DOCUMENT RESUME

ED 267 906 PS 015 704

AUTHOR Marzano, Robert J.
TITLE Integrated Instruction in Thinking Skills, Learning Strategies, Traditional Content and Basic Beliefs: A Necessary Unity.
INSTITUTION Mid-Continent Regional Educational Lab., Aurora, CO.
SPONS AGENCY Department of Education, Washington, DC.
PUB DATE Jun 85
CONTRACT 400-83-0004
NOTE 39p.
PUB TYPE Viewpoints (120)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Beliefs; *Cognitive Processes; Curriculum; Elementary Secondary Education; Epistemology; *Holistic Approach; *Instruction; *Metacognition; Models; Perception
IDENTIFIERS Anderson (John); *Learning to Learn; *Thinking Skills

ABSTRACT

The purpose of this paper is to describe a framework in which thinking skills instruction and other needed instructional emphases can be integrated into a unified whole. Discussion focuses on John Anderson's unitary model of cognition (1983), learning-to-learn, the nature of traditional curriculum content, thinking skills such as storage and retrieval, matching, and execution, and basic beliefs, or epistemic thoughts, which control broad categories of human behavior. The major implication of the model is that the present conceptualization of the acts of teaching and learning should be expanded far beyond the domain of content area knowledge. Specifically, the components of the teaching/learning process should include (1) learning-to-learn strategies, (2) a new approach to content which emphasizes basic concepts and organizational patterns of declarative knowledge and the developmental nature of procedural knowledge, (3) basic reasoning skills in the areas of storage and retrieval, matching, and execution, and (4) basic beliefs which are high level controlling principles. These beliefs include the notion that perceptions are subjective and generated from a specific point of view and that one's point of view is controllable and can be changed. An eight-page list of references concludes the document. (RH)

ED267906

INTEGRATED INSTRUCTION IN THINKING SKILLS, LEARNING STRATEGIES, TRADITIONAL CONTENT AND BASIC BELIEFS: A NECESSARY UNITY

by

Robert J. Marzano
Mid-continent Regional Educational Laboratory
Denver, Colorado

June, 1985

PS 015704

"The work upon which publication is based was performed pursuant to Contract No. 400-83-0004 of the the National Institute of Education. It does not, however, necessarily reflect the views of that Agency."

INTRODUCTION

The need for direct instruction in thinking is evidenced from many quarters including national reports on excellence (eg. A Nation at Risk, 1983), policy makin~ o~ganizations (eg. the Education Commission of the States, 1982) and theo on intelligence (eg. Sternberg, 1983). Yet Bereiter (1984) warns that unless thinking skills instruction is integrated with more divergent goals and practices, it runs the risk of "going the way of all frills." In other words, if viewed as another "add on" to the curriculum thinking skills instruction will have little lasting effect on education. In fac: one might interpret the back to the basics movement within education as a reaction against the splintering effects of different educational programs. For example, Block (1985) asserts that the creation of discrete programs for select groups and select types of learning (eg. gifted and talented, learning styles programs, brain lateralization programs) might have the effect of reinforcing an anti-egalitarian form of education. This is not to say that the intent of such programs is not useful or needed within education. It is to say that labelling them as separate programs might have the negative effect of creating artificial and harmful distinctions. As Condon (1968) says, when we impose a label on a phenomenon we create a reality that previously did not exist: "For better or for worse, when names are learned we see what we had not seen ..." (p. 31)

What appears needed is some framework in which thinking skills instruction along with other needed instructional emphases can be integrated into a unified whole. The purpose of this paper is to describe such a framework -- one which can incorporate many of the areas recommended by curriculum theorists and can meet the mandate by Sternberg (1984) that instruction in reasoning and thinking be based on sound cognitive theory. Specifically the model presented here incorporates instruction in learning-to-learn skills, thinking skills, traditional content and basic beliefs. These areas are consistent with those elements of the total curriculum suggested by Tyler (1975) and Gow and Casey (1983). The model is based on a unitary theory of cognition described by John Anderson (1983). We will first consider the rudiments of that model and then its application to instruction.

A UNITARY MODEL OF COGNITION

Developing a model which incorporates seemingly different curricular goals implies a unitary theory of cognition and behavior. That is, the different skill areas mentioned above could be validly included in a single framework only if there is some underlying "sameness" to human cognition and behavior. Theories of cognition and behavior which posit a single underlying process are called unitary. A unitary approach has been the bases for information processing models explaining such constructs as problem solving (Newell and Simon, 1972), inference (Lehnert, 1978) and general schema systems (Bobrow & Winograd, 1977; Minsky, 1975; Schank & Abelson, 1977). Perhaps the most comprehensive unitary model is that developed by Anderson (1983): "The most deeply rooted preconceptions guiding my theorizing is a belief in the unity of human cognition, that all higher cognitive processes, such as memory, language, problem solving, imagery, deduction and induction are different manifestations of the same underlying systems" (p.1) It should be noted here that this position is not universally held among theorists in cognition. Anderson cites Chomsky (1980) as one of the major spokesman for the pluralistic view of mental abilities: "...there seems little reason to insist that the brain is unique in the biological world, in that it is unstructured and undifferentiated, developing on the basis of uniform principles of growth or learning --say those of some learning theory or some yet-to-be conceived general-purpose learning strategy --that are common to all domains." Recent years have seen a popularization of the pluralistic view of mental abilities. For example, Gardner (1983) posits at least seven different types of intelligence. In a similar vein the educational interpretation of brain lateralization research (eg. Hart, 1983; Zdenek, 1983) and the learning styles movement within education (eg. Kolb, Rubin & McIntyre, 1974; Gregoric, 1979; Letteri 1982; Dunn and Dunn, 1978) have added to the popular belief that cognitive abilities are distinct, independent constructs.

It appears that the main criticisim of unitary theories is that they do not account for wide differences in abilility within individuals. That is, it would seem that a unitary model could not explain why most individuals are adept at some tasks and inept at others. Regardless of this outward appearance, unitary theories do in fact explain individual variance in behavior and ability. As Anderson (1983) says: "This is not to deny that there are many powerful special-purpose 'peripheral' systems ... However, behind these lies a common cognitive system for higher-level processing." (p.1)

Anderson suggests that human beings are continuously involved in two basic activities: 1) recognizing information from the outside world and 2) acting on that recognized information. A useful metaphor is that human beings are continuously asking and answering the questions "What is it?" and "What should I do about it?" (Rigney, 1980) These two questions map well onto two basic types of information in long-term memory: declarative and procedural.

Declarative memory contains factual knowledge about the world. As Sywlester (1985) puts it, declarative memory contains the who/what/where/when and why facts about the world. Procedural memory contains information about processes -- how to do things. For example, a sailor would know such declarative information as the names of various parts of a boat and the characteristics of certain types of storms. She would also know such procedural information as how to raise a sail and how to tack. According to Anderson (1983) procedural knowledge can be described as mental programs stored in if/then formats called productions. To use a simplistic example assume that an individual has a program like that below:

IF: 1) it is snowing and
2) the time is before 9:00 a.m. and
3) the snow accumulation is more than three inches;

THEN: I must shovel the driveway.

