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AN APPROACH TO TEACHING FOR CRITICAL THINKING IN A COMMUNITY COLLEGE HEALTH SCIENCE CURRICULUM

A Thesis Presented

By

DONIS TATRO LEWIS

Submitted to the Office of Graduate Studies
University of Massachusetts, Boston in partial fulfillment
of the requirements for the degree of

MASTER OF ARTS

September 1985

Critical and Creative Thinking Program

AN APPROACH TO TEACHING FOR
CRITICAL THINKING
IN A COMMUNITY COLLEGE HEALTH SCIENCE CURRICULUM

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CHAPTER I

THE RATIONALE

During a recent seminar on critical thinking at the University of Massachusetts/Boston, I described a workshop I had developed for faculty in a community college dental hygiene program. Later that same evening one of the seminar participants asked me, "...couldn't one assume that by the time a student reaches the college level -- specifically a dental hygiene program -- there would not be a need to teach critical thinking?" Having worked with dental hygiene students for five years, I knew that this assumption could not be made.

Raymond Nickerson cites several reports (Carpenter, 1980, Karplus, 1974, Renner and Lawson, 1973, Tomlinson-Keasey, 1972) that support his statement that "A sizable fraction of high school graduates who are about to enter college are not adequately prepared to do the kind of thinking their college experience will require of them. Students frequently get through basic math and science courses with no more than a superficial understanding of the concepts and relationships that are central to the subjects they have studied and without the ability to apply those concepts and relationships effectively to real world problems."[1]

Ideally, by the time a student does enter college, he/she should have developed some good critical thinking skills. Perhaps in the future, when elementary, middle and high schools all teach critical thought, the emphasis in college can be directed towards reinforcement rather than introduction. California is taking steps toward that goal. In 1982 a joint publication of the Academic Senates of the California Community Colleges, the California State Colleges and the University of California was distributed to every school in the state. This publication emphasized that upon entering college, students should have developed the ability "to understand, organize, synthesize, and communicate information, ideas, and opinions" and be able to demonstrate those thinking skills by "writing compositions, reports, term papers, and essay examinations."[2]

It will take time before such ideology is refined and implemented into the secondary education system so that the effects of it will be witnessed in our colleges. In the meantime we need to assess and develop a means for dealing with the deficiencies of our current college and post-graduate level students.

Paul Connolly, Director of the Bard College Institute for Writing and Thinking, contends that neither high school nor college students argue well. He feels that "much of what occurs in school fails to evoke and develop students'

talents -- and, indeed may work against such development."[3] Two problems that have been identified at Bard as the sources of "poor arguing ability" are: 1) inadequate or inattentive reading and listening, and 2) inability to advance inquiry.

Stephen Norris offers systematic evidence which suggests that college students do not perform well on tasks that are designed to assess critical thinking competence. Two tests that are intended to measure critical thinking ability are the Cornell Critical Thinking Test and the Watson-Glaser Test. The Cornell test determines whether or not the examinee has a knowledge of the principles of reasoning and their application. Norris reports that when a group of undergraduate college students was given the Cornell Critical Thinking Test, levels X and Z, the median scores were fifty-eight percent. When the Watson-Glaser Test (designed to measure ability to recognize assumptions, evaluate arguments, and appraise inferences) was administered to college students, the results put their median scores in a range from sixty-five to seventy-five percent.[4]

Nickerson suggests that a possible reason so many entering college students lack the ability to engage in the abstract thinking that will be required of them is that (from a Piagetian perspective) they are stuck at a concrete-operations level of cognitive development. Piaget describes this level of concrete operations in cognitive development

for children who are not yet able to apply their mental operations to purely verbal, abstract or hypothetical problems. He offers a way to bring such students into the formal-operations stage (which is the cognitive level that enables an individual to perform mental operations on problems other than those with concrete, physical manifestations) through emphasis on student participation, inquiry, exploration, hypothesis formation and testing.[5]

In addition to the fact that students are not prepared for college when they arrive, the research shows that conventional college curricula do not do anything to remedy the problem. In a study conducted by Brown, Haas, Vost and West, which was undertaken to determine to what extent a traditional four-year college program enhanced critical thinking development, the results showed that there were "no statistical differences between the pretest scores (measured by essay examinations) of the cluster (freshmen college students) and control (senior college students) groups."[6] The examiners were surprised because they thought that some critical thinking skills development would have occured in four years of college even if those skills were not specifically addressed in the objectives.

In a study designed to test for a relationship between active student involvement and level of critical thinking in those students, Daryl G. Smith determined that as student

participation, faculty encouragement and use of student ideas, and peer-to-peer interaction increased in class so did the students' ability and inclination to think critically.[7] It is disturbing to note, however, that even when part of a specific study, the teaching methods incorporated direct student participation less than twenty percent of the class time. If teachers involve their students in the learning only twenty percent of the class time when objectives have been made explicit, one can only wonder what small percentage of active involvement must take place where there are no objectives for critical thinking.

The very least we can do with regard to these reports by teachers is to recognize that there is a need to teach college students to think more critically. Until we acknowledge this need, it is not likely to be addressed in our colleges. Some of the previously mentioned studies have indicated what thinking skills need to be addressed. Skills that college students seem to be deficient in are evaluation of and formulation of arguments, recognition of assumptions, and appraisal of inferences. Also in need of improvement is their comprehension, organization, synthesis and communication of ideas and opinions. But in addition to focusing on specific skills, there is the contention among the experts that there needs to be an emphasis on metacognition. Falkof and Moss state that "...unless we specifically point

it out, most students are unaware of the thinking processes involved in formulating relationships...(they) need to be consciously aware of 'thinking about their thinking.'"[8] Richard Paul also supports this concept by saying "...that students (and experts) who do the best analyses, syntheses, and evaluations tend to do them mindfully with a clear sense of their component elements. So, if the concepts of critical thinking are presupposed in mindful analysis, synthesis, and evaluation, we can best heighten that mindfulness by raising those component concepts to a conscious level."[9]

In bringing critical thinking skills to a conscious level in students, it is important to point out that thinking critically is a matter of degree. As Richard Paul has said, "No one is without any critical thinking skills, and no one has them so fully that there are no areas of his or her life and thought in which uncritical thinking is dominant."[10] Certainly learning a list of skills and how to apply those skills is not enough. The concept of critical thinking needs to be much broader to encompass the temperament for critical thought. "One must have the disposition to think productively and critically about issues, or else no amount of skill in doing so will be helpful."[11]

Norris goes on to describe three requirements that make up this critical disposition or spirit. "The first is to

employ critical thinking skills in reasoning about situations encountered in the world. The second requirement is that critical thinking must be turned upon itself, that is, to think critically about one's own thinking... Finally, there must be a disposition to act in accord with the dictates of critical thought."[12]

Seigel's paper, "Critical Thinking as an Educational Ideal," goes beyond the desire to instill a disposition and provide a means for better thinking. He argues that it is a moral obligation to teach in the "critical spirit." This conclusion follows an argument which states that to conduct our interpersonal affairs morally, we must respect other people. The inclusion of students would obligate us to treat them with respect. What does Siegel mean by respect? He does define respect as "Among other things it means recognizing the student's right to question, to challenge, and to demand reasons and justifications for what is being taught ... involves recognizing the student's right to exercise his or her independent judgement and powers of evaluation ... to be honest with them. To deceive, indoctrinate, or otherwise fool students into believing anything, even if it is true, is to fail to treat them with respect."[13]

But where does one begin to organize and work toward such a monumental goal? Richard Paul suggests that lower

order thinking skills are a good place to begin and work toward a higher order critical mind. "If we understand speaking and writing as constructing a point of view, developing ideas in some logical relation to each other, and listening and reading, as entering into someone else's point of view, into his or her organization of ideas, then we are in a better position to grasp how the teaching of basic academic competencies ought to be understood as incipient higher order thinking skills."[14]

Also, to know where to begin, it is necessary to look at who the students are. The students in the health science programs at the community college level are predominately women. There are a wide range of circumstances that bring them to enroll in such programs. Some are middle-aged women who, after having raised families, are seeking a satisfying career. Other students come to us after having completed baccalaureate programs in other areas, -- again for career purposes. But by far, the majority of our students are recent high school graduates. These students have opted for a two-year, associate degree program over the more traditional liberal arts four year college program. The standards for being accepted into the program are declining due to a diminishing number of applicants. As the academic records of incoming students become more "average," the teachers are faced with what one community college instructor

calls "under-prepared students." John Chaffee of La Guardia Community College says, "Students cannot learn to write or compute well if they don't first know how to think."[15]

The dental hygiene program consists of specific required didactic and lab courses in addition to clinical work with patients. All of the didactic courses are of a lecture format. Time is spent almost exclusively on providing what Ennis refers to as "banks of soon-to-be-forgotten facts." The focus has been on providing information for the students. This is followed by complaints that they cannot apply the information or make judgments about it. When I described my project to develop a means for teaching critical thinking through a dental hygiene curriculum to a graduate of many years, she was in awe. She wondered how there could possibly be room for critical thinking when there is so much knowledge to gather in such a short amount of time. But what is knowledge? For facts or information to become knowledge, they must be thought about, not merely memorized. Richard Paul has said, "Knowledge, rightly understood, is viewed as a distinctive construction by the learner, something that issues out of a rational use of mental processes."[16] We, in the health science fields, need to get away from the administration and memorization of facts. Daryl Smith suggested, in his study with college students, that a decline in critical thinking could actually result

from an emphasis on memorization and a lack of practice.[17] We have fallen into what McPeck describes as "...specific subject-oriented courses permitting information and authority to rule in the place of reason, and where authority reigns unreflective obedience will follow. Critical thinking, by contrast, requires knowledge of the reasons that lie behind the putative facts and various voices of authority."[18]

It is exactly this "unreflective obedience" in our students that disturbs us the most. Norris describes a psychological experiment, (Milgram, 1963) with frightening results, that emphasizes how dangerous this submission to authority can be. A mock situation was set up in which an actor, unbeknown to the subject, was placed in an enclosed room with electrodes attached to him. The subject sat outside the room at a control panel, which would supposedly administer increasingly higher voltages of electricity to the "actor." It was the subject's responsibility to administer the punishment of electric shock when the "actor" answered a question incorrectly. The experimenter (voice of authority) remained with the subject to encourage, or rather demand, the use of increasingly higher voltage. The study was designed to determine the degree to which people would allow their commitment to authority to override their competing moral principles. The results were devastating:

"...only fourteen out of the forty subjects defied the experimenter's order and refused to carry the experiment to the end. The remaining twenty-six subjects continued until the maximum sock of four hundred and fifty volts was administered."[19]

This experiment reminds me of a situation that involved a graduate dental hygienist. This woman had successfully completed our program, graduated from our college, and passed both National and Northeast Regional Board Examinations. She clearly had the "knowledge" that radiation had harmful effects and was familiar with available safety precautions. Yet when her employer (a dentist) instructed her to stay in the room with the patients during x-ray exposure, she did just that. Somehow her commitment to authority overrode her knowledge of what was in her best interest.

