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ABSTRACT

The conceptual focus of this study centers on a key aspect of improved schooling: the development of sophisticated thinkers in the K-12 sequence of education. The document is organized into four major sections. The first section describes how the theoretical bases of a thinking skills program are developed and rooted in the literature. In section two, the proposed program design is presented through the development of a 3-level model of thinking. Section three addresses implementation concerns such as instruction, staff development, subject matter integration, and program assessment. Section four presents a selected resource guide to indicate the kinds of materials and information that ought to be made available to educators to help them plan and create a program based on the proposed design. A concluding section summarizes the study and suggests how the overall design can be used by practitioners seeking to build a K-12 program. Seven appendixes provide a glossary of thinking skills; a checklist for materials considered in thinking skills programs; a thinking skills lesson plan; a general teaching algorithm; a student evaluation form; an appraisal of thinking skills throughout the K-12 curriculum; and a model of thinking skills: a basic processes continuum pre K-12. (Contains approximately 135 references.) (LL)

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THINKING SKILLS THROUGHOUT THE CURRICULUM:
A CONCEPTUAL DESIGN

by

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To the memory of

JEAN PIAGET

who made children's thinking serious study

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INTRODUCTION

Periods of educational reform often lead to new perspectives on the significance of schooling. Such times also tend to underline the failings of the current program and generate attempts to remedy or correct existing conditions. So it is with the current reform period and the nation's energetic pursuit of excellence in teaching and learning. Much has been said about increased educational standards, more testing, higher achievement, and greater improvement. Somewhat less has been directed toward understanding what are the major factors influencing student achievement and what are the most productive ways to pursue these factors.

The conceptual focus of this study centers on a key aspect of improved schooling: the development of sophisticated thinkers in the K-12 sequence of education. Never before has so serious a challenge to education emerged as the current need to achieve higher order thinking performance on the part of secondary school graduates (Presseisen, 1985). This study presents a thinking skills program design which addresses major concerns of "researching, rethinking, and reordering" the priorities in today's curriculum (Berman, 1985). It is a design based on both current research and knowledge about implementation in schooling. The student body of the public school is the primary population for whom the design is intended, as an important premise of the study maintains it is critical that higher order cognitive abilities be developed in <u>all</u> the nation's youth.

Issues related to how to help students think better or learn more effectively are as old as schooling itself. But the current movement for teaching thinking is different from earlier efforts. Empirical research now provides the bases for understanding a new rationale for cognitive improvement.

Researchers from a number of disciplines have presented evidence which indicates that the ways students learn in specific content areas can be developed and modified (Belmont, Butterfield & Ferretti, 1982; Schoenfeld, 1979). These research findings can be brought to bear on what is meant by higher order thinking processes. These same findings can influence the way educators conceive of both student abilities and the instructional program. Much hinges on how the particular thinking skills are defined and developed, as well as on the relationships that are drawn between these skills and instruction in specific content areas. Such depictions and definitions are major aspects of the program design proposed in this study.

A thinking skills program ultimately must be concerned with implementation in the classroom as well as throughout a district. How should the curriculum be organized for thinking instruction? What are the important aspects of a staff development effort that are key to a successful thinking skills program? What resources are needed to support sound thinking skills instruction? These are issues that have no quick, easily-arrived-at answers. That does not diminish their significance to the outcomes of the overall task. The proposed design also attempts to wrangle with such implementation issues.

There are four major sections in the study. In Chapter One, the theoretical bases of a thinking skills program are developed and rooted in significant research literature. Underlying assumptions and program goals are examined. In Chapter Two, the proposed program design is presented through the development of a three-level model of thinking. The nature of the various thinking processes are explored in this model through the analysis of generic thinking skill examples characteristic of classroom instruction. Discussion is provided to help readers understand the design implications for teaching these thinking skills in various subjects of the school's curriculum. In Chapter Three, implementation concerns such as instruction, staff development, subject matter integration, and program assessment are discussed in terms of the implications of the proposed design and the context of practical constraints in building a thinking skills program. In Chapter Four, a selected resource guide is presented to indicate the kinds of materials and information that ought to be made available to educators in order to help them plan and create a program based on the proposed design. Finally, the concluding chapter summarizes the study and suggests how the overall design can be used by practitioners seeking to build a sound K-12 program.

The enhancement of cognitive performance is a timely topic in American education currently generating a great deal of discussion, writing, and research activity. The design proposed in this study attempts to address the major issues that confront the development of curricular programs in the current thinking skills movement. In meeting these issues, potential for change and the ultimate improvement of educational practice exists. Applications of this design and the fine tuning of responses in real school programs will determine the level of success that can be reached in this curriculum renewal effort.

1. THE THEORETICAL BASES OF A THINKING SKILLS PROGRAM

There is no academic discipline called "thinking skills." Rather, a movement has emerged in American education in the 1980s that embraces a number of academic fields and research literatures. This movement is not unrelated to the cognitive revolution in psychology which dates back to the 1950s. As in the earlier period, the current movement focuses on the significance of human development with its related concerns of intelligence, physical and brain development, and studies of achievement. But another impetus sparks the renewed interest in thinking. The current technological revolution, the advent of information systems and the development of computerized learning influence the ways we conceive of thinking and the views we have of instruction. Much of the current interest in cognitive science stems from fascinating developments in the areas of human information processing, linguistics, and artificial intelligence which have spurred the technological renaissance (Kaplan, 1985).

Understanding the current thinking skills movement requires that one realize the positive side of its motivation. As opposed to undermining the capacity of human processes, the technological revolution has made us more aware of the speciality of human performance. A new appreciation has been inspired in the potential that each human being has for becoming an expert learner. Studies of child prodigies have raised questions about how all students develop expertise, what role is played by teaching and coaching, and how performance in one area might help or enhance ability in another field (Feldman, 1983). There is new functional approach to education that is positive and, according to Beilin (1985), stresses not only skills, strategies, rules and cognitive processes, but the role that parents, schools, and culture play in influencing cognitive development. There is a new emphasis on learning by doing and being involved in learning. There is a greater appreciation of the importance of early intervention in children's lives to help them become better learners. The great changes that have influenced various academic fields contributing to the development of human thought are central to understanding the bases of a thinking skills program.

A Changing View of Human Potential

The current interest in the learner as a thinker did not appear *de novo* in 1985. Educational research from the turn of the the nineteenth century reflects historic roots in the cognitive potential of every child (Dewey, 1938; Piaget, 1970; Bruner, 1967). Albeit, this was a minority position. The major thrust of education until would World War II held that "education was a process of passing facts from those who had them to those who didn't and pedagogy was the art or science of packaging those facts" (Lochhead, 1985, p.4).