Technically the <u>if</u> part of the program is called the antecedent condition; the <u>then</u> part of the program is called the consequent action. If the individual wakes in the morning and finds antecedent conditions 1, 2, and 3 met, then s/he will engage in the consequent action--shoveling the driveway. This "production theory" model of procedural knowledge implies that: 1) procedural memory is built from declaration memory and 2) using procedural memory involves not only knowing a process but also when to use the process. Relative to the first implication, if an individual did not kn such basic concepts as <u>snow</u>, <u>shovel</u> and <u>driveway</u> s/he would not be able to use the production. As Sywlester (1985) says "mastery of a procedure or skill often begins at the declarative memory level" (p. 71). This assertion is also consistent with research findings about learning classroom content--

namely that without the factual knowledge relative to the content, students have little success in acquiring the more complex procedures within the content area (Heller & Reif, 1984; Larkin, 1981; Anderson, 1982). Relative to the second implication, the process the individual must know is shoveling snow. In addition, the individual must know the conditions (antecedent conditions) under which the process is to be used. Thus, if the individual knew how to shovel snow but did not know when to shovel snow his/her process knowledge would be useless. Glasser (1981) calls these antecedent conditions "comparison stations." Using a cybernetically based model he asserts that comparison stations are central to human behavior. We are always looking for or "controlling for" antecedent conditions. When we recognize information (answer the question "What is it?"), we immediately check to see if this information matches some set of antecedent conditions. (We ask the question "What do I do about it?") If there is a match, we engage in some process (the consequent action).

This cycle of recognizing information--looking for a match--executing some process, is applied over and over at an unconscious level. Powers (1973) claims that this cycle explains such micro-processess as cellular activities and such macro-processes as moral judgements. However, theory indicates that in terms of cognitive behavior this cycle exists within a larger cycle. That larger cycle includes attention focusing, goal setting, epistemic thinking, and task monitoring. We will briefly consider each part of that larger cycle.[1]

Both Glasser (1981) and Powers (1973) assert that individuals possess thousands of comparison stations. Yet, classic experiments in psychology (Norman, 1969) indicate that working memory has limited capacity. This indicates that there must be some selection at any point in time as to which stations to control for. That is, we must engage in the process of activating some stations--setting them to a ready state--and deactivating others. This process is called attending. There are two basic types of attention: automatic and voluntary (Luria, 1973). Automatic attention is reflexive in nature--a reaction to stimuli; voluntary attention is under conscious control. In other words, we are either consciously controlling what we are attending to or reacting unconsciously to salient stimuli. When we attend to a new set of stimuli we activate a new set of comparison stations. For example, while driving at night you might voluntarily turn your attention to the stars. At that point a new set of comparison stations is set to a ready state. You begin to notice things about the sky of which you were previously unaware.

At any pont in time the number of comparison stations which are set to a ready state can be narrowed by setting a goal. Anderson makes the distinction between data driven and goal driven behaviors. When a goal is introduced into the cycle those comparison stations which relate specifically to the goal are given a high state of readiness--a high potential for activation. The potential for other comparison stations is dampened. Goal setting, then, decreases even further the number of possible comparison stations that can be activated. Neisser (1967) calls this a controlled state; Lindsay and Norman (1977) call it a conscious state. Everything becomes more streamlined because there are fewer options to consider.

It is at this point that epistemic thinking becomes a factor. Epistemic thoughts are those that form the basis of ones reality. McCombs (1984) asserts that this type of thinking is the driving force behind goal driven behavior. To illustrate epistemic thoughts consider some basic elements of attribution theory. Weiner (1972) states that an individual's beliefs (epistemic thoughts) about whether success on a task is dependent on his/her effort versus his/her ability influences the individual's motivation for the task and the probability that the individual will engage in future similar tasks. More specifically, if an individual feels that effort is the key ingredient in success then s/he is more likely to be motivated and engage in future similar tasks. However, if the individual feels that ability is the key ingredient in success then s/he will be less motivated and less apt to engage in future tasks. In other words, a useful epistemic belief is that sustained effort will eventually lead to success. Other epistemic thoughts which seem important to goal accomplishment include a sense of control (Harter, 1983), a sence of value for the goal (Frieze, Francis & Hanusa, 1983) and a commitment to precision (Whimbey, 1980).

Once an individual actually engages in a task--sets out to accomplish a goal--the process becomes cybernetic. That is the individuals uses the goal as a means of changing and correcting behavior much as a guided missle changes direction and speed (corrects it behavior) based on the information it receives relative to its approaching target. Key to this phase of the cycle is a sensitivity to feedback (being aware of available information) and self evaluation (determining whether the available information indicates that the task is going well or poorly.) (McCombs, 1984)

The outer cycle, then, includes voluntary attention, setting goals, monitoring epistemic thoughts and finally monitoring how well the task is going. This outer cycle combined with the inner cycle describes a general process which applies to many academic and nonacademic tasks. This two-cycle model of human behavior can be used as a framework to house instruction in learning-to-learn skills, traditional content, thinking skills and basic beliefs. We consider each of these areas below.

LEARNING-TO-LEARN

It is the conscious control of the outer cycle which constitutes what I am calling learning-to-learn skills. It appears that many of those individuals considered successful in today's technological society are aware of the outer cycle. For example, Peters and Waterman (1982) cite numerous examples of top executives consciously using goal setting behaviors and training themselves to be sensitive to feedback. Similarly there are many very powerful training programs within business (eg. Tiece, 1976) which use adaptations of the outer cycle as described here. However, within mainstream public education few components are systematically taught even though there has been a long-standing mandate from the research community that such metacognitive awarenesses should be a formal part of the educational process. For example, Weiner (1972) states that achievement enhancing epistemic thoughts (attributions) should be systematically developed in children. Brown, Campione and Day (1981) state that training in these activities has the highest probability of sucess relative to educational objectives; McCombs (1984) asserts that this area holds the promise of unlocking a door for "those students whose deficiences preclude them from enjoying the positive benefits of learning and self-development" (p. 216)

There are two basic approaches to introducing learn-to-learn skills within the classroom. One is to use a learning strategies format in which students are presented with specific algorithms or processes to use in learning situation; the second approach is to introduce different elements of the outer cycle into instruction not as an integrated process but as discrete learning activities. We will consider each briefly.

A learning strategies approach provides students with a broad heuristic or process initially learned as an ordered sequence of steps. Effective learning-to-learn strategies have been developed by many (eg. McCombs, 1984; Jordan & Merrifield, 1981). Using the outer-cycle metaphor presented here an effective learning-to-learn strategy would necessarily include the following components:

- o voluntarily attending to a task
- o stating explicit goals relative to the task
- o monitoring personal beliefs about: 1) control of and responsibility for the task and 2) the need for and utility of intense and extended effort.
- o monitoring feedback to determine how well the task is progressing
- o evaluating what worked and did not work after the task is completed.

During the pilot testing phase of the model presented in this paper teachers were asked to create their own adaptations of a basic learning-to-learn strategy using the elements described above. Figure 1 contains one such teacher-made adaptation for secondary level instruction.

FIGURE 1
Learning-to-learn Strategy

1. Relaxing Phase:
   Students are asked to relax and end whatever previous activity they were engaged in.

2. Awareness Phase:
   Students are asked to notice:

   a. their level of distraction (eg. How much are you attending to thoughts unrelated to this class?)
   b. their attitude toward the class (eg. Do you believe the class is valuable or not valuable? Do you believe the class is interesting or boring?)
   c. their attitude toward working (Are you committed to being involved in the class or do you want to coast?)
   d. their attitude toward their ability (eg. Do you have a sense of power about your ability to perform well in this class or do you have a sense of sinking?)

3. Responsibility Phase:
   Students are asked to:

   a. hold off or "bracket" any thoughts unrelated to class
   b. generate interest and value for the class
   c. commit to being involved and exerting necessary effort
   d. take a stand that they can do well

4. Goal Setting Phase:
   Students are asked to:

   a. set some specific goals for the class.
   b. integrate the teacher's goals with their own.