An example such as this makes me wonder how often students who have been "taught" of the hazards of and safety measures for the use of radiation disregard their knowledge to obey an employer. Consenting to authority can override a knowledge that the use of outdated x-ray equipment may be unsafe for the patient. A dental hygienist may disregard his/her judgment of what is dangerous and accept the judgment of a dentist because a dentist has had more "education."

I recently witnessed another example of blind obedience in one of our students. During a geriatric rotation to a

nursing home a dental hygiene student was asked to work with a dental student to perform an intraoral examination on a patient. The dental hygiene student hesitated to do the exam until the mouth mirror had been delivered to her. The impatient dental student, who was her partner, told her to go ahead, -- "One doesn't need a mouth mirror to do an oral exam." Even though she knew that she could do a more thorough job with the mirror, she conceded to the voice of authority and performed the exam without the mirror. Later when I questioned her about this, she explained that she did know better, but assumed the dental student knew best.

Why are our students so unsure of the knowledge and information they possess? I believe it is because they have neither been encouraged to seek reasons for information nor expected to provide justification for their actions.

Richard Paul blames twin obstacles for the lack of development of rational learning: "1) being told, and coming to expect to be told, what to believe (belief inculcation); and 2) being told, and coming to expect to be told, precisely what to do (the over-proceduralization of thought). Together they fatally undermine independence of thought."[20]

I see this happening in our clinical setting. Students become so accustomed to being told what to do that they do

not think for themselves when expected to do so. Students consistently approach their clinical instructors with racks of recently developed x-rays to be evaluated. Although the students have the knowledge required to determine whether or not a radiograph has adequate diagnostic value, they usually rely on their instructors to decide which films need to be retaken. Too often the instructors are willing to provide this judgment for the students.

I talked with several of our clinical instructors about these and other issues. We all agreed that there is a lack of independent thought on the part of our students. Another issue that arose, which disturbed several instructors, was the lack of curiosity in the students. They cited several examples of individual students showing no desire to discover the cause or reason for a particular phenomenon. It was a unanimous decision that our methods of teaching were reinforcing this type of behavior in our students. The department as a whole wants to look at our dental hygiene curriculum and develop ways to help our students think more critically. They feel, however, that accreditation requirements and rigid behavioral objective style of teaching are obstacles that need to be overcome.

I believe that we can work within these "boundaries" of accreditation standards and behavioral objectives. The most significant change in the classroom will be in

pedagogy. I agree with Siegel's view that "...perhaps most significant are the connections between critical thought and the manner of teaching -- the critical manner."[21] Rather than focusing on the elimination of information provided in the classroom, we should view it as a shift in responsibilities. Students will be responsible for the gathering of facts, information, etc. and the teacher will be more responsible for helping the student to think about and use the material. In this way, there should be no significant loss in content; and there would be an increase in knowledge. Certainly, accreditation requirements could still be met.

I do not view the use of objectives as restrictive. They can be rewritten to include a demonstration of the use of critical thinking within the subject content. We should view the objectives as a tool for evaluating the effectiveness of our new methods and philosophy.

My goal is to create a curriculum that will provide an example of this. Encompassed within a specific dental hygiene course will be metacognition, practice with specific critical thinking skills, and encouragement of a critical and inquisitive spirit.

FOOTNOTES: CHAPTER I

[1]Raymond S. Nickerson, "Kinds of Thinking Taught in Current Programs," Educational Leadership, (September 1984): 28-29.

[2]Carol B. Olson, "Fostering Critical Thinking Skills through Writing," Educational Leadership, (November 1984): 30.

[3]Paul Connolly, personal letter.

[4]Stephen P. Norris, "Synthesis of Research on Critical Thinking," Educational Leadership, (May 1985): 40-41.

[5]Nickerson, "Kinds of Thinking," p. 32.

[6]M. N. Brown et al, "Design and Implementation of an Evaluation Procedure for an Innovative Undergraduate Program," College Student Journal 11 (1977) 4:7.

[7]Daryl G. Smith, "College Classroom Interactions and Critical Thinking," Journal of Educational Psychology, 69 (1977) 2:188.

[8]Lucille Falkof and Janet Moss, "When Teachers Tackle Thinking Skills," Educational Leadership, (November 1984): 8.

[9]Richard W. Paul, "Bloom's Taxonomy and Critical Thinking Instruction," Educational Leadership, (May 1985): 37.

[10]Richard W. Paul, "Critical Thinking: Fundamental to Education for a Free Society," Educational Leadership, (September 1984): 7.

[11]Norris, "Synthesis," p. 40.

[12]Ibid. p. 44.

[13]Harvey Siegel, "Critical Thinking as an Educational Ideal," The Educational Forum, (November 1980): 13-14.

[14]Paul, "Critical Thinking: Fundamental," p. 13.

[15]Suzanne Perry, "Teaching Underprepared Students without Compromising Standards," Chronicle of Higher Education 26 (June 1, 1983): 28.

[16]Paul, "Bloom's Taxonomy," p. 38.

[17]Smith, "College Classroom Interactions," p. 188.

[18]John E. McPeck, Critical Thinking and Education, (New York: St. Martin's Press, 1981), p. 157.

[19]Norris, "Synthesis," pp. 41-42.

[20]Paul, "Bloom's Taxonomy," p. 39.

[21]Siegel, "Critical Thinking as Educational Ideal," pp. 10-11.

CHAPTER II

THE CONTROVERSY

There are two distinct positions as to how to implement the concept of critical thinking into a curriculum. These opposing arguments are 1) to teach critical thinking as a separate course, using no particular subject as a vehicle with the expectation that the students will transfer learned skills to various disciplines; and 2) to teach critical thinking by infusing pertinent skills into an already existing curriculum.

This chapter will first describe what various experts, namely, Ennis, McPeck, Norris, and Sternberg, are saying and relate their positions to the basic question of how to implement critical thinking into a curriculum. The second section of this chapter will examine the differences in what these authors believe and will discuss the controversy that their differing opinions create. Lastly, I will propose what I believe to be the most rational approach for teaching students to think critically.

Robert H. Ennis

In his paper on the assessment of critical thinking in the fourth grade[1], Robert Ennis defines critical thinking as:

"the reflective and reasonable thinking that is focused on deciding what to believe or do." In another paper, he analyzes the concept of critical thinking and explains it this way: "As a root notion critical thinking is taken to be the correct assessing of statements."[2] He provides a list of twelve specific ways to prevent errors when assessing statements. He makes a point of saying "The exclusion of other important kinds of thinking ... from this basic concept of critical thinking does not imply that the others are unimportant, nor does it imply that they are separable from its practice."[3]

Ennis goes on to differentiate three dimensions of critical thinking: 1) the Logical Dimension that judges alleged relationships between meanings of words and statements; 2) the Criterial Dimension that covers knowledge of the criteria for judging statements; and 3) the Pragmatic Dimension that provides for the impression of the background purpose of a judgement and for determining whether a statement is good enough for the purpose.[4]

When he wrote his paper on the concept of critical thinking, Ennis had not yet made a judgement as to what would be the best mode for presenting critical thinking to the students. He openly questions what the appropriate age of students would be for mastering various aspects, criteria,

and dimensions of critical thinking. And he asks: "We need to know in what curriculum patterns the aspects and/or dimensions are most effectively presented. Should they be integrated into existing courses or presented in a separate course? If integrated, which courses should be the vehicles? Or should all courses be involved, since critical thinking is needed in all areas?"[5] In a later argument he answers his own question by explaining that the choice should be made for practical reasons. He would make elementary schools his first choice because "one teacher generally has control over most of the subject matter ... A principle that is introduced in one subject or activity could then be applied in other areas under the guidance of the same person."[6] The secondary level, as he explains it, would find difficulty in adding a separate course in critical thinking because of the already existing requirements. Ennis's recommendation for that level is to incorporate critical thinking into one or two of the already existing courses. His concept is based on the idea that it would be better to have one centralized course where students would learn the principles and may then transfer them to other areas, than to have each teacher of every subject be presenting the same principles. He does concede that " ...we cannot expect complete transferable learning... to occur from this one central course."[7]

Ennis predicts that when primary and secondary schools provide adequate training in critical thinking, the need for a separate course in thinking at the college level will diminish and the emphasis in college will be on thinking skills within specific subject areas. But until that time, he recommends a separate critical thinking course for college students.

It is apparent from this discussion that Ennis believes there are some fundamental critical thinking skills that can be applied to many subjects. In his article, "Critical Thinking and the Curriculum," he provides four concrete examples: conflict of interest; strawperson fallacy; denial of the consequent; and ability of a hypothesis to explain or help to explain facts. He claims that "These four principles show that there are elements of critical thinking that are general and that bridge subjects."[8]

Because of these beliefs, it is Robert Ennis's contention that critical thinking may be taught separately, within a specific course, or both.

John E. McPeck

John McPeck uses the term reflective skepticism to describe critical thinking. It is this "suspension of assent toward a given statement, established norm or mode of doing things"[9] that allows a person to consider

alternative hypotheses and possibilities. McPeck goes on to say "... knowing how and when to apply this reflective skepticism effectively requires, among other things, knowing something about the field in question."[10] It is on this point that McPeck focuses his argument. He believes that if a person demonstrates critical thinking ability in one area, there is no reason to expect that individual to express that ability in any other area. It is the in depth knowledge of the subject that enables one to think critically rather than possession of a general critical thinking ability. "There is no set of supervening skills that can replace basic knowledge of the field in question."[11] Thus, judging from his even more explicit statements: "...there is no universal skill properly called critical thinking..."[12] and "...skills, like critical thinking in general are parasitic upon detailed knowledge of, and experience in, parent fields and problem areas."[13] McPeck does not believe in the generality and, consequently, the ability to transfer critical thinking skills. In fact, he goes as far as to say: "...the core ingredient of critical thinking is foundational knowledge which is epistemology."[14]

Not only does McPeck view critical thinking as subject specific and dependent, but he also emphasizes that the ability to think critically is not enough: "One must also develop the disposition to use the (critical thinking)

skills."[15]

McPeck envisions the way to encourage this disposition and develop critical thinking skills in a subject area by replacing the current emphasis on facts and skills with the understanding of their justification. "Critical thinking... requires knowledge of the reasons that lie behind the putative facts and various voices of authority."[16]

It is John McPeck's firm belief that critical thinking must be taught and fostered within specific subject matter. It cannot stand alone as a separate course from which skills will be transferred because every subject requires very specific skills. Towards the end of his text McPeck states: "There is no defensible justification for constructing courses in reasoning and critical thinking in isolation from specific areas."[17]

Stephen P. Norris

In his paper, "The Choice of Standard Conditions in Defining Critical Thinking Competence," Stephen P. Norris avoids defining critical thinking. As a matter of fact, this is an area for which he praises John McPeck: "McPeck has done a service in pointing out that critical thinking ability cannot be properly described by definitional fiat."[18] The closest Norris comes to defining critical thinking is in his scientific investigation into what

reasoning is. He stresses that to denote the term reasoning, one must consider an indispensable intentional element. "The point is that no informed decision about the referent of 'reasoning' can be made without detailed knowledge of the underlying nature of what we currently, presci-entifically, refer to as 'reasoning', and without examining the interests and intentions we are attempting to meet."[19] Throughout his paper, Norris uses the concept of deductive reasoning as analogous to critical thinking. He uses this aspect of critical thinking because it is an area in which a significant amount of analysis and research has been done. He states "... what I say about deductive logical competence could be said about the whole of critical thinking..."[20]

The role of Norris's paper is not so much to provide another concept of critical thinking, but to examine the current controversy brought about by the philosophies of Ennis and McPeck. Through analysis of the controversy, he hopes to form a resolution to direct efforts in the field of critical thinking.