After the war, however, in the context of school studies, awareness of child development and examinations of classroom learning led some researchers to a different of view both teacher and student as dynamic forces in an ever-changing teaching-learning system. Consider, for example (see Figure 1), models presented by Gordon (1966) nearly twenty years ago. Gordon saw the Einsteinian model of the learner as the appropriate view for educational decision making. The active, transactional relationships of an open system seemed to serve the needs of Gordon's world and fitted the newly developing behavioral science concepts and early systems theory orientation of that era: intelligence is modifiable; the child interacts with the environment and changes as result of that interaction; the role of the teacher and the materials of instruction are significant to the quality of interaction; and the learner can use feedback to regulate better his or her own learning and, ultimately, to control that learning.

Newtonian Model Man	Einsteinian Model Man
A mechanistic, fixed, closed system, characterized by:	An open-energy, self-organizing system, characterized by:
(1) fixed intelligence	(1) modifiable intelligence
(2) development as an orderly unfolding	(2) development as modifiable in both rate and sequence
(3) potential as fixed, although indeterminable	(3) potential is credible through transaction with environment
(4) a telephone-switchboard brain	(4) a computer brain
(5) a steam-engine driven motor	(5) a nuclear power-plant energy system
(6) homeostatic regulator (drive-reduction)	(6) inertial guidance and self-regulatory feedback-motivation system
(7) inactive until engine is stoked	(7) continuously active

Figure 1: Gordon's Changing Model of Human Potential

From Studying the child in school (p. 2) by I. J. Gordon, 1966, New York: John Wiley. Reprinted by permission.

Several of Gordon's principles are reiterated in the literature of the current thinking skills movement. Sternberg (1981, 1984a, 1984c) agrees that intelligence can be modified and that classroom experience can be organized to enhance its development. He further suggests that educators should concentrate on intelligence as multiple thinking and learning skills and not as static I.Q. scores, and he challenges practitioners to work actively to enhance students' reasoning capacities. Whimbey (Whimbey & Whimbey, 1975) maintains that intelligence can actually be taught and suggests that instruction be focused on the multiple processes that constitute good thinking. He discusses the controversy between researchers who believe in one general intelligence ability, Spearman's "g", and those who promote lists of varying abilities. Recently, he stressed that it is the processing and reflection about the various abilities that really help the student improve his or her higher cognitive capacity (Whimbey, 1984).

In emphasizing the importance of the child's interaction with the environment, the current thinking skills movement challenges the thesis of innate intelligence and the fixed notion of an immutable telephone switchboard brain, as characterized in Gordon's Newtonian model. There are multiple instructional environments possible, says Resnick (1976); the educator's task is to enable children to be active in each and to reflect on their rich experience. Such reflection may differ among various youngsters, because each person is a unique amalgam of many talents and abilities, but metacognitive realizations are an important aspect in each student's learning and thinking. Metacognition, the consciousness of one's own thought processes, is a factor that sets the current thinking skills movement apart from earlier periods of cognitive encouragement. Becoming more aware of one's abilities and disabilities are key realizations to ·eing able to change or improve one's intellectual capacity. Knowing how a student thinks -- as expressed and performed by the student -- can be the resource most needed by the teacher to help create a productive learning environment in the classroom. Mediating the metacognitive, says Costa (1984), is the heart of teaching thinking skills. Mediation, says Feuerstein (1980), is the major task of teaching.

The current thinking skills movement is sensitive, too, to the complexity of human thought and reflection. Knowing is not something that can merely be tested on Friday, at the end of a unit, or at the conclusion of a convenient semester. Expertise develops gradually and is very much related to prior knowledge acquired and to the quality of experience in "playing with" that knowledge. So it is with thinking skills, and there is much to learn from comparing the growing proficiency of a novice performer to that of the more mature or successful learner. Some researchers discuss this awareness in their particular subject matters, such as in reading (Chall, 1983; Osborn, Jones, & Stein, 1985), science (Larkin, 1980), and mathematics (Schoenfeld, 1980). In each area, it is evident that there is both a growing complexity of information and a increasing abstractness of process. Much hinges on how thinking skills are defined in any subject area and on the ways students acquire more proficient ability in handling particular cognitive difficulties. Some researchers indicate how important it is that textbook presentations parallel student instruction, and express disappointment that current published material appears to be rather weak in depicting higher cognitive operations (Nicely, 1985).

The more emergent view of human potential is partial, too, to differing definitions of human intelligence than were held in the past. Gardner's (1983) study proposes seven separate intelligences and raises questions about what subject matters should be included in the curriculum, as well as with what degrees of emphasis. If certain thinking processes underlie all disciplines or pertain to certain intelligences, aren't these significant as organizing centers for curriculum? And in dealing with the new world of computerized information, how best can culture, technology, and intellect interrelate for instructional purposes? Olson's (1973, 1976, 1985) insights in this area may be useful in planning for the enhancement of thinking. Multiple symbol systems exist in the world, he suggests, to be tapped by the learner's multiple intelligences. But, by and large, schools fail to develop or use these various systems. Basic skills programs cater to linguistic and quantitative modalities in simplistic ways. Are we missing the boat of developing human potential more broadly? Several leaders of the thinking skills movement maintain we are and even suggest that the inability and failure of many students in the current system may stem from such narrowness of approach. Feuerstein, Jensen, Hoffman & Rand (1985) advocate an instructional program that remediates the "individual to rediscover redundant rules that are embedded in new content, or that require use of new modalities" (p.60). By gradual reinforcement and careful reiteration, they say, a particular skill can be taught and the student can become more fluent in that specific operation.

Finally, there is a notion in the more current view of human potential that there may be optimal times for learning or instructional intervention. The research on child behavior that spans from Piaget's studies after World War I to the Perry Preschool program research today (Berrueta-Clement, Schweinhart, Barnett, Epstein & Weikart, 1984) and current assessments of adolescence and formal reasoning (Mergendoller, 1981; Elkind, 1983; Benderson, 1985) suggest that particular periods in the learner's development are key to certain cognitive experiences and should be maximized in the design of instruction. This is not to say that the same experiences are important for all children at the same instructional moment, but rather that the sequence of change and the quality of experience parallel to the learner's involvement are important considerations in planning the entire school program. A program design for thinking skills needs to be concerned with this developmental aspect of the learner's condition and relate it, too, to the design of classroom instruction.