5. Task Engagement Phase:
   Students are asked to:

   a. be aware of whether they are getting closer to or further away from their stated goals.
   b. make any corrections necessary in thier own behavior or seek help to further the attainment of their goals.

6. Task Completion Phase:
   Students are asked to:

   a. determine if their goals were accomplished
   b. evaluate what worked and what did not work relative to their goal.

The learning-to-learn strategy in Figure 1 was used as an instructional framework for all class activities much as the Hunter (1984) or Rosenshine (1979) models are used as frameworks for instruction. That is, the beginning of class was devoted to phases 1-4. During phase 5 students engaged in normal content activities. Classes ended with phase 6.

The second approach to develop learning-to learn skills is to present isolated elements of the outer cycle. Typical components selected include goal setting, attention training, cognitive restructuring and self-evaluation.

Over forty years ago Sears (1940) found that successful students tended to set explicit goals. More recently Brophy (1982) found that successful students set increasingly more difficult goals. Bandura and Schunk (1981) found that learning goals must be proximal (short-term) rather than distal (long-term) to have an effect on learning and motivation.

Attention training involves creating an awareness on the part of students of when they are and are not attending to a task. Most research in this area has been conducted on impulsive students. For example, Goodman (1977) found that small children could be trained to attend more directly for a longer period of time. Similarly, Egeland (1974) observed that attention training increased student reading performance.

Cognitive restructuring refers to a variety of techniques used to change an individual's self-statements as well as the premises, assumptions and beliefs underlying those self-statements (Meichenbaum, 1977). Commonly cognitive restructuring involves using verbal mediation and affirmations. Verbal mediation is simply talking to oneself about a task. Apparently the act of "languaging" one's thoughts makes them more salient and manageable (Ericsson and Simon, 1979). Affirmations are positive declarative statements meant to replace negative self-beliefs and/or increase the salience of goals. Harmon (1982) believes they should be systematically used in education.

Self-evaluation techniques usually involve monitoring progress toward a goal. Techniques developed by Carno and Mandinach (1983) include selectivity, planning and monitoring. McCombs (1984) states that self-evaluation and regulation skills provide a basic structure for the development of positive self-control.

Whether approached as a set of discrete skills or as an integrated strategy, there appears to be a strong research and theory base to support explicit instruction in generalized learning-to-learn skills as described above. Basically such an emphasis would begin to convey the message to students that they must take an active role in the learning process. Baird and White (1982) contend that only minor improvements will be made in learning outcomes unless there is a fundamental shift from teacher to student responsibility via direct instruction in such metacognitive strategies as those described above.

TRADITIONAL CONTENT

Before discussing how traditional content can be taught within the model we should first consider a definition of content. According to the Beginning Teacher Evaluation Study (Fisher, Filby, Marliave, Cohen, Dishaw, Moore & Berliner, 1978) and supporting studies (Berg, 1980; Rosenshine, 1980) the content of the early grades reflects an emphasis on fundamental procedures in reading and mathematics--the so called basic skills. As students progress through the grades the emphasis shifts to a knowledge of information about such traditional areas as algebra, history, biology and literature. Such knowledge is commonly referred to as "domain specific."

Domain specific knowledge is a well-formed network of valid information in an academic area and strategies for using that information (Doyle, 1983, p. 168). This view of content knowledge is consistent with Anderson's (1983) distinction between declarative and procedural memory. Declarative memory contains the well-formed network of valid information; procedural memory houses the strategies for using declarative information. Teaching traditional content, then, requires instruction in both declarative and procedural knowledge.

Declarative knowledge is fundamentally propositional and hierachial in nature. Propositions are groups of concepts organizaed in such a way as to be true or false. "Thus...'John' is a concept but is not information that can be true or false in nature...where as 'John is ill' would be a proposition because it could be true or false" (van Dijk, 1980, p. 207). There is ample research evidence to show the primacy of propositions in processing information (Bransford & Franks, 1971). That is, we naturally organize information into propositons. They are so basic to the processing of information that we might say they constitute a good operational definition of an idea. The propositions within a content area are organized into larger structures--groups of propositions organized in some systematic way. Much of the current research in information processing has been devoted to identifying those larger structures. Some of the more common organizational structures include macro-structures (Kintsch & van Dijk, 1978), facts (van Dijk, 1980), schema (Rumelhart, 1975) and frames (de Beaugrande, 1980)

Knowing the declarative knowledge within a content area, then, requires a knowledge of the concepts, propositions and large organizational patterns of propositions. This translates into some fairly straight-forward instructional implications. The first implication is that concepts should be systematically taught within content area classrooms. Concepts are elementary particles of thought. Klausmeier and Sipple (1980) state that "concepts provide much of the basic mental materials for thinking. They enable the individual to interpret the phsyical and social world and to make appropriate responses. Without concepts with which to think, human beings like lower form animals would be limited mainly to dealing with sensorimotor perceptual representations of reality that are closely tied to immediate sensory experience" (p.4).

Within education the term "concept" is widely misused to represent a variety of constructs. Here it is used in a fairly rigorous way. A concept is the "socially accepted meaning of one or more words which express the concept" (Klausmeier and Sipple, 1980, p. 78). For example, the word dog is a label society uses to represent the conceptualization of a set of four-legged animals with certain characteristics. We might say that vocabulary knowledge is the outward indication of an individual's store of concepts. It is no wonder, then, that vocabulary knowledge has been cited as one of the strongest predictors of general academic ability. For example, Anderson and Freebody (1981) report that the strong relationship between vocabulary and general intelligence is one of the most robust findings in the history of intelligence testing.

Focusing on concept/vocabulary development as a key component of content area instruction is not a new idea within education. It was Becker's (1977) recommendation after a thorough analysis of the research on the various interventions for the educationally disadvantaged that systematic instruction in the basic concepts as defined by Dupuy (1974) should be an educational priority. There are many theories about how best to teach concepts (see Mezynski, 1983 for a thorough review) and the level of effort that should be devoted to direct instruction (see Nagy & Hermen, 1984). That some level of direct instruction in basic concepts within content area classrooms should occur seems well supported. More specifically, the model described here asserts that teachers should identify those concepts (vocabulary words) that are key to their content area and then systematically teach and reinforce them.

The second implication is that students should be taught to recognize organizational patterns in information they read and hear. It has been shown that the more higher level organizational patterns are made salient in written material, the easier the information is to process and retrieve (Meyer, 1975; Kintsch, 1974; Frederiksen, 1975). Unfortunately most textbooks are not written in a format that makes these organizational patterns obvious to students (Pearson, 1981). Similarly information presented orally in content area classrooms is not organized into salient patterns. For the most part, then, the burden is on the student to create some type of organizational pattern for information read or heard. In fact, studies indicate that better students look for or create patterns as a basic comprehension strategy (Goetz, Palmer & Haensly, 1983); less successful learners do not appear to have this metacognitive awareness. Fortunately, current research also indicates that students can be taught organizational patterns and how to use them as a basic technique for understanding content area material (Taylor & Samuels, 1983; Leslie & Jett-Simpson, 1983). This suggests that the content area teachers should act as guides in helping students see the various ways of organizing information within the content area. Rather than viewed as static data to be learned as presented by the teacher or textbook, content should be viewed as fluid information which can be arranged in many ways to best fit the prior knowledge of the student.

Hawkins (1974) refers to this as "unpacking" the curriculum; Bussis, Chittenden and Amarel (1976) refer to it as accessing the "deep structure" of the curriculum.