Norris identified the core of the issue to be whether or not critical thinking skills can or cannot be generalized. He does begin by offering his own opinion: "I believe that at some level of analysis human abilities have to be transferable competencies."[21] He uses an analogy

generalized. He concludes by summarizing: "Yet, given our lack of detailed knowledge of reasoning, it is quite reasonable to maintain that failure to find reasoning abilities which cut across subjects and contexts is due only to our inability to identify and instantiate the required set of standard conditions."[29] And as far as practical educational application of philosophical theory is concerned, Norris believes "Ennis's guidelines and conceptions are appropriate to the interests of educators, and should not be discarded, leaving nothing of comparable quality to take their place."[30]

Sternberg

It was Norris's discussion of standard conditions that led me to look at Sternberg's triarchic theory of intelligence. This theory does not attempt to answer the question of the generality of critical thinking skills, but provides a sound basis for some research on the subject. Norris has said "Our current knowledge is meagre, so that it can lead only to highly ambiguous conclusions." Norris concludes, "At present, agnosticism is probably the best scientific stance." It may be argued that until scientific investigation has yielded evidence, we cannot know whether critical thinking skills are or are not transferable.

Sternberg believes the best way to test for the ability

of transfer is to provide abstract problems for test takers to measure their logical competence. Sternberg argues that data (linguistic and personal bias and belief factors; content/context) tells us that people use their knowledge of the world to supplement logical competence.[31] Thus, to get a true measure of an individual's logical competence, the test should remove the element of knowledge by describing relatively novel everyday problems.[32]

According to Sternberg's triarchic theory, to understand and assess thinking skills we need to examine three aspects or the "triarchy" of intelligence. The three aspects are: 1) Mental processes and representations that underlie thinking. These processes can be divided into three kinds: a) Metacomponent or executive processes (planning what to do, monitoring it while it is being done, and evaluating it after it is completed). b) Performance components or nonexecutive processes (used to carry out the instructions of the metacomponents - they actually solve the problem). c) Knowledge - acquisition components are lower order processes (used to learn what to do in the first place).[33] 2) The relative degrees of familiarity of the tasks or situations to which these processes and representations are applied. Sternberg states: "Assessment of thinking is probably most useful when the problems to which the processes are applied are relatively, but not wholly,

novel."[34] He feels that in order to test for thinking ability the challenge of the problem needs to be in the components of thought rather than the knowledge that needs to be brought to bear upon the problem.[35] 3) The real-world contexts to which the processes and representations are applied to tasks and situations of varying degrees of familiarity. This obviously tests for transfer because it is providing "problems that in some way measure the ability of the child to apply thinking skills in his or her everyday life."[36]

It is apparent from statements made in describing his triarchic theory of intelligence that Sternberg does not consider critical thinking to be subject specific. He seeks to remove the knowledge component from problems to get a finer look at the thinking component. Also, his belief of the generality or transferability of thinking skills is made clear when he expresses the desire to use problems that are relatively but not wholly novel in testing students for competency.

Discussion

Separately, both Ennis's and McPeck's concepts of critical thinking seem plausible. But after studying both, one must concede that they cannot both be correct. The idea of one centralized critical thinking course with

transference to various subjects contradicts McPeck's notion that critical thinking is subject specific and must be taught within a given subject matter. It is necessary, then, to take a closer look to determine the weaknesses, if any, in each argument.

Initially, because McPeck made an issue of Ennis's definition of critical thinking being wrong,[37] I considered the difference in the definitions of critical thinking to be the root of the controversy, but I see now that it is not. The discrepancy in the definitions is not so much a matter of disagreement as it is a misinterpretation by McPeck of Ennis's definition in A Concept of Critical Thinking. McPeck takes Ennis's definition of critical thinking as "the correct assessment of statements" very literally. I believe Ennis meant this definition to be only a single component of critical thinking. Surely Ennis conceives of a broader picture than simply assessing statements. He too would agree that thoughts and actions often need to be analyzed critically. In his paper on "Assessment of Critical Thinking in the Fourth Grade," Ennis offers another definition: "Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do." Norris supports my belief when he says: "Ennis's conception of deductive logical competence is indeed quite broad." Deductive logic is yet another area of thinking critically that Ennis has addressed.

The real conflict, however, in this controversy is in whether or not critical thinking skills can be generalized. If yes, then Ennis is correct -- general skills could be learned and transferred from one area to another. If no, then McPeck would be correct. If critical thinking cannot be generalized, we cannot teach for transfer, but only within a specific subject. Unfortunately, research has not yet answered this question; and as Norris has pointed out, both Ennis and McPeck have made the mistake of staking a claim without "sufficiently rigourous" or "scientific" evidence.[38] However, it is interesting to note how differently each projects his claim. McPeck very dogmatically pronounces that "...critical thinking does not denote a generalized skill."[39] Whereas, Ennis, with less severity, suggests: "...some of the principles of critical thinking are more easily generalized (less domain specific) than others."[40] And from there, Ennis goes on to give specific examples of principles that can bridge subjects (i.e., conflict of interest; strawperson fallacy; denying the consequence; and the ability of a hypothesis to help explain the facts).

Ennis disputes McPeck's logic in his famous claim (that "Thinking is always thinking about something..."[41] Thus critical thinking is subject specific. So critical thinking instruction must take place within subject-matter areas, the disciplines.") on the grounds that the argument exploits the

ambiguity of the word subject.[42] But I would argue that in addition to that ambiguity, it does not logically follow that because one must think about <u>something</u> that the skills used in thinking about that subject cannot be used with other subjects.

In fact, on a practical level, one could support the hypothesis of generalization and transfer of critical thinking skills. A simple example might be in the reading of Ennis's general principles of critical thinking.[43] Ennis describes the principle of the "strawperson fallacy" as a mistake to misdescribe a person's position, and then attack the position as if it actually were the person's position -- he goes on to give examples to make its application clear. I later found myself identifying this fallacy in McPeck's text -- (a completely different context from how it was explained to me). McPeck condemns one of Ennis's dimensions of critical thinking. McPeck uses the example of Ennis's criterial dimension: "...clearly links specialized (field-dependent) knowledge with the concept of critical thinking itself." and then builds his argument about critical thinking being non-generalizable from there. Whereas, it is wrong for him to "assume" Ennis denies the need for knowledge of a field in critical thinking. In fact, Ennis can be quoted as saying "...I am firmly convinced that a thorough knowledge of the subject about which one is thinking

is essential for critical thinking..."[44]

Furthermore, Ennis does not claim that critical thinking should not be part of subject matter instruction. He only challenges the contention that it is the only way to address critical thinking.

It is also of interest to consider that if Sternberg is able to achieve his goal -- (which is to remove the distractions of knowledge from test questions -- providing "abstract" problems to which students can apply their critical thinking) and the students are able to provide answers demonstrating critical thinking skills, then critical thinking can be removed from specific contexts and generalized.

Based on the current literature, it is fair to say that no one theory has been proven or disproven. It seems reasonable, then, to assume that there are some general critical thinking skills that can be transferred to various subjects. Our knowledge in other fields would indicate that this position may be true. In this light I draw upon one of Ennis's analogies between critical thinking skills and writing and math skills. "The principles of writing sentences and paragraphs and computing and comparing percentages are clearly not limited to the domains in which they were taught to me. Is there any reason to think that it is different for critical thinking?"[45] Believing that

some thinking skills are general is not to say that certain fields of knowledge may not require specific skills unto themselves, but that there are some fundamental skills which extend into all areas of study.

I believe that the ideal way to communicate critical thinking skills would be to include in a curriculum both a centralized area for emphasizing the basic principles of critical thinking and the infusion of those skills into existing course work. The advantage of a specific critical thinking course would be to help students focus their attention and understand what is trying to be achieved. With a "prepared" mind they would be more receptive to thinking skill development in other subjects. It would be necessary for all teachers to be trained in critical thinking skills to help them coordinate the desired goals and allow for better infusion of those skills into the class work.

The ideal and the real world often have trouble coinciding. It would be practical at this point in the research to emphasize the infusion of critical thinking skills into some of the existing curricula, rather than introducing a separate critical thinking course. I say this for three reasons. First, most experts in the field of critical thinking would support this mode of instruction. Second, it would be more practical in most school systems to work within the current framework than to try to add more courses.

Third, it would be more efficient for the students to be using required course content as a vehicle for developing their critical thinking skills.

FOOTNOTES: CHAPTER II

[1]Robert Ennis, "Large Scale Assessment of Critical Thinking in the Fourth Grade," revision of presentation made at the annual meeting of American Educational Research Association, Chicago, Ill., 1 April 1985, p. 1.

[2]Robert Ennis, "A Concept of Critical Thinking," Harvard Educational Review 32 (Winter 1962) 1:83.

[3]Ibid., p. 84.

[4]Ibid., pp. 84-85.

[5]Ibid., p. 109.

[6]Robert Ennis, "Critical Thinking and the Curriculum," National Forum Phi Kappa Phi Journal (Winter 1985): 30.

[7]Ibid., p. 31.

[8]Ibid., p. 29.

[9]John E. McPeck, Critical Thinking and Education, New York: St. Martin's Press, 1981), p. 6.

[10]Ibid., p. 7.

[11]Ibid., p. 9.

[12]Ibid., p. 14.

[13]Ibid., p. 10.

[14]Ibid., p. 156.

[15]Ibid., p. 19.

[16]Ibid., p. 157.

[17]Ibid., p. 159.

[18]Stephen P. Norris, "The Choice of Standard Condition in Defining Critical Thinking Competence," Institute for Educational Research and Development, Memorial University of Newfoundland, St. John's, Newfoundland, (May 1984), p. 23.

[19]Ibid., p. 12.

[20]Ibid., p. 5.

[21]Ibid., p. 4.

[22]Ibid., p. 5.

[23]Ibid., p. 8. McPeck's epistomological objection is that principles of reasoning are typically discipline specific. Norris observes that McPeck has not provided "examples of reasoning procedures which are used in one particular field but are not applicable to other fields."

[24]Ibid., p. 10.

[25]Ibid., p. 12.

[26]Ibid., pp. 13-16.

[27]Ibid., p. 18.

[28]Ibid., p. 19.

[29]Ibid., p. 23.

[30]Ibid., p. 24.

[31]Ibid., p. 18.

[32]Robert J. Sternberg and Joan Baron, "A Triarchic Approach to Measuring Critical Thinking Skills: A Psychologist's View," in Symposium at the annual meeting of American Education Research Association, Chicago, Ill., 1 April 1985, p. 9.