A Changing View of Instruction and the Instructional Program

As views of human potential have changed over the past several decades, different views of instruction and the instructional program have also emerged. These views stem from alternate characterizations of the learner and from a more complete understanding of the instructional process itself. Bruner (1985) describes five would-be models to depict the young learner: tabula-rasa, hypothesis generator, nativism, constructivism, and novice-to-expert. Three of these models touch upon expectations of the current thinking skills movement. A hypothesis generator student exhibits the active curiousity thinking skill educators hope to find in the classroom. Information is manipulated freely and one right answer does not dominate instruction. The student-as-constructor of knowledge is self-reliant and gradually masters the rules of knowledge development. This student builds autonomy and self-management skills. The novice-to-expert learner emphasizes the pragmatics of learning and the efficiency of specificity and explicitness. He or she learns from a coaching instructor and knows the value of practice. Interestingly, it is many of the aspects of metacognition that are captured in these depictions, referring not only to the learner's independence and control over their own thinking but "involves not only knowing what one does and does not know, but also knowing what to do when one fails to comprehend" (Osborn, Jones, & Stein, 1985, p.11).

Inevitably, in designing a thinking skills program, the model of the learning process itself must be dealt with, for this becomes the basis of instruction. In their analysis of specific published thinking skills programs, Campione and Armbruster (1985) raise the question of what organizational framework is most appropriate for exploring learning in the classroom. The scheme they devise (see Figure 2) has four dimensions; it is worthwhile

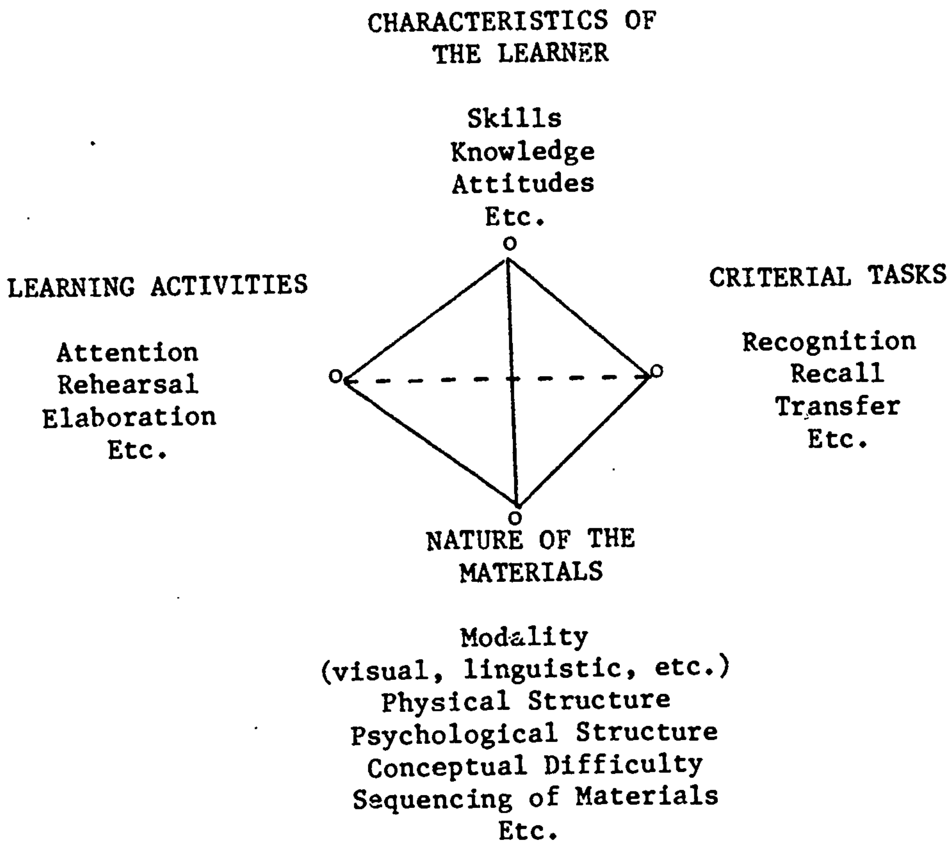


Figure 2: An Organizational Framework for Exploring Questions about Learning

From Acquiring information from texts: An analysis of four approaches (p. 332) by J. C. Campione & B. B. Armbruster. In J. W. Segal, S. F. Chipman, & R. Glaser (Eds.), 1985, Thinking and Learning Skills (Vol. 1), Hillsdale, NJ: Lawrence Erlbaum Associates. Reprinted by permission.

to review them. The characteristics of the learner are obviously important: they include the level of individual skill, the amount and quality of prior knowledge and particular values and attitudes that might affect learning. Criterial tasks, the processes most involved in thinking itself, are a second consideration as an aspect of learning. The particular activities associated with learning -- emphasizing it is important to do something with the objects of learning -- are stressed. And finally, the nature of the educational materials themselves, how they are presented, and what they are capable of inspiring, plays an important role in setting the stage for the interaction among students and teachers in the instructional process.

From this model of learning, an instructional design proposed to enhance student thinking skills would emphasize some different conditions than have been stressed in the traditional, teacher-dominated classroom. First, the teacher's role would not be portrayed as the fount of all wisdom, a lecturing informer, or the sole repository of knowledge. The teacher as facilitator or model, occasionally as critic and always as motivator, may well work from the back of the classroom and, hopefully, also in the school's resource center and out in the community-at-large (Costa, 1984). In terms of teaching thinking, coverage of content would not be as important as explication of process, raising of novel questions, or determining the cause of student error. Thinking classrooms are busy places -- they may even be noisy and may group students differently for different learning needs. Students would be encouraged to be proud of and responsible for their own work, to seek automomy in learning, and in certain cooperative group activities, to seek these same characteristics with cooperation of their peers. In such classrooms, testing would be designed to be diagnostic, to help figure out what students don't understand, to locate the sources of misconception, and to relate as closely as possible to the content of the subject matter and to the processes associated with learning it.

What would the curriculum be like in a thinking and learning skills classroom? Eisner (1985) suggests it should be "a mind-altering device" (p.11), much as Sizer (1984) advocates it is subject matter that "should lead somewhere, in the eyes and mind of the student" (p.111). Sizer stresses, while referring to Bruner's The Process of Education, that curriculum should relate ideas meaningfully, similar to Campione and Armbruster

(1985) saying: "The trick is to make the unfamiliar more familiar and hence more memorable" (p. 332). The thinking skills curriculum, and the related strategies of learning, present a classroom dynamic of exploration and searching: to find the best match of task, information, and skill which motivated students can pursue in creating for themselves an understanding, a personal meaning, of the world around them. The expert's knowledge and ability might help the learner, but for that wonderful moment of realization and mastery, the learner him- or herself is the actual inventor or scholar or, as Feldman (1985) suggests, craftsman.

