksheet ; Observing (Information)

Choose a picture from a feature story in a newspaper or magazine.

Read story, caption or article connected with the picture.

1) Senses

Write down the way this picture effects each sense.

a) sight

_____

_____

b) hearing

_____

_____

3) touch

_____

_____

4) smell

_____

_____

5) taste

_____

_____

2) Memory:

a) Have you seen anything like this picture before?

b) What?

_____

_____

_____

c) How are they similar:

_____

_____

_____

d) How are they different:

_____

_____

_____

e) Does this picture remind you of something else?

f) Why?

_____

_____

_____

3) Imagining

a) Try to tell a different story about this picture:

_____

_____

_____

_____

_____

_____

b) Change something in the picture and tell how it changes the meaning of the scene.

_____

_____

ANALOGIES

When working with analogies keep in mind that the use of analogical reasoning is essential part of all original inference. Induction, statistical inference, mathematical and scientific research, the social sciences and the arts all make constant use of analogical thought. Analogy is at the bases of all discovery.

Making analogical connections as a method of gathering and understanding information, or facts is particularly important., and needs to done consistently and carefully.

The following are steps to be followed in working with analogies. Naturally, children ought to be encouraged in intuitive and imaginative activities. A systematic approach to analogies will not stand in the way of their creativity and imagination.

Step 1: Observe and describe

Step 2: List attributes

Step 3 : Compare and contrast

Step 4 : Summarize

Step 5 : Point beyond summary

Example:

1&2) CAT DOG

---

3) List:

similarities:

differences:

4) Summarize:

A cat is like a dog because:

A cat is different from a dog because:

5) Construct new activity going beyond conclusions

DEFINITIONS (Notes)

Types of definition

1) **Lexical:** reports the meaning a term already has, it is part of common usage; may be found in the dictionary. Lexical definition is either true or false, and may be varified.
2) **Stipulative:** definition given a brand new term when it is first introduced. Assignment of meanings to new symbols is a matter of choice, of stipulation. New terms may be introduced for a variety of reasons, e.g. code, math symbols, new discoveries, new objects etc. . Stipulative definitions can be temporary (as in code, or math), or permanent (in naming new concepts or objects).
3) **Precising:** uses established term, but establishes which definition is to be used, and how. It reduces vagueness of term.
4) **Theoretical :** formulates a theoretically adequate or scientifically useful description of object to which it is applied.
5) **Persuasive:** purpose is to influence attitudes; they are expressive , and neither true nor false.

Purposes of defining

1) Eliminate ambiguity	Lexical
2) Eliminate vagueness	Precising
3) Increase vocabulary	Stipulative, lexical
4) Explain theoretically	Theoretical
5) Influence attitudes	Persuasive

Worksheet on definitions:

1) Give five different definitions of one the following terms:

a) thought

b) education

c) student

d) music

e) language

f) science

g) beauty

h) choose a term yourself

Lexical:

Stipulative:

Precising:

Theoretical:

Persuasive:

negative:

positive:

Assignment #1 - Definitions
Computers and Information Science
Critical Thinking and Reasoning

Computers are indeed machines, but the raw material they process is information not any physical material or manufactured goods. Product quality in physical material or goods is relatively easy to test, a simple touch or working examination usually reveals inferior merchandise to the prospective buyer. As buyers, we have to decide if we wish to spend more for more quality. For buyers, or more properly, consumers of information, the case is not so easy. One of the characteristics of our age is that we are drowning in the stuff, information is everywhere. Some of it is very important, even life saving, for some individuals. Much of the rest is, as the rough expression states, is 'garbage'.

"G.I.G.O. Garbage in, garbage out". This truism, like most truisms, is true, but useless; it gives a description but no practical hint for a way out of the difficulty. The central problem of the Information Age is one of discernment or discrimination. "What is the 'garbage', and what is quality information, true to fact, free of bias and opinion, either personal or theoretical?" The problem is not an easy one. It requires application of our most human qualities, reasoned judgement. As students of information science you must understand the meaning of the information and its implications before any intelligent decisions can be made about any of it. The first step is proper definition.

The purpose of this exercise, and others like it, is to familiarize you with the groundwork of good thinking. After reviewing the five basic kinds of definition, you will work with a passage from a current text or newspaper to explore using these new tools to evaluate the text and the information it contains.

We will work on definitions of 3 words only. MONEY, BANK, and EXCHANGE.