Before leaving the discussion of declarative knowledge I should comment on the exclusion of prositions as a unit for instructional focus. As mentioned previously propositions are basic to thinking. The semiotic extension theory asserts that humans are predisposed to organize information into propositions (McNeill, 1975). In other words, organizing information into propositions is so fundamental to thinking that no formal instruction in the nature of propositions is necessary. Research supports this point. For example, Sach (1967) found that while memory for specific aspects of a sentence faded quickly, the memory for the propositional gist of a sentence was remarkably stable. Similar findings have been reported by Pearson (1974-75) and Bransford and Franks (1971).

Procedural knowledge includes knowing a process and when to use the process. Recall Anderson's (1983) description of a production--an information structure which includes a consequent action (a process) and antecedent conditions (when to use the process). Although procedural knowledge is an integral part of content area information, it is frequently overlooked as a subject for direct instruction (Doyle, 1983; Bussis et al, 1976). For example, Beyer (1984) asserts that insufficient instruction in procedural knowledge is a leading factor in the poor performance of many students. The implication is that content area teachers should identify those procedures specific to their content and explicitly teach and reinforce them. For example, a social studies teacher might identify such procedures as map reading or locating information in a reference book. A mathematics teacher might identify procedures for solving specific types of problems.

This is not to say that a content area teacher should identify all procedures within their area or that procedures should be taught in a production format. It is to say that the most important procedures within a content area should be defined and explicitly taught to students. For example, Culler (1980) suggests that there is a specific process to comprehending poetry. He states that in the absence of this knowledge, an individual is almost totally incapable of processing the information presented in a poem.

Research indicates that when learning a procedure an individual will progress through three stages. Fitts (1964) calls the first stage the cognitive stage. At this stage the learner can verbalize the process (describe it if asked) and can perform at least a crude approximation of the procedure. According to Anderson (1983) at this stage it is common to observe verbal meditation, in which the learner rehearses the information required to execute the skill. In the second stage, called the associative stage by Fitts, the performance of the procedure is "smoothed out". At this stage errors in the initial understanding of the procedure are detected and dropped along with the need for verbal rehearsal.

During the third stage, the automomous stage, the procedure is refined. It is at this level that the procedure becomes automatic as described by Laberge and Samuels (1974). That is, the procedure once called on by the learner is automatically executed and takes very little of the available space in working memory.

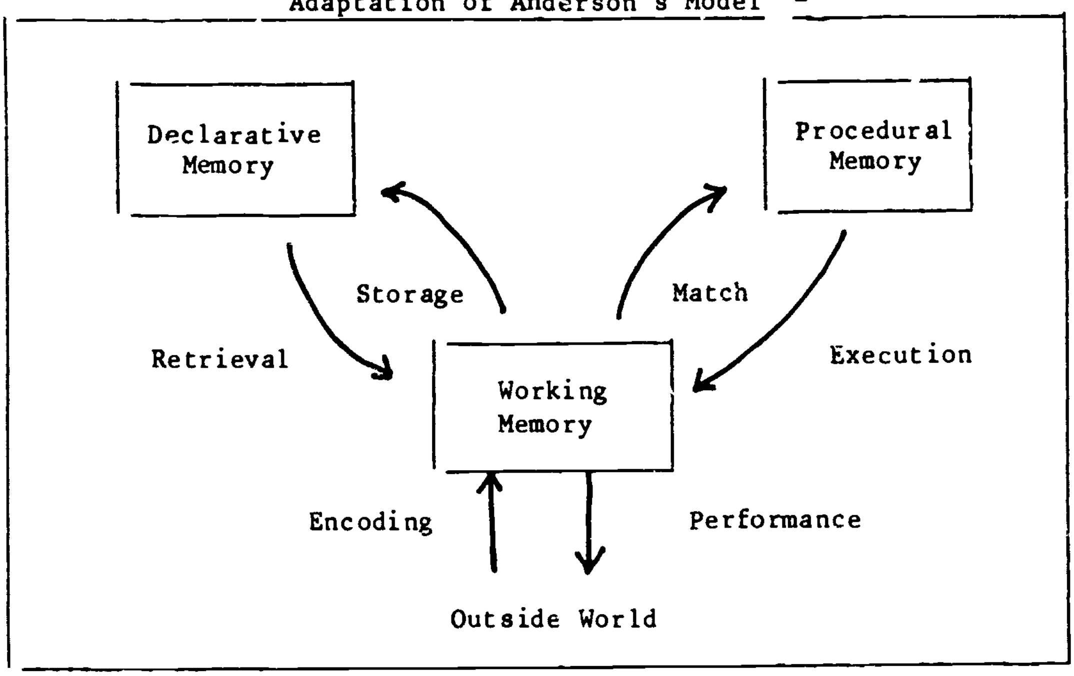
Procedure learning, then, is a long process and would appear to require many of the modeling, guided practice, individual practice and review techniques recommended in the teaching models of Hunter (1984), Rosenshine 1979 and Good, Grouws and and Ebmeir (1983). It would also appear to require far more emphasis within content area classrooms than it is currently receiving.

THINKING SKILLS

Thinking skills as defined in this model are those skills considered basic to cognition of all types yet not explicitly taught and reinforced in public and private education. It is actually a misnomer to refer to them as "thinking skills" since they are no more nor less components of thinking than any other part of this model. However, since they are basic to reasoning and generalize to learning in all content areas, they have been given the name "thinking skills" or "reasoning skills" in many current programs. Here I follow that same convention. To understand these skills consider Figure 2 which contains an adaptation of Anderson's (1983, p.19) model of the basic processes interacting with declarative and procedural memory.

Figure 2

Adaptation of Anderson's Model 2



According to Figure 2 there are four functions which govern the utilization of declarative and procedural knowledge: retrieval, storage, matching and execution. "The storage process deposits permanent records of temporary working-memory information into declarative memory. The retrieval process brings these records back into working--memory. The match process selects productions (procedures) to apply according to the contents in working memory. Finally, the execution process creates new working memory structures through production systems "(Anderson, p.47). We might say that these four processes represent fundamental cognitive abilities. We will consider each briefly. Before doing so, though, I should point out that any attempt to transform a model of cognition into instructional pedagogy is at best a rough translation. Most cognitive models (particularly the one used here) describe cognitive processes at the micro level--a detailed, linear analysis of the process or production being studied. For example, Anderson's model was developed for a computer simulation program called ACT, Adaptive Control of Thought. Clearly, instruction in thinking skills can not occur at the level of specificity used to develop a computer program which simulates human cognition. The procedures or "thinking skills" identified within these categories are more macro-processes. In general all of the processes identified within a category have the same basic goal (eg. storage and retrieval, matching information); however, because they are macro-processes there is some overlap of categories. That is, processes in one category might share characteristics with processes in another category. They are presented here more as an instructional framework rather than as models of cognitive behavior.

1. Storage and Retrieval

Storage and retrieval procedures are combined here because, as far as instruction is concerned, there is a great deal of overlap between them. That is, those instructional procedures which facilitate storage also facilitate retrieval. One type of storage and retrieval technique is "construction." It is simply the process of organizing information for efficient storage in long term memory. In more technical terms construction is the act of organizating information into useful macrostructures. In teaching terminology construction can be considered the process of synthesizing. Van Dijk (1977, 1980) states that there are at least three components to the construction process: 1) identifying general concepts that subsume more specific concepts, 2) deleting information that has been subsumed under more general concepts and 3) inferring unstated generalizations. This process has been translated into a procedure which can be taught to students from the upper primary grades through high school (Marzano, 1985).

A second type of storage and retrieval technique is the use visual-imagery mediatation (the creation of strong mental images). Apparently, visual-imagery mediation is basic to the operation of most memory techniques (Bellezza, 1981; Paivio, 1971). It also appears that people who practice visual-imagery mediation become more proficient at it (Belleza, 1983; Bugalski, 1977). When combined with construction, visual-imagery mediation can be presented to students as a study skill technique.