The current emphasis on thinking changes the focus of instruction and the teachers's orientation to it. Teachers, as charters of the curriculum's course, face the awesome task of pulling together the appropriate mix of material, activity, and skill for each student's progress in class. Obviously, there is a great deal to consider both in the classroom and beyond it. But time and space have been enlarged in this new relationship. Teachers should be concerned with the important teaching moment, but not just in one classroom and not just for the current year. There is need for discussion among professionals in the school about each child's long-range, developmental performance. There is a need to plan the program and select materials across several grade levels, all oriented to a common understanding of what academic achievement ought to be and become for a school's population. There is an assumption in several of the new thinking skills programs that collegial interaction among staff is a requisite of that program and a necessity for program development. There is an underlying assumption that teachers are professional and must have the autonomy to make professional decisions about learning and the curriculum. The focus is K-12 development and each student's success in schoolwork over the long haul are particular causes of concern.

The current thinking skills movement thus presents a re-ordering of the relationships of education:

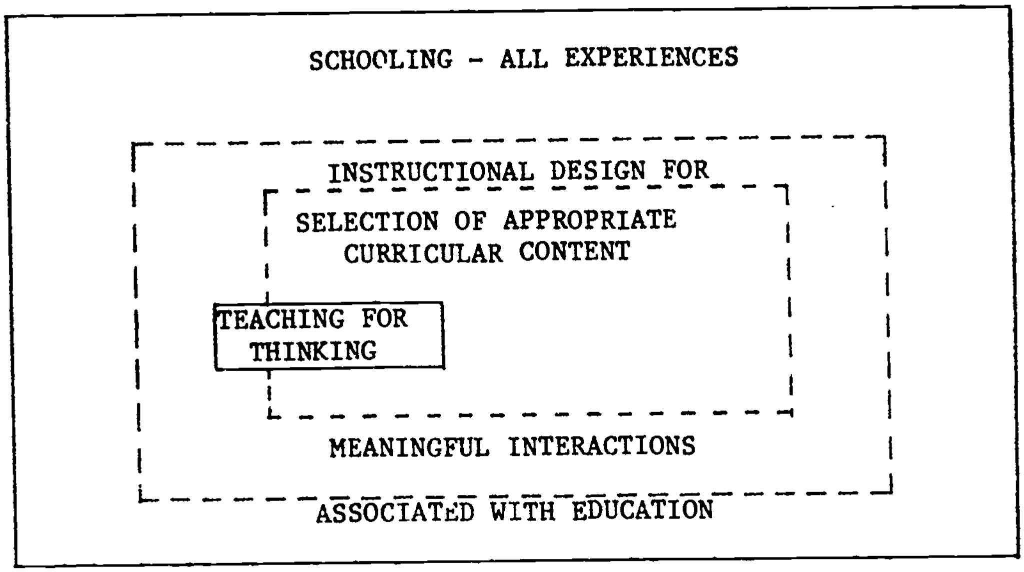


Figure 3: Educational Relationships in the School

The heart of education is the teaching process itself; it is the act on the teacher's part that mediates between the learner and that portion of the environment to be learned (Berman, 1968). It is the stage setting for the student's learning and, in Sizer's (1984) terms, it is "intuitive, serendipitous and even mysterious" (p.191). The curriculum is the important planned content that is the grist for the teaching mill and in some ways, especially in established disciplines, there are particular relationships, like metaphors, between the substance itself and ways of knowing it. Both teaching and curriculum are part of a larger instructional design which is concerned with pedagogical methods, the logical interaction with other learners, and even the interrelationships among various contents and meanings across multiple years of study. Here is where metacognitive concerns are at work and the gradual building of cognitive operations into complex schemes of subject matter knowledge takes place. Reif (1984) speaks of how the learner supplants earlier notions with more adequate conceptions as complex cognitive schemas are built; he also suggests that it may be necessary to explicitly and systematically teach these methods by careful design, if we want them to develop. Finally, schooling -- the sum total of the learner's educational experience -- rooted in high expectations and highly reliant on a qualitative educational climate -- surrounds the other dimensions and sets the tone for the entire school program. At this level, the role of school leadership, staff development, and the on-going influence of building and central office support are most keenly felt.

Basic Assumptions of a Thinking Skills Program Throughout the Curriculum

The foregoing theoretical considerations lead to several basic assumptions as the underpinnings of a thinking skills program for K-12 curriculum. These assumptions serve as the guiding principles of program development in the proposed design and include:

1. Focus instruction and curriculum on intellectual abilities embodied in basic and advanced cognitive processes which develop throughout a student's experience at school.
2. Define basic and advanced cognitive processes and employ these processes as the thinking skills in instructional decision making.
3. Continue to examine these cognitive processes and their depiction in the presentation of specific contents, as well as related to the rules of more complex content formation.
4. Vary instructional contexts and learner modalities in applications of the several cognitive processes.
5. Strive for the development of student intellectual autonomy and more efficient self-monitoring of cognitive performance.
6. Improve classroom activities and organization (individual and group) to enhance cognitive experiences at all grade levels.

7. Develop assessments, including tests, appropriate for cognitive development, and use the results of such examination diagnostically and for planning better instructional activities.

8. Focus on critical learning periods for students -- early childhood's initial presentation and upper elementary grades development (early adolescence), when there is a shift to higher order operations.

9. Constantly seek the best materials and media oriented towards developing cognitive operations and obtain such items for ready classroom use and for continued curriculum planning.

10. Plan and implement staff development programs and technical support efforts that help teachers and administrators jointly focus on thinking skills instruction and program development.

These guidelines and the research from which they are drawn are the conceptual bases for an exemplary program design described in the next section of this study.

2. PROGRAM DESIGN

There are some basic understandings that need to be sought about the the nature of the thinking and learning skills that are the heart of a school's program. Such understandings are the substantive bases around which a curricular design can be built. Such understandings are also the outcomes of seeking answers to at least the following questions:

1. What thinking and learning skills should be included in the K-12 curriculum?

2. How are these thinking and learning skills defined? Is there an order to their depiction?

3. How are these thinking and learning skills sequenced through various grade levels?

4. How are students' developing abilities accounted for in the sequence?

5. How are these thinking and learning skills related to existing courses or subject matters?

6. How are these thinking and learning skills best developed in actual classroom lessons and related student activities?

7. How are these thinking and learning skills characterized in various student assessments, including both classroom and standardized testing?

These questions represent the significant issues in the initial stage of developing a thinking skills program. They are not easy questions to answer and, in fact, research may not currently be available to respond to all of them. Yet that should not hinder the pursuit of the information required. At some point in the pursuit of this information, practicitioners will go ahead and make the commitment to an actual program and will learn from experience itself, as well as from earlier theoretical considerations.

A program design for teaching thinking requires a basic conceptualization rich enough to account for the complexity of human thought processes.