[33]Ibid., pp. 7-8

[34]Ibid.

[35]Ibid., p. 9.

[36]Ibid.

[37]McPeck, Critical Thinking, p. 43.

[38]Norris, "The Choice of Standard Condition," p. 23.

[39]McPeck, Critical Thinking, p. 57.

[40]Ennis, "Critical Thinking and the Curriculum," p. 29.

[41]McPeck, Critical Thinking, p. 3.

[42]Ennis, "Critical Thinking and the Curriculum," p. 29.

[43]Ibid., p. 28.

[44]Ibid., p. 29.

[45]Ibid., p. 30.

CHAPTER III

THE APPLICATIONS

The intent of this chapter is to review the available literature on teaching critical thinking in colleges and one postgraduate program. In examining the literature, it has not been evident that there are cognitive needs specific only to college/adult students. Some psychologists would consider the college student to be in the same cognitive stage as an adolescent student. This theory is based on Piaget's studies with children. Piaget believed that by the time a child is fifteen or so, he/she should have all the cognitive structures necessary to do the most intellectually challenging tasks. He called this culmination of intellectual development The Formal Operational Period. The Formal Operational Stage includes both adolescents and adults. There is, however, opposition to this theory. Arlin, Greenfield, and Riegel each believes that the adult population requires new conceptualizations of mature intellectual functioning.[1] It is reasonable to assume that the use of methods and materials developed for high school students could be applicable to college students. However, I still see a value in examining how critical thinking is being taught in college, not to isolate college curricula from pre-college curricula, but to establish the need of

critical thinking in this population and encourage its use among college instructors.

One practical consideration that does separate college students from pre-college students is the structure of a college program. In a field such as dental hygiene, there is little room to add courses to the curriculum. In the existing courses the need for conceptual knowledge has to be addressed. The methods for teaching critical thinking cannot ignore the content.

The college curricula I intend to include in this discussion are chosen from a wide spectrum of fields. I will begin with the implementation of critical thinking in liberal arts programs and work toward more career specific programs.

California's State University Requirement

In 1982 the California State University system took a giant step into the field of critical thinking. It established a requirement for its undergraduates (300,000 students on nineteen campuses) to take at least nine semester units in "Communication in the English Language," of which part must be critical thinking.[2]

This California State University Chancellor's Office Executive Order (#338) defines critical thinking as follows:

> "Instruction in critical thinking is to be designed to achieve an understanding of the relationship of language to logic, which should lead to the ability to analyze, criticize, and advocate ideas, to reason inductively and deductively, and to reach factual or judgemental conclusions based on sound inference drawn from unambiguous statements of knowledge or belief. The minimal competence to be expected at the successful conclusion of instruction in critical thinking should be the ability to distinguish fact from judgement, belief from knowledge, and skills in elementary inductive and deductive processes, including an understanding of the formal and informal fallacies of language and thought."[3]

This goal is progressive and well defined, however the California State University system is so large that monitoring and implementing the order to achieve the goal has been difficult. Perry Weddle, professor of philosophy at Sacramento State University, says "each campus of the nineteen has a degree of autonomy in interpreting 338."[4] At Sacramento State University there are several courses offered that would satisfy the state's critical thinking requirement. In their philosophy department there is a course called "Logic, Critical Thinking." The sociology department offers "Sense and Nonsense in Social Research." Other departments that have designed courses to include critical thinking skills are history, psychology and English, which offers "The Argumentative Essay." The student thus has considerable choice, depending upon

his/her area of interest.

Other California state colleges have interpreted the implementation of critical thinking skills courses much more loosely. At Chico State College the only course offered which fulfills the requirement is the philosophy department's formal logic course. Fresno State College offers no critical thinking courses. Their interpretation of the order designates any general education academic course as acceptable.

There is a problem also with students transferring from California's community colleges into the universities. Weddle has expressed that "The community colleges, with the exception of philosphy people (and only half of them) have no idea what a reasoning course should do, yet they are implementing them by the score, and transferring their students into the California State University with the critical thinking requirement met."[5]

Professor Weddle was not able to describe the exact content or the methods of how the various courses teach critical thinking skills. He has repeatedly requested such information from the various departments, but to no avail. He does stress the tremendous need for some continuity among the colleges. The faculty is very unsure of what to do with this requirement. It is Weddle's feeling that California needs a master's program such as the

Critical and Creative Thinking Program at the University of Massachusetts in Boston. Teachers and administrators themselves need courses in the area of critical thinking to help them better understand the skills to be addressed and develop a manner in which to present those skills.

Bard College's Institute for Writing and Thinking

Some of the faculty at Bard College, Institute for Writing and Thinking, are training teachers to teach critical thinking. To date, they have offered two workshops for high school and college teachers on "The Teaching of Critical Inquiry."[6]

Bard's course for teachers on "Teaching Argument through Writing" was divided into seven workshops and a pre-workshop session. The Pre-Workshop and Workshop I are of a metacognitive nature. The workshop's leader has the responsibility for introducing and defining some of the language and concepts that will be used throughout the weekend conference. Bard is focusing on the concepts of "community of discourse," "community of inquiry," and distinguishing between "linear" and "dialectical" arguments. After a brief discussion, the participants are asked to do some free-writing for themselves. The workshop leaders then share some writing from a chosen text, to allow the teachers to share expectations and identify pedagogic

assumptions that will be examined throughout the weekend.

Workshop II focuses on resolving two confrontational arguments that have a dialectical structure. This resolution is accomplished through the development of a third argument that will be written by the participants.

Workshop III concentrates on "invention heuristics" which will help the participants explore the textual issues with which they are working. This workshop's goal is to create a concise statement of the writer's position on the texts and on their relationship to one another.

Workshop IV is another writing period, beginning with creating metaphors and analogies. These analogies will be incorporated into an essay by each participant. The fifth workshop plans to use these essays to discuss the validation of arguments. Small groups will focus on each participant's argument (essay) to "enrich the author's sense of what is problematic"[7] with his/her written work. Workshop V also uses the previously composed essay to discuss "believing and doubting." The workshop leader will instruct particpants to ask themselves, "In what ways does this piece of writing extend your thinking and/or challenge your thinking?"[8]

The last workshop (Workshop VI) is intended to be a roundtable evaluation of the practical problems of implementing the methods that were used in the workshops into

the teachers' own classrooms.

When the participants were asked to describe what they had gained personally and professionally for their students from the workshops, some of their responses were: "...clearer sense of the process of inquiry;" "...great awareness of my own process in developing an argument;" "...useful emphasis on independent research by students;" and "...the generative possibility of argument." After having participated in a workshop themselves, these teachers had a clearer idea of how to implement methods that would develop thinking skills in their students through writing. Teachers in other colleges have likened writing to problem solving:

> "Writing is among the most complex of all human mental activities ... the writer must produce an organized set of ideas for a paper by selecting and arranging a manageable number of concepts and relations from a vast body of knowledge and fit what they know to the needs of another person, a reader, and to the constraints of formal prose."[9]

When Carol B. Olson presents a workshop on thinking and writing, she uses a tool with which most teachers are familiar, Bloom's Taxonomy of Educational Objectives, as a point of departure because "...all of Bloom's categories in the cognitive domain -- knowledge, comprehension, application, analysis, synthesis, evaluation -- are integral to composing."[10]

Critical Thinking Studies with College Students

Leonard Gibbs, Associate Professor of Social Work at the University of Wisconsin - Eau Claire, is working at implementing critical thinking skills into a curriculum on social work. He expresses the need for a graduate program in critical thinking for teachers in Wisconsin. Professor Gibbs feels there is a need to substantiate the effectiveness of teaching for critical thinking skills through college curricula. He is particularly interested in a "randomized trial that evaluates some procedure for teaching critical thinking against the effectiveness of control or alternate procedure."[11]

There have been some interesting studies done with college students in the area of critical thinking skills development. Daryl G. Smith, Professor of Psychology at Scripps College in California, conducted a study with teachers and students at a small liberal arts college. There were twelve classes to be evaluated, evenly divided among the humanities, social sciences and natural sciences. The goal of the study was to determine the relationship between specific classroom behavior and critical thinking. The hypothesis Smith was testing was that "the greater the degree of active student involvement and the higher the levels of questioning and student participation, the greater the change in or level of critical thinking."[12]

The results of Smith's research did show that student participation, faculty encouragement and use of student ideas and peer-to-peer interaction emerged as positively related to change in critical thinking behaviors as measured by the Watson-Glaser Critical Thinking Appraisal and the Chickering behavioral self report index. Smith suggests that "Efforts at student involvement, then, might be encouraged not only for the sake of student contentment, but for cognitive benefits as well."[13]

Charles H. Logan, Professor of Sociology at the University of Connecticut, conducted a study involving college sociology students. The intent of his study was to determine whether or not students farther along in the "normal" curriculum of a sociology department would be:

> "1) more spontaneously inclined to critically analyze the form and logic of statements dealing with social issues, even when not instructed to do so; and 2) better able to adequately criticize such statements when they are specifically instructed to do so."[14]

As part of the study an experimental critical thinking class was taught with very little emphasis on traditional sociology subject matter. In this experimental group, most of the class time was spent discussing issues such as the meaning of objectivity, scientific method, and critical thinking and their application to thinking about social issues. Materials chosen for discussion were taken from

controversial current events that had significant social impact. The professor of the course did not lecture, but would "think critically out loud" to provide an example for the students. Time was also spent trying to develop a willingness on the part of the students to apply these critical thinking methods.

After studying results from the control and experimental groups, Logan determined that "the highest scores and the greatest differences revolved around just one semester of a course known to have been specifically aimed at teaching students to think more scientifically about social problems."[15]

It is encouraging to note that these studies indicate when the subject of critical thinking is addressed in any course, the students respond favorably in critical thinking testing situations.

The University of Massachusetts' Undergraduate Program

The University of Massachusetts' undergraduate program attempts to infuse critical thinking skills, along with writing and math skills, into its core courses required of all students. In 1979 the College of Arts and Sciences Senate suggested that core courses move away from their previous definition as a "body of essential knowledge" towards one emphasizing "...methods or ways of understanding

the world and one's experience in it..."[16] The University of Massachusetts Core Curriculum Committee expects that teachers of core courses will "integrate an understanding of their subject matter within the context of the core area with explicit instruction in the methods and skills required to develop the understanding."[17] Core courses are offered in the Arts, the Natural Sciences, History and Cultural Studies, Philosophy and Humanistic, and Social and Behavioral Sciences. Each core course within these areas of study is expected to incorporate one of the following into the curriculum: writing, critical thinking, or mathematics.

Within these basic guidelines, implementation is loose. Choice of what skill to teach within a given subject is left to the instructor and the department. The Core Curriculum Committee does monitor course proposals with attention to skills development, but it does not prescribe specific skills for particular courses.