A third category of storage and retrieval technique might be labeled memory frameworks. Within this category are loci methods (Ross & Lawrence, 1968) and pegword methods (Lindsay and Norman, 1977). Basically memory frameworks create "slots" with which students can associate information.

A common example is the rhyming pegword mnemonic (Miller, et al, 1960) in which the following jingle is first memorized: "One is a bun; two is a shoe; three is a tree; four is a door; five is a hive; six is sticks; seven is heaven; eight is a gate; nine is a line; ten is a hen." A student, then "deposits" information into each of the ten slots using visual-imagery mediation.

Storage and retrieval techniques are most useful in learning content area declarative knowledge. For example, they can be presented to students as study skill techniques especially useful in preparing for tests. Storage and retrieval techniques are also useful in the early stages of learning procedural knowledge. For example, they may be used at the cognitive stage when it is important that students have some verbal description of the procedure.

2. Matching

Matching procedures are those which enable an individual to identify how incoming information is similar to and different from information stored in long-term memory. Within this model there are five types of matching skills: 1) categorization, 2) extrapolation, 3) analogical reasoning, 4) evaluation of logic and 5) evaluation of value.

According to Mervis (1980) categorization is an essential skill because "by categorizing a person is able to render the unfamiliar familiar, and because one is able to generalize about an object based on knowledge about its category, one is able to know more about the object than just what can be ascertained by looking at it." (p. 279) During categorization similar and dissimilar characteristics of concepts are matched. Within classroom instruction categorization is most easily reinforced as a supplemental activity to vocabulary instruction (Marzano, 1984). That is, students can be asked to categorize new vocabulary words as a reinforcement activity.

Extrapolation is the process of matching the pattern of information read or heard with that of information from a different subject area or different context. For example, the process of baking a cake can be extrapolated to the process of making a car; similarly the examples supporting a generalization about World War II can be extrapolated to the examples supporting a generalization about politics. According to Alston (1964) this type of thinking is similar to the basics of metaphor. Arter (1976) has shown that it can be taught successfully even to young children.

Analogical reasoning is one of the most commonly included elements within thinking skills instructional models. According to Alexander (1984) few intellectual skills are as pervasive or as essential as the ability to reason analogically. Within education analogical reasoning has become synonymous with a type of reasoning problem of the Form A: B: C: _____. The working dynamic of such problems is for students to identify the relationship between A and B and then find an element to coincide with C which has a matching relationship to that between A and B. Sternberg (1977) has developed a four step process for teaching analogical reasoning within the classroom.

Evaluation of logic is the process of matching the structure of information with some formalized system of logic. Most commonly the system developed by Toulmin (1958; Toulmin, Rieke and Janik, 1977) is used as the logic criterion. Toulmin's model is easily translated into a system for evaluating the logic of "claims". Students are taught to evaluate the data used to generate the claim, the warrants used to support the claim and the backing used to support the warrants.

Evaluation of value is the process of matching information to some internalized value system and then analyzing the logic of that value system. Spiro (1980) has stated that this "attitudinal" characteristic of thinking is the central aspect of cognition. It allows one to see the information base from which judgments are created. This is akin to what Paul (1984) calls dialectic thinking which, he asserts, is a necessary skill for peaceful coexistence.

Each of the five matching procedures is easily integrated into the existing curriculum since each can be used in conjunction with content area declarative information. For example, a statement (proposition) taken from a social studies text might be used to reinforce evaluation of logic; a pattern found in a science text might be extrapolated to a pattern found in literature; analogies might be created as a way of integrating information from different content areas.

3. Execution

Execution procedures build new cognitive structures or drastically restructure existing information. I should mention here that virtually all procedures mentioned thus far create new knowledge to a certain extent. However, the procedures mentioned here are more singular in that purpose than others within the model. There are three basic execution or knowledge building procedures: 1) elaboration, 2) problem solving and 3) composing.

Elaboration refers to inferring information not explicitly stated in information read or heard. Various categories of inference have been proposed by researchers and theorists (eg. Bruce and Schmidt, 1974; Warren, 1979). Within this model three types of inference are proposed: 1) elaboration of characteristics as defined in the early work of Hull (1920); 2) elaboration of causality as described in attribution theory (Weiner, 1978, 1980) and 3) elaboration of general background as defined in van Dijk's (1980) description of a "fact." For all three types of inference the instructional process is basically the same. Information is selected from content area material and one or more types of elaboration are applied to the information.

Problem solving occurs when an individual must "fill-in" missing information. This is at the core of all problems: a goal is desired and information necessary to accomplish that goal is missing. Without missing information no problem state exists. This missing information might be procedural or declarative in nature. For example, if an individual were trying to bake a cake but did not know how to separate egg whites from egg yolks, the problem would be one of a missing part of a process. If a student were asked to describe in detail (make a report on) the characteristics of squirrels but did not know their food gathering habits, then, the problem would be one of missing declarative information. Problem solving algorithms have been developed for mathematics (Polya, 1957; Wickelgren, 1974), physics (Reif & Heller, 1984) and general scientific application (Novak and Gowin, 1984). All of these algorithms are easily adapted to emphasize the salience of missing declarative or procedural information.

Composing is the process of creating new linguistic information. Within mainstream education composing is usually thought of as a process involving written language, although it can just as validly be thought of as an oral language process. Nickerson (1984) identifies writing as one of, if not the key procedure for enhancing thinking skills: "Writing is viewed not only as a medium of thought but also as a vehicle for developing it". (p.33) The constructive nature of writing (its generation of new cognitive structures) has been well documented. For example, Flower and Hayes (1980) assert that writing is a generative process which creates new ideas for the writer. Similarly, many professional writers report that composing is the process of finding out how the story turns out (Marzano & DiStefano, 1984).

Again, all three execution processes can be easily integrated into the curriculum. Elaboration is commonly reinforced as a questioning strategy used with content material. Problem solving is generally done in the sciences and mathematics although more general applications have been developed (eg. Gourley & Micklus, 1982) which cut across all content areas. Similarly programs such as "writing across the curriculum" (Applebee, 1977) emphasize the use of composing as a tool for developing synthesizing, organizational and knowledge generation skills in all content areas.

BASIC BELIEFS

Basic beliefs refer to those epistemic thoughts which control broad categories of human behavior. We dealt with some epistemic thoughts (eg. beliefs about control of and responsibility for a task) when we considered learning-to-learn strategies. Here we consider more general epistemic beliefs. Glasser (1981) and Powers (1973) call these beliefs controlling principles. Technically a principle is a high level generalization which governs selection of behavior (Klausmeier & Sipple, 1980). Basic principles are so fundatmental as to be part of one's system of knowing what is real and what is not-- in effect basic principles represent one's epistemology.

Commonly these basic beliefs are ignored as a formal part of the curriculum yet, there is ample evidence to indicate that basic beliefs are communicated and modeled in an indirect, hidden way within the curriculum (Gircux & Purpel, 1983). Such theorists as Maxine Greene (1971) have long argued that their inclusion in the curriculum should be done on a more conscious basis. Adler (1982) as part of "column three" of the Paideia Proposal suggests that basic beliefs should be systematically addressed in the curriculum via Socratic questioning and active participation in the discussion of books.