That is not a small requirement. A three-level model of thinking is presented in this design as a working description of these processes. The model is not intended as a prescription but as a tentative taxonomy considered consistent with current research. The model is based on Kitchener's (1983) work in cognition and on earlier discussions of thinking and learning (Presseisen, 1984).

COGNITION	- Related to the various thinking skills characteristic of human intelligence, including basic and complex processes;
METACOGNITION	- Related to how we become aware of and acquire thinking skills and enable others to use them;
EPISTEMIC COGNITION	- Related to the collective knowledge produced by thinking and the development and extension of such of bodies of information.

Figure 4: A Tri-Level Model of Thinking

The first level of the model refers to the cognitive processes that underlie the students' thinking. These are the skills generally focused upon and most frequently associated with academic learning: identifying, classifying, reasoning, generalizing, etc. Much of the current literature on thinking skills stresses the significance of higher order processes like problem solving and critical thinking. For the model to be useful, it must not only provide definitions of these processes, but it must also indicate in some way how these various processes relate to one another and how they might best be approached in a curriculum that seeks student success in mastering them.

The second level of this model addresses the metacognitive processes that appear to be influential in helping the student learn to work with the initial skills. What must the learner become conscious of to improve his or her performance? Are there routines that all learners can develop to assist themselves in the instructional task? How do expert performers refine such routines or even invent new ones in their quest for achievement? How do these processes develop over the thirteen years of a student's studies at public school? Like the cognitive processes, the suggested model needs to help explicate the metacognitive processes, indicate how these processes are related to one another, and give some guidance on their development over the curriculum sequence of studies at schools.

And finally, the third level of the model of thinking pursued includes the epistemic cognitions that develop as the learner works with disciplines of knowledge much older and more extensive than the immediate program. Although this level of concern is probably far beyond the domain of the elementary-secondary school -- belonging to the stretches of graduate higher education and research -- to some extent Bruner (1960) was accurate when he suggested "that intellectual activity anywhere is the same, whether at the frontier of knowledge or in a third-grade classroom" (p. 14). The child studying American history or the adolescent learning geometry or physics is bound by the nature of the disciplines themselves, and relationships within the subject areas inevitably influence the students' thinking and learning, as well as the teacher's presentation. Although the design cannot dwell on such relationships with extensive explanation -- that is something for future research -- it is mindful that, as Macdonald (1966) suggested nearly twenty years ago, disciplines are

> special languages to deal in special ways with aspects of reality. Awareness of the metaphorical nature of our discipline languages and the special perspectives each brings to common aspects of reality would be of great benefit for communicating the relatedness of the disciplines to each other (p.45).

The program design generated from the three-level model of thinking will touch on epistemic considerations, but its main thrust, in terms of application to elementary and secondary teaching, will be the cognitive and metacognitive processes of the first two levels. In those processes, the generic thinking skills that cut across the entire curricular sequence will be pursued. Where these processes appear to be consistently important to several content areas, a more generalized thinking skills sequence may be generated and some consideration of interdisciplinary relationships addressed.

The following sections seek to explicate this three level model of thinking and relate it to the organization of an overall curricular design.

Cognition: Definition of Essential Thinking Skills

There is no agreed-upon taxonomy of basic thinking skills. Various definitions of thinking exist and a relatively long historical literature has accumulated on the kinds of thinking that seem to influence education (Presseisen, 1984, pp. 2-4). The fact that the developmental stages of a learners' cognitive ability always interact with the learner's actual thinking performance is but one of the perspectives key to understanding what processes are the essential building blocks of children's thought. The first question is what are the cognitive processes themselves?

It is proposed that the learner's basic or essential thinking skills can be divided into five major categories which can then be organized according to increasing complexity and abstractness. Figure 5 suggests a continuum of these basic processes.

- QUALIFICATION - finding unique characteristics
  Units or basic identity
  Definitions; specific facts
  Problem/Task recognition;

- CLASSIFICATION - determining common qualities

  Similarities and Differences; Correspondence
  Grouping and Sorting; Comparisons
  Either/or distinctions
  Typologies;

- RELATIONSHIPS - detecting regular operations

  Parts and wholes; Patterns; Numerical progressions
  Analysis and Synthesis; Taxonomies
  Sequences and Order; Hierarchy; Prioritization
  Logical deductions; Generalizations;

- TRANSFORMATIONS - relating known to unknown characteristics creating new meanings

  Analogies
  Metaphors; Idioms
  Logical inductions; Translations
  Applications; Hypotheses;

- CAUSATION - establishing cause and effect, interpretation

  Predictions; Forecasting
  Inferences
  Judgments
  Evaluations; Assessment;

INCREASING COMPLEXITY AND ABSTRACTNESS

Figure 5: A Model of Essential Thinking Skills: Basic Processes

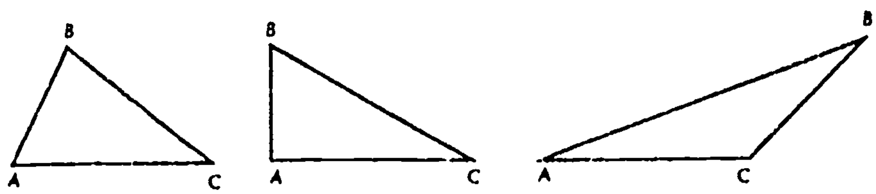
These are the groups of processes or skills which might appear when the student is working with any subject matter. It is not the exactness of any one process that is important, although their definitions are crucial to providing common meanings about thinking to teachers and students (see Appendix A).

Rather, what is important is the kind of cognitive operation that is embedded in each category of thinking. These operations are the mental manipulations that students go through in trying to make sense of academic tasks. They learn to perform these manipulations in varying contexts as well as in differing modalities (verbal, quantitative, spatial, figural, and symbolic). The primary concern of a thinking skills program is to be sure that students learn to perform the skills of each category in appropriate tasks through various subject matters, and with increasing complexity. This will assure not only that the learner finds meaning in the instructional task, but that the learning pertains to a variety of cognitive skills and to a developmentally appropriate accumulation of these skills. Some thinking skills programs are organized to do just that; they will be briefly discussed later.

Examples of specific items that tap particular thinking skill categories would be useful to illustrate these basis processes. They are herein presented. Citations are noted regarding the sources of the particular example. Discussion is provided to indicate how the particular example relates to the larger questions of curricular design.