Considering other colleges' (University of California; University of Wisconsin, Eau Claire) cries for critical thinking courses for their faculty, it is surprising to discover how little interaction there is between University of Massachusetts' undergraduate core teachers and the graduate Critical and Creative Thinking Program. Associate Dean Howard Cohen said that very few teachers of core courses show any interest themselves in taking graduate

level thinking courses.[18]

Judging from examples of teaching basic skills given in the University of Massachusetts Faculty Handbook, the primary method of teaching critical thinking is through writing. Ann Berthoff teaches Composition in the University of Massachusetts English Department. Professor Berthoff compares thinking to composing. She says, "Composing is a matter of finding, developing, organizing ideas; it is a matter of forming concepts and forming sentences and paragraphs which can represent them."[19] She recommends incorporating writing into class time. One way she has included writing in class is to interrupt a lecture or discussion by asking her students to write for five minutes about what is at issue. Professor Berthoff suggests that writing in class also encourages discussion. She has found that students are more apt to question subjects that they realize they will be writing about shortly.

Another manner in which an instructor has used writing as a tool for developing thinking is by being explicit in her instructions for paper assignment -- emphasizing such skills as summarizing, paraphrasing, abstracting, and contrasting.

David Hunt of the University of Massachusetts Historical and Cultural Studies Department uses debating in class to develop reasoning skills. By taking a view-

point, documenting the position, and presenting the evidence logically, the student learns to develop an argument. Professor Hunt stresses that this emphasis in his class is on reasoning and documentation rather than on coming up with the right answer.

Other University of Massachusetts teachers use a variety of pedagogy. Lois Rudnick teaches thinking through History and Cultural Studies by using "oral articulation." She has students role play so that they may see from a point of view not their own. Reading also has been used to develop thinking skills. Jennifer Radden has her students break reading into three parts: first, do a skim reading to grasp the author's position; second, do a close reading with paragraph summarizing -- she encourages students to write notes in the margins of their texts; and third, write a one-page schematic summary of what they have read -- students are encouraged to compose this summary from the notes they have made in the margins of their text.

The undergraduate students at the University of Massachusetts/Boston are required to pass a Writing Proficiency Examination after completing their core course requirement before they can enter their junior year of college. This examination can be repeated if the student fails the first taking. There is no other basis for determining the effectiveness of the college's core

curriculum thinking program.[20] It is difficult to evaluate whether or not any difference is being made in these students' critical thinking ability.

Harvard Medical School's "New Pathways Project"

It is significant that medical schools such as Harvard Medical School, University of New Mexico, McMaster University, whose students have excelled in traditional undergraduate college and university programs are also exploring and designing curricula that emphasize thinking skills. Harvard Medical School's "New Pathways Project" is particularly interesting to me because I see many similarities between a medical program and a dental hygiene program. Much of the course work emphasized in the first year in both programs is human anatomy and physiology. There is a huge body of knowledge with which students need to be familiar. In addition to knowing and understanding scientific fact, the students must be able to apply this knowledge when working with patients. Upon completion of the medical program and the dental hygiene program, both groups of students must prove their mastery of the subjects by passing board examinations before they can practice in their field.

Harvard's project is formally called The Oliver Wendell Holmes Society: A New Pathway to General Medical

Education at Harvard Medical School. The philosophy of the project is summarized in a May 1984 progress report to the Medical Curriculum Committee:

> "Education in medicine, whose knowledge base is never stable, should emphasize methods as much as content. Students should be given fewer 'answers' and more tools -- tools for self teaching; for synthesizing, framing and revising knowledge; for keeping pace with a rapidly changing profession. They should have the opportunity to practice, from the earliest days of medical school, skills of seeking out information, testing hypotheses, and problem solving. Much of what we want to accomplish has to do with what faculty and students do together; we hope to stimulate changes in the attitudes and conceptual frameworks within which faculty teach and students learn. It is our overriding goal to shape an environment of active student learning, for, as Aristotle wrote, 'The things we have to learn before we can do them, we learn by doing them.'"[21]

The New Pathways program plans to emphasize skills specific to questioning, problem-solving, and critical thinking. The primary methods of pedagogy will be experiential and problem-based learning. A problem-solving approach to learning encompasses numerous critical thinking skills. The New Pathways program breaks problem-solving skills into four categories: first, the collection, organization and analysis of information in relation to a specific problem -- "(e.g., asking significant questions, setting priorities and planning effectively)"; second, the

ability to see the inter-relatedness of problems; third, reasoning through problems and reaching probabilistic judgements; fourth, assessing the validity of information, including research articles.[22] Other critical thinking skills to be addressed are observation, teaching, and decision making.

The students will spend sixty percent of their time "sharing knowledge." This shared knowledge will include no more than five hours of lecture per week; five to seven hours a week spent in tutorial groups (five to seven students working with a faculty tutor) working on problem solving with specific cases; and three to six hours per week on field exercises (hospital, laboratory, community, etc...). The remainder (forty percent) of the students' time will be used for personal or "unshared" learning. This category may include thesis work, self directed problem-based learning, concentration, and external courses.

The New Pathways Project will be implemented in September 1985. Only twenty-five of the medical school's one hundred and sixty-five entering students will be admitted to the program. This "experimental" group with a readily available "control" group will provide a means for evaluating the effectiveness of the project.

An Inquiry Approach to Teaching Dental Hygiene

In my investigation of critical thinking curricula for college students, I have encountered one project which specifically addresses dental hygiene education. Throughout the past decade the American Dental Hygiene Association has presented workshops for dental hygiene faculty. These workshops have been based on an inquiry approach to learning. Much of the proposed curriculum design is taken from a Deweyan philosophy of education. This approach to education emphasizes the students' participation in their own learning experiences.

The goal of the workshops was to model an inquiry approach for the participants. Through participation in periodic workshops, occasional individual and small group tutorials, regular self-directed, self-assessment activities, and independent reading and writing, the teachers were able to identify discrepancies between their intentions and their practices in the classroom. Acquisition of educational content, rather than being an end in itself, became a means to the end of "reducing the discrepancies between one's intentions and one's practices."[23] It was anticipated that by participating in this type of learning experience the teachers would be motivated and able to activate an inquiry approach in their classrooms.

The skills (or categories) emphasized in this inquiry

approach to dental hygiene are components of a problem-solving mode of learning. The workshop leaders called the first category "situations of experience," which asks students to recognize cause and effect relationship. The process is begun by giving students something to do which calls for the noting of connections between their doing and its consequences. The second category was termed "The development of challenging problems." In this category of instruction, the teacher would confront students with problematic situations. The students should be forced to think and investigate to make choices; and this would lead to the third category, "the generation of ideas." This area could also be considered the formulation of tentative hypotheses. Next in the process of problem solving is the "observation and collection of data." The collection of data is a way to use the subject matter of a particular course as a vehicle for developing these thinking strategies. After comparing and contrasting various hypotheses and determining reliable and unreliable sources of information, the student is encouraged to "develop a reasoned hypothesis." The students are expected to support their beliefs and opinions with factual evidence. According to the Deweyan approach, students should take a stand on one hypothesis and follow it through by "experimental application and testing." The student is then responsible

for the last category, "evaluation and judgement of results." Self evaluation is an important aspect of the Deweyan Inquiry Approach. The workshops encouraged teachers to view students' answers as intermediate in learning, not final. After evaluating their own work, students should be given the opportunity to make revisions or corrections they deem necessary.[24]

Pre-tests and post-tests were administered to the teachers who participated in these workshops, and also to their students. Judging from the comparison of the post-tests to the pre-tests, there was a significant change in the behaviors of both the teachers and the students. The following changes were noted: first, increased faculty identification with attributes seen as central to an inquiry set (i.e., experimental and reflective questioning and puzzling; second, increased faculty experimentation with behaviors that expand students' thinking, experimentation and comprehension; third, decreased faculty use of practices incompatible with students' inquiry behavior (i.e., extrinsic motivation, neglect of direct experience and mechanical following of established method); fourth, increased faculty utilization of practices compatible with students' inquiry, as reported by students, (i.e., developing challenging problems, generating ideas, developing tentative explanations for problems that arise); and fifth,

an increase in student utilization of inquiry behaviors.[24]

I have talked with two dental hygiene instructors who had participated in this inquiry workshop. They both report that they have incorporated some inquiry methods into their classroom teaching. They find it difficult to teach exclusively in this inquiry mode because of restrictions placed on them by department and college policies. For example, they find that the required use of behavioral course objectives places restraints on explorative learning. One of these teachers has, on occasion, tried to work within this departmental requirement by having her students help write the course objectives. Both instructors feel that the best way to enact an inquiry approach for students is to get all the members of a faculty to attend a workshop together. Group attendance would decrease resistance to new ideas, provide teachers with peer support, increase continuity of learning methods for students, and probably provide more noticable change in students' behavior.[26]

FOOTNOTES: CHAPTER III

[1]Ruth L. Ault, Children's Cognitive Development 2nd ed., (New York, Oxford: Oxford University Press, 1983), p. 75.

[2]"What CT News is," CT NEWS, Spring 1985.

[3]Ibid.

[4]Perry Weddle, personal letter.

[5]Ibid.

[6]Paul Connolly, personal letter.

[7]Connolly, personal letter.

[8]Ibid.

[9]Carol B. Olson, "Fostering Critical Thinking Skills Through Writing," Educational Leadership, (November 1984): 31.

[10]Ibid. p. 32.

[11]Leonard Gibbs, personal letter.

[12]Daryl G. Smith, "College Classroom Interactions and Critical Thinking," Journal of Educational Psychology, 69 (2) (1977): 185.

[13]Ibid. p. 188.

[14]Charles H. Logan, "Do Sociologists Teach Students to Think More Critically?", Teaching Sociology, 4 (1) (October 1976): 30.

[15]Ibid. p. 37.

[16]Core Curriculum Committee. "Reading, Writing and Thinking in the Core," Draft of a University of Massachusetts Handbook.

[17]Ibid. p. 3.

[18]Howard Cohen, interview held at University of Massachusetts, Boston, MA, June 19, 1985.

[19]Core Curriculum Committee, Faculty Handbook.

[20]Howard Cohen, interview.

[21]Progress Report submitted to the Medical Curriculum Committee. The Oliver Wendell Holmes Society. (May 1984): 12.

[22]Ibid. p. 9.

[23]Karen J. Connell et al, "What does it Take for Faculty Development to Make a Difference?", Educational Horizons, 55 (2) (Winter 1976-1977): 109-110.

[24]Bob Burton Brown, The Experimental Mind in Education, (New York: Harper & Row, 1968).

[25]Connell, "What does it Take?", pp. 112-114.

[26]Kristine Perkins and Robin Sylvis, interview, June 1985.

CHAPTER IV

THE SYNTHESIS

My practicum project for the Critical and Creative Thinking Program at University of Massachusetts/Boston was a Continuing Education Curriculum in Dental Radiology for practicing dental assistants. These students had been using x-ray equipment in dental practices with no prior formal education or training in radiology. The course needed to address the hazards of radiation, the safety precautions available, and the skills required for the competent use of x-radiation. The goal of my project was to teach the course in a manner that would develop critical and creative thinking in the students.