There are a number of areas which seem important relative to the integration of basic beliefs into the curriculum. One of those areas appears to be a trust in external causal support. Abraham Maslow in a paper entitled "On the Need to Know and the Fear of Knowing" (in Harmon, 1982) pointed out that humans are culturally taught not to trust themselves or the inherent order of life. This creates what we might call an adversary stance toward life--that is, a belief that circumstances will generally not support the accomplishment of goals (eg. a belief in the validity of Murphy's law). This leads an individual to be overly cautious and less inclined to take risks. However, a belief that somehow circumstances will, in general, align in the accomplishment of goals has been linked to creativity (Amabile, 1983; Fromm, 1982) and productivity (Harmon, 1982).

A second basic belief important to general behavior is the subjectivity of perception. One of the more powerful scientific realizations within the last decade is that perception is fundamentally subjective in nature. That is we perceive only what we expect to perceive. This is most evident in experiments on visual perception (Lindsay and Norman, 1977). Smith (1978) dramatizes the subjective nature of human perception in his discussion of reading comprehension:

> What we have in our heads is a theory of what the world is like, a theory that is the basis of all our perceptions and understanding of the world, the root of all learning the source of all hopes and fears, motives and expectancies, reasoning and creativity. (p. 57)

In isolation this is a fairly deterministic view of humar cognition. If we can perceive only what we expect to perceive we are tantamount to being stuck in a perceptual "programming loop." However, along with the realization that perception is primarily subjective--driven by paradigms which create perceptual expectation--is the complementary hypothesis that humans have the power to voluntarily shift paradigms at will given that they are aware of the paradigm from which they are currently perceiving. This concept of voluntary paradigm shifting has affected a wide range of human endeavors from theory and practice in social science research (Skrtic, 1983; Schwartz and Ogilvy, 1979) to economic theory (Henderson 1984-85) to human productivity (Bodek, 1984-85). It would appear, then, that two basic beliefs which exert a high level of control over cogniton might be stated in the follwing way:

1. A belief that perceptions are subjective and are generated from a specific point of view.

2. A belief that one's point of view is controllable and a willingness to change a given point of view.

These two principles have been linked to creativity (Johnson-Laird, 1983), effective-problem solving (Wickelgren, 1974; Whimbey 1980; 1984) and dialectic thinking (Paul, 1984).

In addition to those mentioned above, there have been many other categories of basic beliefs suggested as appropriate for systematic inclusion in the curriculum. For example, Macagnoni (1979) states that basic beliefs in six areas should be studied as a formal part of public education--beliefs about physical, emotional, social, itellectual, aesthetic and spiritual principles. Goodlad (1983) stresses that public schools should explicitly address beliefs relative to aesthetic expression, emotional and physical well-being and moral and ethical character.

IMPLICATIONS

The major implication of the model presented here is that the present conceptualization of the acts of teaching and learning should be expanded far beyond the domain of content area knowledge. Specifically the components of the teaching/learning process should include: 1) learning-to-learn strategies, 2) a new approach to content which emphasizes basic concepts and organizational patterns of declarative knowledge and the developmental nature of procedural knowledge, 3) basic reasoning skills in the areas of storage and retrieval, matching and execution and 4) basic beliefs which are high level controlling principles.

The "job" of teaching would necessarily include attention to all of the components in an integrated fashion. The learning-to-learn strategies described previously would form the general framework in which instruction occurs. During content area instruction clear distinctions would be made between that information which is declarative and that which is procedural. Systematically students would be guided through storage and retrieval techniques using content area information. Similarly students would be presented with matching and execution activities as a way of reinforcing and expanding their knowledge of content. Finally, areas of the content that relate to basic beliefs would be highlighted and used as the platform for Socratic dialogue.

Such an approach to teaching would be highly focused (involve identifiable activities for specific purposes) yet broad in nature. It would also necessarily change current practices in student assessment.

Doyle (1983) states that accountability drives the academic tasks presented to students. As a result students are especially sensitive to cues that signal accountability. Students tend to take seriously only those tasks for which they are held accountable (Carter & Doyle, 1982; King, 1980; Winne and Marx, 1982). This implies that the areas described in this model should be included in academic assessment. However, many of the competencies described above can not be assessed via objective, multiple choice formats (eg. students' abilities to use basic reasoning processes) and some competencies have no "correct answer" to use as a criterion (eg. basic beliefs). Consequently the inclusion of many of the components of this model would necessitate a shift in the scope and practice of assessment. Specifically assessment would utilize non-quantitative data gathering techniques commonly associated with qualitative research. (eg. Miles & Huberman, 1984) It has been suggested that without such a shift, formal education will remain entrenched in current testing practices which commonly are dicriminatory against certain socio-economic groups (Haney, 1984; Houts, 1977)

In summary, the model presented here would affect the very fabric of what is considered academic content, the way it is presented to students and the manner in which it is assessed.

Notes:

1. The reader should consider the outer cycle and inner cycle as metaphors for the actual cognitive processes underlying these operations. The intent is not to imply that these cycles represent distinct independent processes. Rather the intent is to create a framework which provides a basis for the identification of distinct instructional practices which can be used in classroom settings.

2. Anderson uses the term production memory rather than procedural memory. Production memory contains productions--the if/then formats described previously. I have used the term procedural memory to describe knowledge stored in production structures. This is more in keeping with current educational interpretation of information processing theory.

REFERENCES

Alexander, P.A. (1984) Training analogical reasoning skills in the gifted. Roeper Review, 6, (4), 191-194.

Alston, W.P. (1964) Philosophy of Language. Englewood Cliffs, NJ: Prentice-Hall.

Amabile, T.M. (1983) Social psychology of creativity. New York: Springer-Verlag.

Anderson, J. (1982) Acquistion of cognitive skills, Psychological Review, 1982, 89, 369-406.

Anderson, J. (1983) The architiecture of cognition, Cambridge, Mass.: Harvard University Press.

Anderson, R., & Freebody, P. (1981) Vocabulary knowledge. In J.T. Guthrie (Ed.) Comprehension and teaching. Newark, NJ: International Reading Association.

Applebee, A. (1977) Writing across the curriculum. The London project. English Journal 66, (9) 81-83.

Arter, J.L. (1976) The effects of metaphor on reading comprehension. Unpublished doctoral dissertation, University of Illinois.

Baird, J.R. & White, R.T. (1982) Promoting self-control of learning. Instructional Science, 11, 227-247.

Bandura, A. & Schunk, D. (1981) Cultivating competence, self-efficacy and intrinsic interest through proximal self-motivation. Journal of Personality and Social Psychology 41 (3), 586-598.

Becker, W. (1977) Teaching reading and language to the disadvantage-What we have learned from field research. Harvard Educational Review, 47, 518-543.

Bellezza, F.S. (1983) Mnemonic device instruction with adults. In M. Pressley & J.R. Levin (Eds.) Cognitive strategy research: pyschological foundations. New York: Springer-Verlag.

Bellezza, F.S. (1981) Mneumonic devices: Classification, characteristics and criteria. Review of Educational Research. 51, 247-275.

Bereiter, C. (1984) How to keep thinking skills from going the way of all frills. Educational Leadership 42 (1), 75-77.

Block, J.H. (1985) Belief systems and mastery learning. Outcomes, 4, (2), 3-14.

Bobrow, D.G. & Winograd, T. (1977) An overview of KRL, a knowledge representation language. Cognitive Science, 1, 3-46.

Bodek, N. (1984-85/Winter-Spring) Werner Erhard on transformation and productivity: An interivew. Revision, 7 (2), 30-38.

Borg, W.R. (1980) Time and school learning. In A. Lieberman (Ed.) Time to learn. Washington, D.C. National Institute of Education.

Bransford, J.D., & Franks, J.J. (1971) The abstraction of linguistic ideas. Cognitive Psychology, 2, 331-350.