I. QUALIFICATION: Example 1

A *triangle* is a figure that looks like one of these:

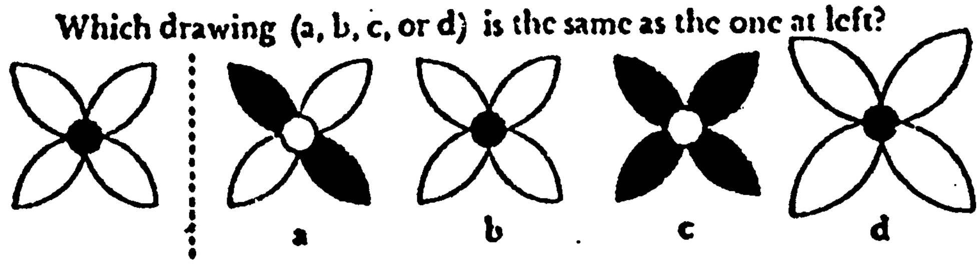


From Geometry (p. 84) by E. E. Moise & F. L. Downs, Jr., 1975, Menlo Park, CA: Addison Wesley. Reprinted by permission.

The essence of qualification is depicting the unique characteristic of the idea or concept involved in learning. The primary function of such a skill is definitional, establishing as in the item noted, the key aspects or being triangular. Much learning depends on having clear understandings of what is the object of instruction. "What is a prime number?" What does it mean to be a citizen?" "What is the weight of an object?" Building a skill of qualification is to develop discriminating abilities and to enlarge the learner's capacities for explicitness and exactitude.

II. CLASSIFICATION: Example 1

Which drawing (a, b, c, or d) is the same as the one at left?

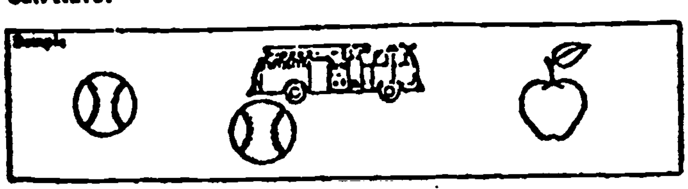


From Thinking skills (p. 87) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission.

Although there is a comparison involved in this example, the task cannot really be completed unless the unique qualities of the item on the left are first established in the student's mind. More complex thinking processes often require the student to move backward to elementary skills in order to arrive at a correct solution. Similarly, basic elements often build up to more complex operations or are extended to more encompassing instances. For example, elementary school youngsters may learn the definition of a homonym as words that sound alike but have different meanings and different spellings. Examples can be generated: "mail/male;" "sun/son;" "there/their." In the third example, the word "they're" could also be introduced and might confuse the thinker unless the basic qualification is again checked. "Does this example fit the definition?" the teacher might query. "If so, how?" The question causes the student to re-examine the initial qualification.

II. CLASSIFICATION: Example 2

"Bob can have the ball *or* the truck. Mark what Bob can have."



From Developing cognitive abilities test: Teacher's manual by J. W. Wick & J. K. Smith, 1980, Glenview, IL.: Scott, Foresman. Reprinted by permission.

II. CLASSIFICATION: Example 3

Exercise: Choose one word in each line that is a synonym and one that is an antonym of the first word.

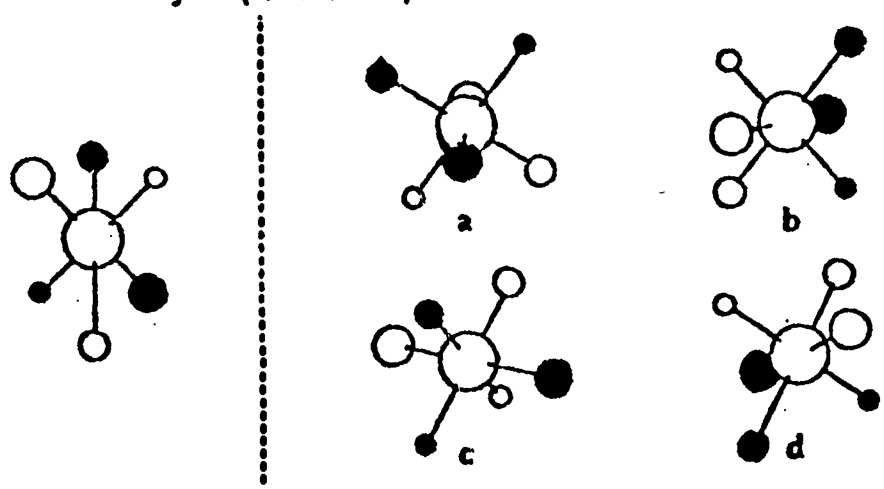
1. slim: balance, chubby, select, thin, shrewd
2. large: small, great, unique, brutal, arbitrary
3. new: exciting, ancient, small, modern, precious
4. brave: high, orderly, craven, courageous, strange
5. smart: dull, pleasant, clever, clear, agreeable

From Our language today (p. 290) by D. Conlin, H. T. Fillmer, A. Lefcourt, & N. C. Thompson, 1970, New York: American Book Co. Reprinted by permission.

Making the comparisons needed in classifications often require the learner to examine and re-examine primary data. "How do these things go together?" "What are the ways these items are alike or different?" are questions that extend the discrimination of the first category to more intricate relations, or at least, to momentary likenesses or differences to be noted and retained. Sometimes, the comparison requires mental manipulation of the evidence, as illustrated in the following example.

II. CLASSIFICATION: Example 4

Which object (a, b, c, or d) is the same as the one at left?



From Thinking skills (p. 123) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission.

Also illustrated in this example is the possibility that one problem may have multiple correct responses. Testing in most instances dwells on the notion there is only one correct response. Teaching for more powerful thinking may need to encourage students to think in terms of several alternative answers, depending on supportive conditions and constraints.

III. RELATIONSHIPS: Example 1

Which answer choice (a, b, or c) goes in the blank space?

	a	b	c
OXXOXXOXX_____OXXOXX	OXX	OXO	XXO

From Thinking skills (p. 87) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission

RELATIONSHIPS: Example 2

Put these words in alphabetical order:

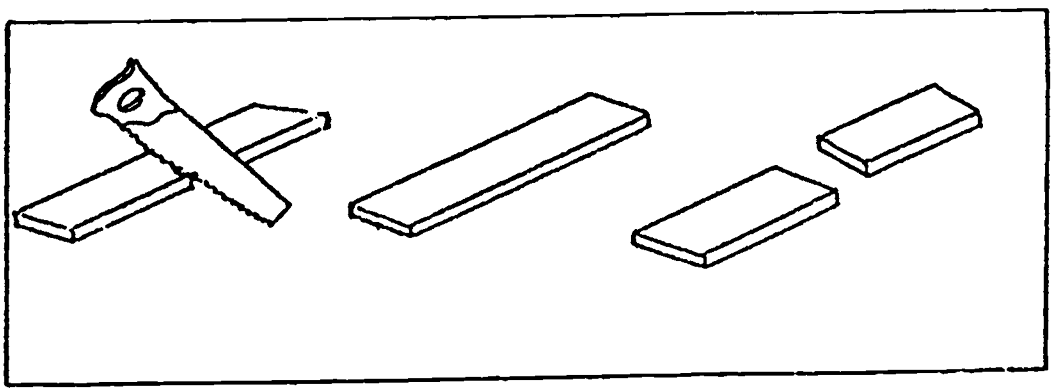
1. strenuous
2. stubble
3. structure
4. style
5. statue
6. steadfast
7. strait
8. strengthen
9. stalactite
10. stupendous
11. straight
12. struggle
13. stealthy
14. stalagmite
15. stationery

From Our language today (p. 10) by D. Conlin et al, 1970, New York: American Book Company. Reprinted by permission.