1. Lexical Definitions are dictionary definitions.
   Money: *1) something generally accepted as a medium of exchange, a measure of value or means of payment as coined or stamped metal or paper currency*
   2) wealth recorded in terms of money
   3) a form or denomination of coin or paper money (from Webster's New Collegiate)

2. Stipulative Definitions are used for specific purposes, new words, or new uses. They may be temporary or permanent. If they are permanent they can become lexical. "Booting a disk" (from boot strapping - meaning originally to raise up by the bootstraps with no external help) is a commonly used phrase not found in most dictionaries. "Let X = John's age" is also a stipulative definition.
   Money: *1) Let money be whatever goods or services we decide to exchange for other goods and services. A chicken, a ritual prayer, or a $10 bill could be money.*

3. Precising Definitions select appropriate lexical definitions to be used. Precising definitions remove ambiguity by carefully narrowing terms.
   Money: *1) U.S. currency, specifically coins, reserve notes, or silver certificates, excluding Treasury bonds or notes, also excluding any checks either governmental or personal.*

4. Theoretical Definitions are terms upon which theories are based. ex. "Atoms are the tiny particles which make up all things." or "Marriage is a perfect union of two souls."
   Money: *1) a certificate representing an equal value of gold or silver deposited in Ft. Knox.*
   2) the symbol for value of goods or services accepted for exchange.

5. Persuasive Definitions are geared to influence opinion. ex. "Abortion is killing." or "Abortion is Choice." Neither statement is a lexical definition.
   Money: *1) Money is the root of all evil. or Money is power.*

EXERCISE ONE

Following the descriptions of the 5 types of definition, please define 'BANK'.

1. Lexical Definitions are dictionary definitions.
   Bank 1) .....
   .....
   2) .....
   .....

2. Stipulative Definitions are used for specific purposes, new words, or new uses. They may be temporary or permanent. If they are permanent they can become lexical.
   Bank 1) .....
   .....
   .....

3. Precising Definitions select appropriate lexical definitions to be used. Precising definitions remove ambiguity by carefully narrowing terms.
   Bank 1) .....
   .....
   .....

4. Theoretical Definitions are terms upon which theories are based. ex. "Atoms are the tiny particles which make up all things." or "Marriage is a perfect union of two souls."
   Bank 1) .....

5. Persuasive Definitions are geared to influence opinion. ex. "Abortion is killing." or "Abortion is Choice." Neither statement is a lexical definition.
   Bank 1) .....

EXERCISE TWO

Following the descriptions of the 5 types of definition, please define 'EXCHANGE'.

1. Lexical Definitions are dictionary definitions.
   Exchange 1) .....
   .....
   2) .....
   .....

2. Stipulative Definitions are used for specific purposes, new words, or new uses.
   Exchange 1) .....
   .....
   .....

3. Precising Definitions select appropriate lexical definitions to be used. Precising definitions remove ambiguity by carefully narrowing terms.
   Exchange 1) .....
   .....
   .....

4. Theoretical Definitions are terms upon which theories are based.
   Exchange 1) .....

5. Persuasive Definitions are geared to influence opinion.
   Exchange 1) .....

There is a major problem lurking in the definition of 'EXCHANGE'. You have probably encountered it. What do you think it is? .....
.....

Stock Market Project

Worksheet on Critical Thinking

From Information to Inference to Implication

Purose: To learn to analyze data, make relevant connections, and to make valid inferences and predictions based on the data and connections established.

Stock	Information Relevant Data Facts Graphs	Implication Connections Relationships Patterns	Inference Commentaries Predition Interpretations Conclusions
PHILLIP MORRIS			
ANGLO AM. CRP.			
FEDERATED			
HEINZ			
K MART			
QUAKER OATS			
SARA LEE			
RJR NABISCO			

Informal Fallacies (Notes)

Ambiguity: (vague usage of language)

Amphiboly: Mistake based on grammatical construction.

Equivocation: Directing attention to unwarranted conclusion, by making a word or phrase , used in two or more senses appear to have the same meaning throughout.

Accent: Putting improper emphasis on a word or phrase, to alter meaning

Division: Assuming that what is true of the whole is also true of the parts.

Composition: Assuming that what is true of the parts is also true of the whole.

Relevance: (Questionable connection between premises and conclusion)

Ad hominem: Attacking one's opponent in a personal and abusive way as a means of ignoring or discrediting his or her argument or position.

Questionable or irrelevant authority: Quoting the judgment of one who is not properly an expert.

False cause: attributing causal relationship where there isnt one.

Cliche: Use of a cliche in place of an argument or reason.

Appeal to popular opinion:Urging acceptance of a position on the grounds that most people agree on it.

Slippery slope or domino: Claiming that a particular action will inevitably lead to a series of adverse consequences.

Appeal to force : Attempt to persuade through threat.

Gambler's Fallacy: A chance event's future outcome is altered by its history.

Appeal to humor or ridicule: Used to cover up unwillingness or inability to contradict opponent.