Specific objectives of the course were to encourage the students to develop the attitude for and the ability to: 1) offer creative approaches to problem-solving situations; 2) question authority and/or challenge the written word; 3) accept the idea that we cannot <u>know</u> everything, and given that concept, what it would take to prove a fact; 4) see relationships among various objects and ideas; 5) think through a situation to recognize valid or invalid reasoning; and 6) be aware of the continuum and changing nature of scientific knowledge.

I designed a pre-test and post-test of the course for the students to take from which I analyzed the effective-

ness of my methods in achieving my goals. The most significant changes in student thinking detected by the pre-tests and the post-tests were in the areas of deductive reasoning and willingness to question authority. A journal I kept on the observations I made on class performance indicated changes in the students' motivation to learn, in their willingness to formulate and ask questions, and in their ability to recognize and define problems.

I have incorporated into my new curriculum on "Thinking Skills in Dental Radiology" the pedagogy I felt was most effective in bringing about these changes of behavior and attitude in the students. The ongoing principle of not providing immediate answers for students worked well to stimulate their curiosity and their own search for an answer. This method also helped to build confidence in the learner -- a sense of self-reliance. In addition to researching subjects, students were asked to find answers to their questions by designing and implementing an experiment and analyzing the results to share with the class. Another strategy that proved effective for recognizing contradiction, differentiating fact from opinion and discerning underlying inferences was giving reading assignments of articles with conflicting views about the safety of x-radiation. Also, we viewed two films which were made at different times (1968 and 1982), both about the uses of

radiation, and this brought about an interesting discussion on scientific knowledge never being final.

One approach that I am changing in my new curriculum is the manner in which I present thinking skills. In the practicum project the subject of thinking strategies was never discussed. Specific skills I wanted to address were introduced subliminally within the content of the course. I believe this was a mistake. I think that if thinking skills had been brought to a conscious level in the students' minds, they would have been better able to direct their efforts toward developing these skills. Instead, they were groping in the dark, frustrated by not being able to understand why subjects and assignments were being introduced in an inquiry mode.

Another change in class format will be a decrease in my providing of information for students. In my practicum project I had difficulty relinquishing this responsibility to my students. I believe even more strongly now that class time is better spent on developing skills for using knowledge and that students benefit more by learning to find information for themselves. This allocation to independent learning hopefully will alleviate some of the frustration I expressed in my journal regarding the lack of time to both provide information and encourage thinking about that information.

Some of my new attitudes toward pedagogy are based on an assimilation of methods demonstrated and discussed by teachers and school administrators at a series of workshops presented at the University of Massachusetts, Boston in the fall of 1984. Kevin O'Reilly's "Critical Thinking in American History Curriculum" stresses the preparation of the students' minds to think critically about what they read. His classes discuss what it means to think critically about a subject before embarking on that subject. He has developed a vocabulary of cue words to help the students identify when an author is demonstrating a cause and effect relationship, making a comparison, generalizing, or offering proof.

The Instrumental Enrichment Program presented by Frances Link also suggests that teachers begin a lesson with a discussion of what specific thinking skills will be addressed in the lesson. She also recommends that a discussion follow each project or task so that the learners may gain insight about how they are thinking.

Ruth Noller offered some problem-solving strategies which I think will prove useful to my students for the problem-solving cases I plan to assign. Her sequenced procedures for problem solving are 1) fact finding, 2) problem finding (stressing redefining the problem if possible), 3) idea finding, 4) solution finding, and

5) acceptance finding.

Basic Challenge, a critical thinking approach used in the Acton Public Schools, provided a workshop which demonstrated a stimulating way to introduce a subject. The participants were asked to be involved immediately in the class by creating (brainstorming) three lists of 1) things they know, 2) things they think they know, and 3) things they need to know about a given subject or topic. The lists were later condensed by categorizing various knowns and unknowns. A discussion on how to find answers to the list of unknowns followed.

I have incorporated Basic Challenge's technique into my first class, using it to introduce the subject of dental radiology, assess my students' needs and lead into a discussion about thinking skills development. This technique will provide a visible example of how the students recently have been thinking. In this one exercise they will have generated ideas, classified and categorized information and discussed reliable and unreliable sources of information.

The pedagogy I plan to emphasize in my curriculum project is a combination of inquiry, writing, and problem solving. Judging from the Bard Workshops and the Inquiry Approach to Dental Hygiene, I think using an inquiry approach to teaching will get the students actively

involved in their learning. Studies discussed in Chapter Three of this thesis showed that student participation facilitates critical thinking. This course will also utilize writing as a tool to enable the students to demonstrate their thinking processes. I agree with the philosophies of the University of Massachusetts' Core Faculty and Bard's Institute for Thinking and Writing that the process of composing a written work and the process of thinking critically about a subject are very closely related and that one enhances the other. A problem-solving approach to course content has been chosen whenever I felt it was applicable. Problem solving incorporates a great number of critical thinking skills and provides a very realistic application of those skills.

The critical thinking skills I have chosen to emphasize in my dental radiology course are those which I believe will be most useful to the dental hygiene students in their clinical work with patients, in the laboratory, in classroom learning, in the reading of scientific journals, and in adaptation to their future employment. I have classified the selected critical thinking skills into what I consider to be five stages of problem solving (see Appendix I). These categories of thinking skills are 1) recognition of problems, 2) gathering pertinent data or facts, 3) analyzing data, 4) formulating hypotheses, and

5) drawing conclusions. The purpose for categorizing the critical thinking skills that are to be addressed in my course is to enable me to see more clearly which skills are most applicable to which radiology topics. The classification of the various skills is not intended to restrict the use of a given skill to a given problem-solving strategy. Certainly many of the skills can and, in fact, need to be used in all the stages of problem solving.

I have selected two lesson plans, one which uses writing and a second which involves problem solving, to compare with a more traditional method of teaching dental radiology. This comparison will address what I hope to accomplish in the area of critical thinking skills development by using these new methods. The two radiology topics being considered in this comparison are properties and production of x-radiation and patient management for dental radiology (see Appendix II, Classes #2 and #10).

The way these lessons were taught in the past was by providing information in a lecture, using an overhead projector, slides of radiographs, and the blackboard for visual aids. Students would take extensive notes on the materials presented and ask questions for clarification of information. Multiple choice quizzes were given periodically to evaluate whether or not the students were picking up the material.

My new curriculum de-emphasizes informational lectures. Instead, the students will be expected to gather information for themselves through reading assignments. Class time will be spent on thinking about the information, including discussions of how best to approach the subject matter. If student writing is to be done, it will not be for the taking of notes, but rather for reflections of their thoughts about the various topics. For example, in Class #2 on the properties and production of x-radiation, the students will be shown two films about radiation. These films were made in different years, 1968 and 1982; and each offers distinctly different messages. After watching each film, the students will be asked to think and write what they believe to be the main points and message of that film. Following these exercises, the students will be asked to write a short paper (2 - 3 pages) comparing and contrasting the two films. They will be asked to consider how two films about the same subject can be so different, to include underlying inferences and/or points of view of the film makers and to decide which of the two films is the more reliable source of information.

I hope that in addition to gathering important information about the properties and production of radiation the students will become aware of how technology changes. I will have asked them to work with very specific thinking

skills -- (comparing and contrasting, recognizing inferences and points of view, reliable and unreliable sources of information and decision making) -- in this one writing exercise. When their papers are discussed, the students and I will be able to evaluate whether or not they were thinking critically about the subject.

One of the topics I chose to emphasize in problem solving was Patient Management (see Appendix II, Class #10). I designed four realistic problem situations to be considered during class time. After reading through a case situation, the students will be asked to think and write independently for fifteen minutes. They will be asked to describe how they would handle the given situation, being explicit as to their underlying assumptions and reasons for their response. Each example is designed to require the use of various aspects of critical thinking. Some of the skills involved in the various cases are identification of the problem, developing an argument, distinguishing relevant from irrelevant information, questioning authority, application of knowledge and generation of ideas.

It is my hope that through examples such as these, students will attempt to think and act more independently with various clinical situations and will make a habit of following a problem through to a reasonable understanding and/or explanation.

It has been demonstrated that this type of problem-solving approach to teaching does create a more independent learner. Dr. Dale Benos, Associate Professor of Physiology and Biophysics at Harvard Medical School, in discussion with me, said that since he has been teaching his courses in this problem-solving format, students are definitely more deliberate about seeking information from its original source. His students go to primary research literature for information regarding their subject to be certain they can evaluate the research for themselves.

Considering my new objectives for the course, I feel that new evaluation mechanisms are indicated. The multiple choice testing of the past serves only to determine whether or not students are learning facts. I plan to replace these quizzes and examinations with frequent writing assignments. These assignments will encourage the students to think critically about and apply the information they are learning. The writing assignments will also provide a means for me to assess whether or not my class methodology is actually helping to develop thinking skills in my students. Instead of a mid-term examination, there will be a term paper due at mid-semester. The topic will have been chosen by each student and approved by me earlier in the semester. I shall read the papers, make suggestions and return them to the students, asking for revisions.

From mid-semester on, the students will work in small groups (outside class time) on a problem or question of their choice. They will develop a hypothesis, a means for testing the hypothesis, and perform any necessary experimentation or research to draw a valid conclusion to the problem. The experiments and their results will be described and presented to the class at the time of the last class session.

There will be a final examination. It will be of an essay format. Case situations will be described and the students will be expected to respond with critical application of their scientific knowledge.

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A P P E N D I X I

THE SKILLS

RECOGNITION OF PROBLEMS

Observation Generation of Ideas Questioning

GATHERING PERTINENT DATA OR FACTS

Collection of Information Classifying/Organizing

Relevant/Irrelevant Reliable/Unreliable Sources

ANALYZING DATA

Analysis of Information Generalizing Recognizing Patterns

Comparing/Contrasting Cause & Effect Relationships

Assessing Validity Seeing Interrelatedness of Problems Inference

FORMULATING HYPOTHESES

Synthesis Theorizing (formulating explanatory models)

Developing Reasoned Hypotheses

DRAWING CONCLUSIONS

Application Decision Making Inventing

Testing Hypotheses Argument Problem Solving

A P P E N D I X II

THE PROPOSAL

CLASS ONE

TOPIC: Introduction - Thinking About the Fundamentals of Radiology

THINKING SKILLS ADDRESSED: Generating ideas; categorizing information; reliable/unreliable sources of information

OUTLINE OF METHODS & CONTENT:

1. Brainstorm exercise: what we know; what we think we know; what we need to know about radiology
2. Categorize or group items in lists
3. Discuss how to go about finding answers to list of unknowns (reliable vs. unreliable sources)
4. Consider list of "knowns" - initiate questions pertaining to knowing something (i.e., "how do you know that?"; "what does knowing mean?"; "if you read something in a text, do you always believe it?" "why?", etc.)
5. Lead into discussion of how we think. Use initial exercise as an example of thinking skills. Intent of course to develop thinking skills; be aware of how to think about and approach problems.