Brophy, J. (1982) Classroom organization and management. Washington D.C. National Institute of Education.

Brown, A.L., Campione, J.C. & Day, J.D. (1981). Learning to learn: On training students to learn from texts. Educational Researcher, 10 (2), 14-27.

Bruce, B.C., & Schmidt, C.F. (1974) Episode understanding and belief guided parsing. New Brunswick, NH: Rutgers University.

Bugelski, B.R. (1977) The association of images. In J.M. Nichol's (Eds.) Images, perception and knowledge. Boston: D. Reidel.

Bussis, A., Chittenden, E. & Amarel, M. (1976) Beyond surface curriculum Boulder, CO: Westview Press.

Carter, K., & Doyle, W. (1982, March) Variations in academic tasks in high and average ability classes. Paper presented at the annual meeting of the American Education Research Association. New York: March.

Chomsky, N. (1980) Rules and represenations. Behavior and Brain Sciences. 3, 1-61.

Corno, L. & Mandinach, E.B. (1983) The role of cognitive engagement in classroom learning and motivation. Educational Psychologist 18, 88-108.

Culler, J. (1980) Literacy comptence. In J.P. Tompkins (Ed.). Reader-response criticism: From formulation to post-structuralism. Baltimore, MD: Johns Hopkins University Press.

de Beaugrand, R. (1980) Text, discourse and process. Norwood, NJ: Ablex.

Doyle, W. (1983) Academic work, Review of Education Research. 53, 159-199.

Dunn, R. & Dunn, K. (1978) Teaching students through their individual styles: A practical approach. Reston, VA: Reston Publishing Co.

Dupuy, H. (1974) The rationale, development and standardization of a basic word vocabulary test. Washington, D.C.: U.S. Government Printing Office.

Education Commission of the States. (1982) The information society: Are high school graduates ready? Denver, CO.

Egeland, B. (1974) Training impulsive children in the use of more effient scanning strategies, Child Development, 45, 165-171.

Fisher, C.W. Filby, N.N., Marliave, R.S., Cohen, L.S., Dishaw, N.M., Moore, J.E. & Berliner, D.C. (1978) Teaching behaviors, academic learning time and student achievement. Final report of Phase III-B. Beginning teacher evaluation study. San Francisco, CA: Far West Laboratory for Educational Research and Development.

Fitts, P.M. Perceptual-motor skill learning. In A.W. Melton (ED.). Catetgories of Human Learning. New York: Academic Press.

Flower, L. & Hayes, J.R. (1980) The cognition of discovery. Defining a rhetorical problem. College Composition and Communication 13, 21-32.

Frederiksen, C.H. (1975) Representing the logical and semantic structure of knowledge acquired from discourse. Cognitive Psychology 7, 371-458.

Frieze, I.H., Francis, W.D. & Hanusa B.H. (1983) Defining success in classroom settings. In J. Levine & M. Wang (Eds.) Teacher and student perceptions: Implications for learning. Hillsdale, N.J. Erlbaum.

Fromm, E. (1968) The nonproductive character orientation. In. L. Gorlow & W. Katkousky (Eds.) Reading in the psychology of adjustment. New York: McGraw Hill.

Gardner, H. (1983) Frames of mind. New York: Basic Books Inc.

Giroux, H. & Purpel, D. (Eds.) (1983) The hidden curriculum and moral education. Berkeley, CA: McCutchan Publishing Co.

Glasser, W. (1981) Stations of the mind. New York: Harper & Row.

Goetz, E.T., Palmer, D.J. & Haensly, P.A. (1983) Metacognitive awareness of text variables in good and poor readers. In J. Niles (Ed.) Searching for meaning in reading/language processess and instruction. Rochester, N.Y.: The National Reading Conference.

Good, T., Grouws, D. & Ebmeier, H. (1983) Active mathematics teaching. New York: Longman.

Goodlad, J.L. (1983) A place called school: Prospects for the future. St. Louis, MO: McGraw-Hill.

Goodman, J.B. (1977) Impulsive and reflective behavior: A developmental analyses of attention and cognitive strategies. Dissertation Abstracts International 34, 5190-B.

Gourley, T.J. & Micklus, C.S (1982) Problems, problems, problems: Discussion and activities designed to enhance creativity. Glassboro, N.J.: Creative Publications.

Gow, D.T. & Casey, T.W. (1983) Selecting learning activities. In. F. English (Ed.) Fundamental curriculum design. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Greene, M. (1971) Curriculum and consciousness. Teachers College Record, 1971, 73, (2), 253-269.

Gregoric, A.F. (1979) "Learning/teaching styles: Their nature and effects. In. Student learning styles: Diagnosing and prescribing programs. Reston: VA.: National Association of Secondary School Principals.

Haney, W. (1984) Testing reasoning and reasoning about testing. Review of Educational Research. 54 (4), 597-654.

Harmon, W.W. (1982) Transforming affirmations as a key to personal change. San Francisco: Institute of Noetic Sciences.

Hart, L.A. (1983) Human brain and human learning. New York: Longman.

Hawkins, D. (1974) The informed vision: Essays in learning and human nature. New York: Agathon Press.

Heller, J. & Reif, F. (1984) Prescribing effective human problem-solving processes: Problem description in physics. Cognition and Instruction, 1, 1984.

Henderson, H. (1984-1985/Winter-Spring) Post-economic policies for post-industrial societies. Revision, 7, 20-29.

Houts, P. (Ed.) (1977) The myth of measurability. New York: Hart Publishing Company.

Hull, C.L. (1920) Quantitative aspects of the evolution of concepts. Psychological Monograpghs, 28 (1).

Hunter, M. (1984) Knowing, teaching and supervising. In. P. Hosford (Ed.) Using what we know about teaching. Alexandria Virginia: Association for Supervision and Curriculum Development.

Johnson-Laird, P.N. (1983) Mental models. Cambridge, Mass.: Harvard University Press.

Jordon, T.J. & Merrifield., P.R. (1981) Self-concept: Another aspect of aptitude. In. M.D. Lynch, A.A. Norem-Hebeisen & K.J. Gergen (Eds.) Self-concept: Advances in theory and research. Cambridge, MA: Ballinger Publishing Company.

King, L.H. (1980) Student thought processes and the expectancy effect. (Research Report No. 80-1-8). Edmonton, Alberta, Canada: Centre for Research in Teaching. The University of Alberta.

Kinstch, W. (1974) The representation of meaning in memory. Hillsdale, N.J.: Erlbaum.

Kinstch, W., & van Dijk, T.A. (1978) Toward a model of text comprehension and production. Psychological Review, 85, 363-394.

Klausmeier, H.J., & Sipple, T. (1980) Learning and teaching concepts. New York: Academic Press.

Kolb, D.A., Rubin, I.M. & McIntyre, J.M. (1974) Organizational psychology. Englewood Cliffs, N.J.: Prentice Hall.

LaBerge, D., & Samuels, S.J. (1974) Toward a theory of automatic information processing in reading comprehension. Cognitive Psychology, 6, 293-323.

Larkin, J. (1981) Enriching formal knowledge: A model for learning to solve texbook problems. In. J. Anderson (Ed.) Cognitive skills and their acquisition. Hillsdale, N.J.: Erlbaum.

Lehnert, W.G. (1978) The process of question answering, Hillsdale, N.J.: Erlbaum.

Leslie, L., & Jett-Simpson, M. (1983) The effects of recall instruction and story deletions on children's story comprehension. In J. Niles & L. Harris (Eds.) Searching for meaning in reading/language processing and instruction. Rochester, NY: National Reading Conference.