When items are related in consistent and regular ways, patterns are to be noted. In some instances, these relationships may not be obvious immediately and require the student to step back to categorization task. In other instances, the pattern may be built upon a rule relationship, as in alphabetical sequence or in a repeated pattern such as a musical scale. Arguments of deductive logic extend such rules to intricate relationships based on assumed premises.

RELATIONSHIPS: Example 3

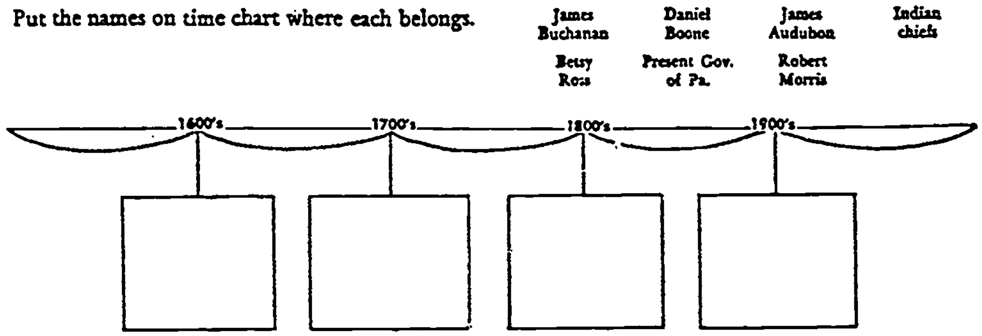
Tester: "Mark the picture that shows how the wood looked after it was cut."



From Boehm test of basic concepts (Form B, #23) by A. E. Boehm, 1971, New York: The Psychological Corporation. Reprinted by permission.

RELATIONSHIPS: Example 4

Put the names on time chart where each belongs.

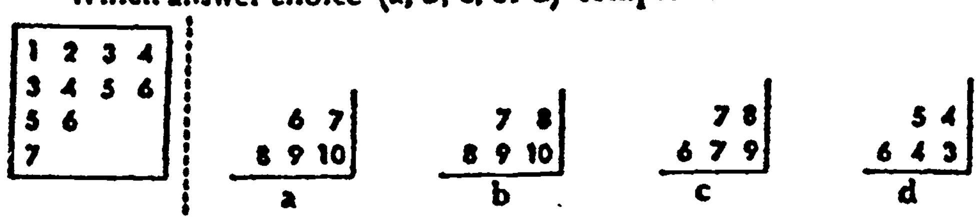


From All about Pennsylvania (p. 56) by L. Wallower & E. J. Wholey, 1971, State College, PA: Penns Valley Publishing. Reprinted by permission.

Sequence can also be a function of time and require the student to determine pattern in the sense of temporal order. Obviously, younger students may be able to deal with tasks of this sort that are close to personal experience as in example 3, but not be able to make the associations that call for historical relationships, as presented in example 4. The developmental sophistication of the learner is an important consideration in determining appropriate relationships to study.

RELATIONSHIPS: Example 5

Which answer choice (a, b, c, or d) completes the box at left?



From Thinking skills (p. 118) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission.

Numerical progression is another relationship that often is encountered at school. In some instances, possible solutions can best be dealt with by having the student analyze backwards in terms of what is the necessary next number to complete a sequence. Other types of numerical relationships may also involve reasoning back and forth "across a problem space," as the following examples indicate.

RELATIONSHIPS: Example 6

(1) Jerry says that these two statements together sort of "add up" to a third statement. What do you think it is?

(a) I have two United States coins with a total value of 15 cents.

(b) The first coin is a dime.

(c) ____

From Discovery in mathematics: Student discussion guide (p. 50) by R. B. David, 1964, Menlo Park, CA: Addison Wesley. Reprinted by permission

RELATIONSHIPS: Example 7

FENCE ARITHMETIC

5	4	6	4
1	5	5	4
8	1	2	3
2	4	4	2

___ 10's

Students are asked to circle groups of numbers that add up to 10. All the numbers must be used in contingent (fenced) groupings.

From Individualized computation Volume dl (p. 22) by R. W. Wirty, (n.d.), Washington, DC: Curriculum Development Associates. Reprinted by permission.

RELATIONSHIPS: Example 8

G-24 government, judge, president, senator

WHOLE __________ **PARTS** ________, ________, ________

From Building Thinking Skills - Book 1 (p. 216) by H. & S. Black, 1984, Pacific Grove, CA: Midwest Publications. Reprinted by permission.

The student needs to build an understanding of how finite parts are but a piece of the whole expressed in the overall mathematical problem. Having a view of the total task may help the student see the significance of the smaller task which he or she must manipulate in bringing about a solution. In other subject areas, like social studies, knowing the relationship between parts and wholes may help the student understand how the entities interact in their particular jobs and responsibilities, as the next example shows.

Spatial relationships concerned with depictions of time or quantity may be a further application of detecting regular operations. Time lines in history and geographical map grids are illustrations of tasks in which students might pursue these relationships. For example, in the Relative Position and Motion Unit of the SCIS science program, students are told the coordinates on a rectangular grid map and are asked to name the specific places designated; then in the following exercise, the students are told specific places and are asked to tell the coordinate units. The goal of this instruction is to point out that location is a relative concept contingent on exact information about spatial and quantifiable relationships (Karplus, 1967, p. 48).

RELATIONSHIPS: Example 9

1. For the sake of argument accept each of the following hypotheses and then give a logical completion for each conclusion.

   (a) Hypothesis: All boys like to play football. My brother is fourteen years old.

   Conclusion: My brother ____________________.

   (b) Hypothesis: Only careless people make mistakes. I am never careless.

   Conclusion: I ____________________.

   (c) Hypothesis: Jack always laughs when he tells a joke. Jack is telling a joke.

   Conclusion: Jack ____________________.