6. Course format and requirements (regular writing assignments; term paper; experiment with results written up or presented in a table clinic; final essay exam.)
7. Present problem (one in which the problem statement is not obvious, requiring student to define problem; and that will require gathering of information that focuses on content of reading assignment). Ask students to think for five minutes; write for five minutes about how they would approach solving the problem

ASSIGNMENT: 1. Read chapters 1, 2, 3, 4 in text

2. Solve the problem discussed above. Write a one-page paper on how you arrived at solution

RATIONALE: The brainstorming exercise is intended to stimulate student participation. The generation of ideas, followed by categorizing those ideas and identifying reliable sources of information involves the students' thinking. Discussion of these thinking skills will raise the processes to a conscious level in the students' minds.

The problem given in class and assigned as homework is to initiate the students' thinking about identifying, defining problems, and how to

approach problem solving. The problem will be designed to require research on the subject of properties and/or production of radiation to provide an inquiry set for the reading assignment. The writing of the process will provide me (the teacher) with a means of assessing how each student arrived at her/his solution.

CLASS TWO

TOPIC: Properties and production of x-radiation

THINKING SKILLS ADDRESSED: Problem solving; comparing/contrasting; inference; reliable/unreliable sources of information

OUTLINE OF METHODS & CONTENT:

1. Discussion of writing assignment: solutions to problem and how they were arrived at
2. Introduce vocabulary and concepts of problem solving strategies: hypothesizing; gathering data/information; testing hypotheses; analyzing results. Question, "Did they use any of these skills in assignment; would they have helped?"
3. Show two films on radiation (what it is; how it is used; dangers of) made in different years (1968 and 1982)

4. After each film, students will think and write for ten minutes on what they believe to be the main points and message of each film.
5. Short discussion will follow the second writing about the differences in the films and why -- one is more recent (why should that make a difference?) What was inferred by each film?

ASSIGNMENT: Write a short paper (2 - 3 pages) comparing and contrasting the two films. Discuss how two films about the same subject could be so different. Include underlying inferences and/or points of view of film makers. Think of how you will decide which is the more reliable source of information and defend your reason(s).

Read chapters 7 and 8 in text.

RATIONALE: Introduction of problem-solving strategies takes place after students have struggled with solving a problem (homework assignment) on their own. The strategies will come out of a comparison and contrast of how students approached the problem.

Showing two films (movies) about the same subject with very different messages is intended to stimulate a deeper investigation of the inferences made by the films and the discrepancies in reliability of information sources.

The writing assignment is to offer the students

a chance to understand how and why they believe what they do. The writing will also provide a means for me (the teacher) to identify how the students choose a source and whether they will investigate more sources to confirm conflicting information.

CLASS THREE

TOPIC: Darkroom and Processing

THINKING SKILLS ADDRESSED: relevant/irrelevant; argument

OUTLINE OF METHODS AND CONTENT:

1. Introductory discussion of relevant and irrelevant information. What sorts of situations call for this kind of thinking? Ask for examples.
2. Pass out handout from Mass. Radiation Control Program on darkrooms and darkroom equipment.
3. Break into 4 - 5 small groups. Each group is asked to evaluate the recommended darkroom design, deciding which components are relevant (essential) and which are irrelevant (non-essential). When the group members come to a decision about this, they are instructed to build an argument defending their opinion.
4. Class reconvenes and each group presents its argument to the class.

5. Discussion will follow about the elements of argument and what makes one argument better than another.

ASSIGNMENT: Each student is assigned to evaluate a darkroom (at work or at school), based on what he/she considers to be essential design characteristics and necessary equipment. A 1 - 2 page paper should be written to defend their evaluation. Read chapter 10.

RATIONALE: The exercise in determining which darkroom "requirements" are essential and which are not is a concrete way to introduce and discuss relevance and irrelevance of elements to an issue.

The exercise to build an argument defending their opinions is a way to initiate and define their reasoning abilities. A discussion following will allow an opportunity to introduce what good reasoning is and some common fallacies that exist.

The homework assignment is an opportunity to apply some of the knowledge gained from class and another chance to argue a point of view.

CLASS FOUR

TOPIC: Radiodontic Pitfalls: Processing & Handling

THINKING SKILLS ADDRESSED: cause & effect relationships; hypothesis formation, and testing

OUTLINE OF METHODS AND CONTENT:

1. Introductory discussion of cause and effect relationships -- come to an agreed upon definition with which to work
2. Question and answer period about reading assignment for class; film; composition; latent image; processing
3. Have students list all the factors "causes" (over which they have some control) that could effect the image on a radiograph
4. Categorize factors; break class into groups - each group chooses a category of "causes"
5. Each group will hypothesize about how its cause will effect a radiograph and will design an experiment to test its hypothesis

ASSIGNMENT: Before the next class students will work out their experiments to determine the effects of their "cause." Read Kodak's Radiodontic Pitfalls booklet.

RATIONALE: Using their knowledge of film composition, latent image, and processing procedures the students will generate ideas and develop a

reasoned hypothesis about what effect a certain factor will have on a finished radiograph. The identification of cause and effect relationships will facilitate their designing a means for testing an hypothesis. The assignment of actually testing their hypothesis through experimentation allows them to follow an idea through to a conclusion.

CLASS FIVE

TOPIC: Radiodontic Pitfalls: Exposure; Controlling Film Quality

THINKING SKILLS ADDRESSED: cause & effect; analysis of results; application of knowledge

OUTLINE OF METHODS AND CONTENT:

1. Each group (from week before) asked to present the results and analysis of its experiment. All results (effects) will be listed on board.
2. The class will work together to analyze the results.
3. Discussion will lead into the concept of causal over determination (many factors can cause the same effect). Introduce questions about how one would determine which cause yielded a particular effect.
4. Distribute individual dental radiographs to each student. Students will be asked to identify an

error in the film, list all the possible causes of that error, and deduce what actually caused that error. If vital information for determining the cause is missing, indicate what that information is and how to find it. This exercise will be written during class time.

5. Discussion of chain causes and effects and multiple causal condition. Ask students to come up with examples for each.
6. Knowledge of why A caused B helps to determine the certainty or probability that B will occur. How can we use our knowledge of how various factors effect films to control the quality of finished radiograph? Discussion and ideas.
7. Introduce mathematical formulae for altering certain "causes" to achieve a desired "effect." Work through a couple of examples.

ASSIGNMENT: Read chapters 11 and 12 in text.

Image Quality Control Worksheet providing problem situations requiring alterations in kVp; mA; or exposure time.

RATIONALE: By introduction of more complicated cause and effect relationships, the student is required to question and analyze available and unavailable information; and through deductive reasoning,

arrive at an answer.

In addition to aiding the student in identification and correction of exposure technique, knowledge of why A causes B and the certainty that B will occur gives them confidence in the fact that they can control the final image on their radiographs. The assignment of problem situations to solve forces them to work through various problem-solving strategies again. We will not go over answers to problems until they ask for them.

CLASS SIX

TOPIC: Intraoral Radiographic Technique (Shadow Casting)

THINKING SKILLS ADDRESSED: problem solving; comparing/contrasting

OUTLINE OF METHODS AND CONTENT:

1. Discussion of problem-solving strategies used in class and class assignments. In this class we want to work through a problem together, clarifying various components of solving a problem.
2. Information or fact finding: from reading assignment and experiences in radiology lab students will draw together (put on board) all the data that relates x-ray taking to shadow casting.

3. Identify the problem: Ask students to "find" problems with radiographic technique that are relevant to shadow casting. List them all on board, identify what the major problem is, and redefine it.

4. Idea finding & Hypothesis Formation: Using a screen, object and light source work with shadow casting principles to gather information pertinent to forming an hypothesis

5. Test hypothesis for (improved techniques) with x-ray film, tooth, and x-ray

6. Draw conclusions about experiment and apply to standard procedures to analyze data and practicality of new method for taking intraoral films.

ASSIGNMENT: Write up a 2 - 3 page report describing today's class. Include procedures involved in problem solving, and outcome of experiment. Support new method or theory with relevant data. Read chapter 5.

Term paper due next week.

RATIONALE: We have been using various aspects of problem solving procedures throughout the course. I wanted to provide one opportunity (example) for the class to work together through a problem situation from beginning to end.

The writing assignment will help me (the teacher) to recognize strong and weak areas in the students' conception of problem solving.

CLASS SEVEN

TOPIC: none in particular

THINKING SKILLS TO BE ADDRESSED: questioning

OUTLINE OF METHODS AND CONTENT:

1. Discuss last week's writing assignment. Relate composing a paper to the steps in solving a problem.
2. Questioning; idea generation session. Open discussion of specific questions and ideas students have about topics that have been covered to date.
3. I (the teacher) will give no direct answer. Instead students will be asked to explore their questions and find answers through research and/or experimentation. This will be their ongoing project for the second half of the semester, to be presented on the last class day. Students may work in small groups on one project.
4. Hand in term paper which was assigned at first class.

ASSIGNMENT: Written progress report on proposed project to be drafted and submitted by the next week.

Read two articles about effects of radiation.

RATIONALE: No mid-semester exam given, rather I wanted to use the available time to bring out questions and, through students' inquiry, provide a means for finding the answers.

The analogy between writing composition and problem solving is intended to help them write better papers. (They will be doing rewriting on term paper handed in today.) Also, using this format for composing papers will reinforce a systematized method for approaching problem situations.

CLASS EIGHT

TOPIC: Biological effects of radiation

THINKING SKILLS ADDRESSED: detecting underlying inferences; comparing/contrasting information; assessing validity

OUTLINE OF METHODS AND CONTENT:

1. Discussion of two articles assigned to be read for this class. What are the facts? Any contradictions? How do the articles compare? Can we determine underlying inference or opinion of either author? What is source of article? What is author's motivation for writing article?

2. Students to create their own argument on the subject and defend it, using relevant facts to support their observations (during class).
3. Discuss ideas and questions that arise in these exercises.
4. Break class into three groups. One group will be assigned to defend the statement, "Biological damage from dental x-rays is equivalent to being in the sun for a day." The second group will be assigned to rebut the statement.
5. After gathering information, building a logical argument and planning strategies, the issue will be debated.
6. The third group will be the judges, who will consider both arguments and decide which argument is valid. They (the third group) will be asked to explain their reasons for their decision.

ASSIGNMENT: Read chapter 6 in text.

Each student will compose a list of questions he/she would ask a dentist during a job interview about the safety measures employed in the office. Explain why these questions are relevant to safety.

RATIONALE: Given two articles about the dangers of x-radiation which give the same "facts" but offer a completely different point of view, the students need

to read between the lines to determine what is being inferred, consider the sources and motivation of author. In an effort to prevent themselves from being manipulated by inference, the students are asked to extract the facts and compose their own argument, sorting out fact from opinion.

The debating exercise provides another opportunity to take a viewpoint and try to build an argument to defend that view. The issue of how decisions are made is introduced in the final judgement.

CLASS NINE

TOPIC: Safety

THINKING SKILLS ADDRESSED: decision making; judgements; questioning authority

OUTLINE OF METHODS AND CONTENT:

1. Discussion of homework assignment: what questions would they ask a dentist and why?
2. When does a patient need an x-ray taken? Discussion of time interval vs. oral exam; guidelines of National Council on Radiation Protection. How does one make a decision on how much radiation is acceptable; whether the benefit of the x-ray outweighs the risk, etc.