Letteri, C.A. (1979) Cognitive profile: Relationship to achievement and development. In. Student learning styles: Diagnosing and precribing programs. Reston, VA. National Association of Secondary School Principals.

Lindsay, P.H., & Norman, D.A. (1977) Human information processing. New York, NY: Academic Press.

Macagnoni, V.M. (1979) Coming to terms with curriculum as a human agenda. In Lifelong learning: A human agenda. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Marzano, R. (1984) A cluster approach to vocabulary instruction. Reading Teacher, 38 (2), 168-173.

Marzano, R. (1985) The systematic teaching and reinforcing of thinking and reasoning skills within content area classrooms, Denver: Mid-continent Regional Education Larboratory.

Marzano, R. & DiStefano, P. (1981) The writing process. New York: D. Van Nostrand.

McCombs, B. (1984) Processes and skills underlying continuing intrinsic motivation to learn: Toward a definition of motivational skills training intervention. Educational Psychologist 19, (4), 199-218.

McNeill, D. (1975) Semiotic extension. In R.L. Solso (Ed.) Information processing and cognition: The Loyola Symposion. Hillsdale, N.J.: Erlbaum.

Meichenbaum, D. (1977) Cognitive behavior modification: An integrative approach. New York: Plenum Press.

Mervis, C.B. (1980) Category structure and the development of categorization. In. R.J. Spiro, B.C. Bruce & W.F. Brewer (Eds.) Theoretical issues in reading comprehension, Hillsdale, N.J.: Erlbaum.

Meyer, B.J. (1975) The organization of prose and its effects on memory. Amsterdam: North Holland Publishing Co.

Mezynski, K. (1963) Issues concerning the acquistives of knowledge: Effects of vocabulary training on reading comprehension. Review of Educational Research 53, 253-279.

Miles, M. & Huberman, A. (1984) Qualitative data analysis. Beverly Hills, CA: Sage Publications Inc.

Miller, G.A., Galan , E. & Pribram, K.H. (1960) Plans and the structure of behavior, New York: Holt Rhinehart & Winston.

Minsky, M.L. (1975) A framework for representing knowledge. In. P.H. Winston (Ed.) The psychology of computer vision. New York: McGraw-Hill.

Nagy, W.E. & Herman, P.A. (1984) Limitations of vocabulary instruction. Technical Report No. 326. Center for the study of Reading. University of Illinois, Urbana-Champaign.

National Commission on Excellence in Education. (1983) A nation at risk: The imperative for educational reform. Washington, D.C.: Government Printing Office.

Neisser, V. (1967) Cognitive psychology. New York: Appleton.

Newell, A. & Simon H. (1972) Human problem solving, Englewood Cliffs, N.J.: Prentice-Hall.

Nickerson, R. (1984) Kinds of thinking taught in current programs. Educational Leadership. 42 (1), 26-37.

Novak, J.D. & Gowin, D.B. (1984) Learning how to learn. Cambridge: Cambridge University Press.

Paivio, A. (1983) Strategies in language learning. In. M. Pressley & J.R. Levin (Eds.) Cognitive strategy research: Educational applications. New York: Springer - Verlag.

Paul, R. (1984) Critical thinking: Fundamental to education for a free society. Educational Leadership. 42. (1), Sept. 1984.

Pearson, P.D. (1981) Comprehension in text structures. In J.T. Guthrie (Ed.) Comprehension and Teaching: Research Reviews. Newark, Delaware: International Reading Association.

Peters, T. & Waterman, R.H. (1982) In search of excellence. New York: Harper & Row.

Polya, G. (1957) How to solve it. Princeton, N.J.: Princeton University Press.

Powers, W.T. (1973) Behavior: The control of perception. Chicago, IL: Aldine.

Reif, F. & Heller J. (1982) Knowledge structure and problem solving in physics, Educational Psychologist, 17, 102-127.

Rosenshine, B. (1979) Content time and direct instruction. In. P. Peterson & H. Walberg (Eds.) Research on Teaching Berkeley, CA: McCutchan Publishing Co.

Rosenshine, B. (1980) How time is spent in elementary school classrooms. In. A. Lieberman (Ed.) Time to learn. Washington, D.C.: National Institute of Education.

Ross, J. & Lawrence, K.A. (1968) Some observations on memory artifice. Psychonomic Science, 13, 107-108.

Rumelhart, D. (1973) Notes on a schema for stories, In. D. Bobrow & A. Collins (Ed.). Representation and understanding. New York: Academic Press.

Sachs, J.S. (1967) Recognition memory for syntactic and semantic aspects of connected discourse. Perception and Psycholphysics, 2, 437-442.

Schank, R. & Abelson. R.P (1977) Scripts, plans, goals and understanding: An inquiry into human intelligence. Hillsdale, N.J.: Erlbaum.

Schwartz, P., & Ogilvy, J. (1979) The emergent paradigm: Changing patterns of thought and belief. Values & Lifestyles Program. Menlo Park, CA: SRI International.

Sears, P.S. (1940) Levels of aspiration in academically successful and unsuccessful children. Journal of Abnormal and Social Psychology 35, 498-536.

Skrtic, T. (1983) The doing of emergent paradigm research into educational organizations. Overland Park, KS: Unversity of Kansas.

Smith, F. (1978) Understanding reading. New York: Holt, Rinehart & Winston.

Spiro, R.J. (1980) Constructive processes in prose comprehension. In R.J. Spiro, C.B. Bertram, & W.F. Brewer (Eds.) Theoretical issues in reading comprehension. Hillsdale, NJ: Erlbaum.

Sternberg, R.J. (1983) Criteria for intellectural skills training Educational Researchers, 12, 6-12.

Sternberg, R.J. (1977) Intelligence, information processing and analogical reasoning: The componential analysis of human abilities. Hillsdale, N.J.: Erlbaum.

Sywlester, R. (1985) Research on memory: Major discoveries, major educational challenges. Educational Leadership 42 (7), 69-75.

Taylor, B., & Samuels, S.J. (1983) Children's use of text in the recall of expository material. American Educational Research Journal. 20, 517-528.

Tiece, L. (1976) Achieving your potential. Seattle, The Pacific Institute.

Toulmin, S. (1958) The uses of argument. Cambridge, England: Cambridge University Press.

Toulmin, S. Rieke, R., & Janik, A. (1979) An introduction to reasoning. New York, NY: Macmillan.

Tyler, R. (1975) Basic principles of curriculum and instruction. Chicago: University of Chicago Press.

vanDijk, T.A. (1980) Macrostructures. Hillsdale, NJ.: Erlbaum.

vanDijk, T.A. (1977) Text and context: Exploration in the semantics and pragmatics of discourse. London: Longman.

Warren, W.H., Nickolas, D.W. & Trabasso, T. (1979) Event chains and inferences in understanding narratives. In. R.O. Freedle (Ed.) New directions in discourse processing, Vol. 2, Norwood, N.J.: Ablex

Weiner, B. (1976) Attribution theory, achievement, motivation and the educational process. Review of Educational Research 42 (2), 203-215.

Weiner, B. (1980) The role of affect in rational (attributional) approaches to human motivation. Educational Research 9 (7), 4-11.

Whimbey, A. (1980) Students can learn to be better problem solvers. Educational Leadership. 37, 560-563.

Whimbey, A. (1984) The key to higher order thinking is precise processing. Educational Leadership. 42 (1), 66-70.

Wickelgren, W. How to solve problems. (1974) San Francisco: W.H. Freeman.

Winne, D.H., & Marx, R.W. (1982) Students and teachers views of the thinking processes for classroom learning. Elementary School Journal, 82, 493-518.

Zdenek, M. (1983) The right-brain experience New York: McGraw Hill.