Appeal to pity: Attempt at persuasion through elicing sympathy.

Red herring: Attempt to hide weakness of position through diversion.

Statistical fallacies: (Based on incorrect use of numerical data)

Biased sample: sample used in prediction is representative only of a portion of the population.

Insufficient sample: Sample is too small to be useful.

Unknowable statistics: Claims based on data that is impossible to obtain at this time.

Accidental statistical correlation: Attributing causal connection to events based on statistical correlation only.

One of the teachers in my class in critical thinking designed a simple curriculum using children's literature to introduce critical thinking in her pre-school classroom. The following is an outline of this sample curriculum:

Information:

Activity #1 : Observation/ Sensory awareness

Teacher shows illustration of the cover and in the book to the children. they describe what they see, and try to guess the plot. If they have a personal stake in the plot, they are more likely to want to listen to the story.

Activity #2 : Classification/ Categorization

Teacher selects two categories from the story (e. g. things that melt, things we can eat, etc...). Then teacher presents items (real or pictures) that fit into each group, excluding for the time being, items belonging to both. Students sort items into categories.

Implication:

Activity #3 : Seriation/ Continuous Concepts

Children tend to think in terms of absolutes or extremes. Choose some easily representable quality from the story (e. g. hardness, sweetness, etc. ...). Have children select the two items that would be on either end of the continuum : the hardest and softest food, for example. Seriate the rest of the items. Help children consider state changes in the items. For example, a fresh carrot is hard, a cooked or stale one is soft; fresh bread is soft, stale bread is hard. Have physical or pictorial representations of the continuum.

Activity # 4 : Questioning

Questions that stimulate thought and do not only require

recall of fact should be asked. It is also important to teach children how to ask questions. This is done by modelling. Sufficient time needs to be allowed for discussion and dialogue.

Activity # 5 : Analogies

Teacher selects two characters or objects from the story. Five steps are followed: 1) observe and describe each; 2) list attributes; 3) compare and contrast; 4) summarize; 5) extend beyond example.

Inference:

Activity # 6 : Dramatization

This activity allows children to experience different perspectives. Teacher selects scenes from the story and chooses some children to act them out. The other children must watch and try to guess what part of the story is being acted out, After the guessing, they are asked to identify the critical movement that led to recognition.

Activity # 7 : Experiential Learning

There are several ways of bringing the story into the children's realm of experience. For example, experiments could be conducted simulating some of the situations in the story, or a field trip can be arranged to a location mentioned or similar to the one in the story.

Imagination:

Activity # 8 : Language Experience

This experience brings the preschooler full circle from reading and experiencing a story to creating their own story. Children can dictate a story based on the experiential activity. Another idea is to have children rewrite the story, so that it has a different outcome.

Guidelines for paper or project

The purpose of a paper or project for this course is to provide you with an opportunity to synthesize, interpret and apply some aspect of critical thinking. Your choice of topic, should, therefore, reflect your needs, preferences and interests.

Some suggested topics

You are not limited to the topics listed below. You may write on a topic of your own choosing.

1) Choose a currently available program in critical thinking (e.g. Lippman's Philosophy for Children). Examine the program in light of the grade level or subject you teach. Describe and critique the program. Could you introduce it without special training in its use? Would such a program be useful in your classroom in promoting critical thinking? Does it address specific problems you are faced with? If you were to try it in your classroom, how would you evaluate success of this program?

2) Choose an aspect of critical thinking and discuss how it is dealt with in your teaching (e. g. observation, definition, analogy...). Develop ways that the teaching of this could be made more structured and self-conscious in your classroom. Be specific, deal with actual topics or units covered.

3) Choose an idea as the major thread in your course. Reorganize your curriculum or part of it to reflect connection to this idea. Again, you need to be quite specific about the material to be covered, the sequence of organization and the connections. You may wish to use the worksheet on goals as the guideline.

4) Design a series of lessons incorporating critical thinking skills. The material covered should be part of your actual curriculum. Be sure to include some means of testing the effectiveness of the innovation.

5) Design an experiment to test the effect of teaching critical thinking. Upon integrating the teaching of thinking skills into your curriculum you need to find out what changes in learning your new teaching strategy brought about.

6) Create an interdisciplinary unit or course, that would promote the acquisition of critical thinking skills. Here the choice of information and the relevant connections are very important. The internal logic or organization of the different disciplines needs to be carefully considered.

7) Design a test for reasoning skills. Choose a skill you feel is most relevant in your teaching. Write objective or essay questions where applicable, to test for the skill within the context of your subject.

8) Design a curriculum project that would connect the personal experiences of students with the work expected of them in school. Use the framework of goal setting and organization in terms of information, implication, inference as guide for your work as well as for the work of the students.

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