3. Evaluate the guidelines for maximum permissable dose set forth by the National Council on Radiation Protection. Put each guideline on board and open discussion about its value as a safety guideline. Should there be laws; how could they be enforced? Would you like to see changes made in guidelines? If so, what?

4. Draft a letter together to NCRP recommending changes with reasons for these changes. Begin by putting major points on board and developing argument for each. Evaluate the arguments for validity.

ASSIGNMENT: Read chapter 19 in text.

Research the subject of advances of and/or alternatives to dental radiology. Write a short 2 - 3 page paper discussing the information you find.

RATIONALE: The assignment to formulate questions is to insure that the students cover the textual material on safety precautions available, and to introduce the idea that it is possible that not all offices employ all precautions.

Decision making is addressed every time an x-ray is to be taken. Given the knowledge of dental treatment and of the hazards of radiation, the student needs to weigh the benefit and risk and

make a dicision.

The homework assignment infers that science is always changing. If x-rays are hazardous, then we should be searching for newer and safer ways to provide the information we need.

CLASS TEN

TOPIC: Patient Management

THINKING SKILLS ADDRESSED: Problem solving - identifying problem; sort relevant/irrelevant information; questioning authority

OUTLINE OF METHODS & CONTENT:

1. Case #1. Consider this situation: a new patient arrives at your office for a scheduled cleaning appointment. He has not been to a dentist in fifteen years. His medical history shows no complicating factors, so you proceed with an oral exam and treatment planning. Your oral examination of the patient reveals generalized 4 - 5 mm pocketing, with isolated areas of 6 - 8 mm's; gingival tissue is inflamed and edematous. You decide a full mouth series of radiographs is indicated for a complete assessment of the patient's oral condition. When you mention the x-rays to the patient, he flatly refuses them.

How will you handle this situation? Be explicit. State all your underlying assumptions and reasons for your response.

The students will spend fifteen minutes thinking about the problem and writing their responses. We will then discuss the problem and responses as a class.

2. Case #2. Consider this situation: a woman arrives for a scheduled full mouth x-ray series prescribed by the dentist (your employer). Upon reviewing her medical history, you find she has responded positively to the following questions: she has been hospitalized within the past two years for surgery; she has arthritis; she is allergic to sulfa drugs; and she has undergone some form of radiation treatment.

   What questions arise in your mind? How would you proceed with this patient?

   Students will think and write independently for fifteen minutes. Class discussion of situation will follow.

3. Case #3. Consider this situation: your patient is scheduled to have his third molars extracted the next day. You have just cleaned his teeth and are about to take periapical radiographs of each tooth for the next day's surgery. When you place

the first film behind the third molar in the soft palate area, the patient's gag reflex is initiated. This patient's reflex is so strong and uncontrollable that each time you replace the film in his mouth the film is pushed out of place. The patient is very uncomfortable.

How are you going to get a radiograph of these third molars that will be required for the patient's scheduled surgery?

Students will think and write for fifteen minutes. Class discussion will follow.

4. Case #4. Consider this situation: you saw Mrs. Jones a week ago for a cleaning appointment. You detected three small caries and schedule her to see the dentist for restorative work. You decided at that appointment not to take any x-rays because Mrs. Jones is pregnant. Mrs. Jones is back in your chair today because the dentist said he could not know if there were cavities between the teeth without BW x-rays. He told Mrs. Jones that you would put a lead apron over her so that she would not be harmed by the x-rays. Mrs. Jones is concerned and is questioning you about the danger to her unborn child.

   What will you tell Mrs. Jones; and how would you

respond to this situation?

Students will work independently for fifteen minutes, followed by class discussion.

ASSIGNMENT: Read chapter 9 in text.

Observe and study pp. 2 - 95 in Kasle Atlas

RATIONALE: The problem case situations are designed to present an obstacle for the students. The student needs to apply various problem-solving strategies to overcome the hurdles. Case #1 will require the students to identify the problem and build a logical argument using their knowledge of radiation. In case #2 the student must sort the relevant from the irrelevant information from the medical history, question the authority of the dentist who prescribed x-rays for this patient, and apply his/her knowledge of biological cumulative effects of radiation to this situation. Case #3 calls for a creative approach. The student should try to generate as many ideas about how to take the x-rays as he/she can. Inventing a new method or technique could be a route to the end. The student should consider the "cause" of the "effect" when considering alternatives. Case #4 presents an ethical issue. The student needs to differentiate fact from opinion, question authority and make a judge-

ment about what is right for this patient.

CLASS ELEVEN

TOPIC: Anatomical Landmarks

THINKING SKILLS ADDRESSED: observation/perception; application of knowledge

OUTLINE OF METHODS AND CONTENT:

1. Divide class into 5 - 6 groups. Distribute one full mouth series of radiographs and a view box to each group. Students are asked to study the films, listing and describing what they see.
2. Distribute an anatomical human skull to each group. Ask the students to use the skulls to identify their observations. Emphasize comparing, contrasting, generalizing whether a structure should appear radiolucent or radiopaque.
3. Using worksheets, have students indicate which anatomy will appear in which periapical film.
4. Class discussion of normal anatomy while viewing various slides of radiographs together. Questioning: What do you see? Is it radiopaque or radiolucent? Why?, etc.
5. Individual exercise in mounting films. Each student will be given a FMX of radiographs of a patient, plus one extra film from some other patient.

They will be asked to mount the films according to the anatomical landmarks and determine which film does not belong to this patient.

ASSIGNMENT: Study Kasle Atlas, pp. 1 - 100. Continue to work on experiment and rewritten term paper due next week.

RATIONALE: The focus of this lesson is on observation and being explicit in a description of what is observed. A discussion will consider what difference knowledge makes on one's perceptions. The use of previous knowledge will also be required for reasoned theorizing about why an area appears radiopaque or radiolucent. The exercise of mounting is a problem-solving situation which requires acute observation and perception to discover which film does not belong.

CLASS TWELVE

TOPIC: Interpretation of Dental Radiographs

THINKING SKILLS ADDRESSED: inference; comparing/contrasting

OUTLINE OF METHODS AND CONTENT:

1. Begin class with a discussion of inference: what it is; when it is used, etc.

2. Distribute a full mouth x-ray series of a patient to each student. Ask the students to study the radiographs and write down everything they can infer about this patient from the films alone.
3. Class discussion of the above exercise: how were the inferences reached, and what was the reasoning involved?
4. Show slides of radiographs on various oral disease and/or conditions, with class discussion: normal vs. abnormal findings on radiographs.
5. Students will work in small groups on an exercise with a patient's FMX and case history - (students will have brought a case and FMX from a clinic patient). Group members will work together to study case and FMX, and then design a treatment plan for the patient.
6. Discussion: How did you reach your decision for a treatment plan? On what information did you base your decisions? What inferences were important?

ASSIGNMENT: Read chapter 17 in text

Read pp. 103 - 144 in Kasle Atlas

Write five - ten questions (interview; fact finding) to ask the panel of experts next week.

RATIONALE: The discussion and the exercises using inference are intended to bring this thinking

skill to a conscious level in the students. By being aware that they are inferring and how that inference was reached, they will be able to ask themselves if the evidence supports their inference. Studying various radiographic slides of abnormal conditions allows students to compare and contrast with normal radiographic landmarks (studied last week).

The development of a patient treatment plan based on case histories and radiographs provides another problem-solving situation for students. In treatment planning, they are analyzing data, developing a reasoned hypothesis and applying their knowledge to a given situation.

CLASS THIRTEEN

TOPIC: Extra-oral Radiographic Techniques

THINKING SKILLS ADDRESSED: inquiry; questioning skills

OUTLINE OF METHODS AND CONTENT:

1. Panel of experts (specialists in the fields of orthodontics, oral surgery, maxillo-facial reconstruction) invited to make a brief presentation of their work and how the use of extraoral radiographs fit into case studies (have been asked to bring examples of radiographs).

2. Following each presentation, students will ask questions of the panelists (some of which have been thought out earlier) to gather additional information about extra-oral radiographs.
3. After the guests have left, there will be a class discussion about inquiry and questioning. We will try to evaluate the questions asked: what kinds of questions revealed the most interesting discoveries; how specific did a question need to be to elicit the desired information.
4. List types of questions on board.
5. Categorize the types of questions according to the information they elicit.

ASSIGNMENT: Choose some aspect of today's presentation and research it more fully.

Write a 2 - 3 page paper about the subject -- due next week.

Read chapter 14 in text.

RATIONALE: The procedures used in this class are for the improvement of questioning skills. The assignment encourages an inquiry mode of learning. Through research and writing, the student follows an idea or interest through on his/her own -- an attribute of an independent learner.

CLASS FOURTEEN

TOPIC: Localization Techniques; Duplicating Radiographs

THINKING SKILLS ADDRESSED: problem solving; developing a reasoned hypothesis; inventing

OUTLINE OF METHODS AND CONTENT:

1. Students will work in small groups. They will be given a problem situation that requires them to design some type of localization technique. They should work together to define the problem, develop a reasoned hypothesis and a means for testing their hypothesis. PROBLEM: A dental hygienist is working with a patient, scaling his teeth. During the procedure, the tip of the instrument breaks off and becomes lodged in the patient's gingival tissue. How could you use your knowledge of radiographic technique to localize the metal piece so that it may be removed surgically?
2. Once the students have developed an hypothesis and a test for the hypothesis, they may go to the x-ray lab, if necessary, to perform any experimentation indicated.
3. Students will report their techniques for localization procedure. We shall discuss these and compare them to conventional localization procedures.

4. Students again break into groups for another problem-solving exercise. PROBLEM: You are working in a dental practice. The patient you have just taken a FMX series on is seeing his periodontist tomorrow. The periodontist needs a copy of the radiographs. The dentist you work for has a policy <u>never</u> to allow the original radiographs out of his office. You proceed to duplicate the films and find the automatic duplicator is broken! Can you devise a means for duplicating these films without the automatic machinery? What do you need to know? What materials would you need?
5. Class discussion of the various duplicating inventions. Are the suggestions reasonable hypotheses? Can they be tested?

<u>ASSIGNMENT</u>: Each group will test its hypothesis for duplicating films without automatic duplicator. Each student should be prepared to present the results of his/her independent experiment that he/she has been working on since mid-semester.

<u>RATIONALE</u>: Another attempt to develop problem-solving strategies through case situations. To find a solution to these problems, the student must generate ideas, collect information, analyze the information, form and test an hypothesis.

CLASS FIFTEEN

TOPIC: Presentation of Experiments

THINKING SKILLS ADDRESSED: Inquiry; argument

OUTLINE OF METHODS AND CONTENT:

1. No set lesson for today. Each student will describe and discuss his/her experiment which he/she has been working on independently since mid-semester.
2. Class members may question after each presentation.
3. Roundtable discussion: informal evaluation -- what do the students feel they learned from this course -- open comments.

ASSIGNMENT: Discussion of final essay exam.

RATIONALE: A chance for students to present and defend an argument (their experiment with results) and for the students to share one another's ideas through inquiry. The roundtable discussion of the course is a deliberate attempt to end the course the way we began it: -- with thinking about thinking.