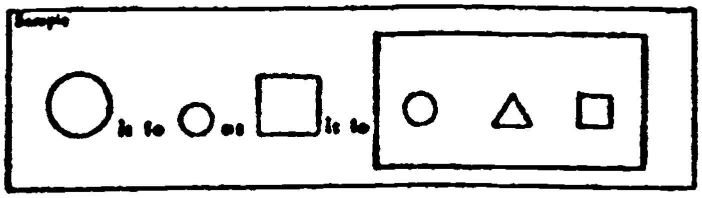
   (d) Hypothesis: In any isoceles triangle, the base angles are congruent.
   In $\triangle$ ABC, AC = BC.

   Conclusion: ____________________.

From Geometry (p. 179) by E. E. Moise & F. J. Downs, Jr., 1975, Menlo Park, CA: Addison Wesley. Reprinted by permission

The student can be introduced to making logical deductions about regular relationships; that is, given basic information that is constant in occurrence, the student can form conclusions about what these given conditions can lead to. A science class, for instance, could trace the development of Mendelian genetics and the potential heredity of subsequent generations in terms of particular knowledge about the parental group. By knowing the possible combinations of genetic traits, students, can deduce the outcome of regularly occurring relationships and anticipate the likelihood of their occurrence in the genetic hierarchy. Where relationships are not constant or intervening information suggests patterns will not be upheld, students can come to realize there are conditions that must be met to make hypotheses work accurately.

IV. TRANSFORMATIONS: Example 1



From Developing cognitive abilities test: Teacher's manual by J. J. Wick & J. K. Smith, 1980, Glenview, IL. Scott, Foresman, Co. Reprinted by permission.

Recognizing simple analogies is obviously rooted in the grouping and sorting tasks that are part of the classification category. Students can start to work on items that use familiar contexts and simpler language structures.

TRANSFORMATIONS: Example 2

Circle the right word to finish each sentence.

1. Toothache is to jaw as headache is to . . .
   a. health b. thought c. head
2. Baseball is to field as basketball is to . . .
   a. street b. court c. backboard
3. Leader is to group as chief is to . . .
   a. tribe b. team c. class
4. Week is to month as month is to . . .
   a. day b. year c. midnight

From Basic goals in spelling (6th ed.) (p. 56) by W. Kottmayer & A. Claus, n.d., New York: Webster-McGraw Hill. Reprinted by permission.

TRANSFORMATIONS: Example 3

$$\frac{\text{RENT}}{\text{MONTH}} = \frac{\text{GASOLINE}}{\quad}$$

GALLON	VOLUME	VOLATILE
a	b	c

From Thinking skills (p. 116) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission

Eventually, the examples get more complicated because differing kinds of relationships become significant. In more difficult analogies, the student needs to generate rules for hidden dimensions within the analogy. The rules form new meanings for the learner and suggest how the answer has to be related to the exemplary item. There may be as many as fifteen types of relationships involved in analogy building. Interestingly, several of them include skills from earlier categories of basic thinking skills:

1-Synonyms	-generous : liberal
2-Antonyms	-never : always
3-Symbol	-cross : Christianity
4-Worker : tool	-author : pen
5-Worker : product	-author : novel
6-Class: species	-mammal : man
7-Part : whole	-pupil : class
8-Function	-bell : rings
9-Cause	-germ : disease
10-Size	-village : city
11-Surplus	-flood : water
12-Lack	-invalid : health
13-Place	-swimming : pond
14-Sex	-duck : drake
15-Description	-snail : slow

From Junior English review exercises Book 1 (p. 15), by E. F. Wood, 1979, Cambridge, MA: Educators Publishing Service. Reprinted by permission.

TRANSFORMATIONS: Example 4

A concept may be thought of in terms of many different metaphors. For example:

Memory is an attic.
Memory is a fishing net.
Memory is a refrigerator.

How else might we think of memory? Think of several additional ways.

Memory is ____?____.

From Thinking skills (p. 138) by R. W. Samson, 1975, Stamford, CT: Innovative Sciences. Reprinted by permission

TRANSFORMATIONS: Example 5

excite	express
except	excuse
extra	exclaim
expel	explode
expect	expense
export	example
explain	exercise
explore	excellent
	exchange

4. The Latin pellere means "to drive" and the Latin portare means "to carry." Write the words from Unit 32 which mean "to drive out" and "to carry out."

From Basic goals in spelling (4th ed.) (p. 1240) by W. Kottmayer & A. Claus, n.d., New York: Webster Division, McGraw Hill. Reprinted by permission.

Playing with language may involve the kinds of transformation found in creating metaphors. Similarly, students can begin to examine the ways in which language is put together or the different ways meaning is derived.

TRANSFORMATIONS: Example 6

EXERCISE: Choose ten of the idioms below and make a drawing or cartoon to illustrate the literal meaning of each of the expressions. Under each drawing, write a sentence that conveys the same idea but uses different words. Try to avoid slang expressions or idioms in your sentences. Have your classmates guess which expressions you have represented.

1. that's not my bag
2. he blew it
3. it bugs me
4. laughing his head off
5. lose your cool
6. feeling his oats
7. being flat broke
8. too many irons in the fire
9. pulling my let
10. let the cat out of the bag
11. working to beat the band
12. throw in the sponge
13. egging him on
14. call on the carpet

From Our language today (p. 20) by D. A. Conlin et al, 1970, American Book Co. Reprinted by permission.

Exploring idioms enables students to discover implicit meaning in words and ways of not meaning what you say. Transformations involve a kind of translation process, as in the reading of dialect shown in the Irish-American version of the nursery rhyme Mary had a little lamb, illustrated in the next example.

TRANSFORMATIONS: Example 7

IV

Begorry, Mary had a littel shape,
And the wool was white entoirely.
An' wherever Mary wad sthir her sthumps
The young shape would follow her completely.

From Our language today (p. 19) by D. A. Conlin et al, 1970, American Book Co. Reprinted by permission.

TRANSFORMATIONS: Example 8

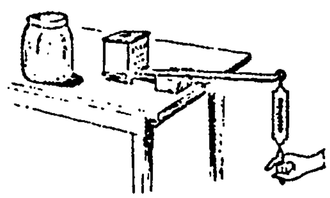
INVESTIGATING FURTHER

Set up a lever like the one shown in the diagram.□ You will need a pint milk carton, some sand or soil, a ruler to be used as a lever, a spring scale, and perhaps a wooden block as the fulcrum. Use the carton filled with sand as your load. You can apply an effort to lift the load by pulling down on the lever.

Keep the fulcrum in the same location all the time. Change the weight of the load by adding or pouring out sand. Will there also be a change in the amount of effort you have to use?

Find out whether the change in load corresponds in any way to the change in effort. You can weigh the load each time by using your spring scale. Write down your results after each trial.

□



From Concepts in science (3rd ed.) (p. 218) by P. Brandwein, E. K. Cooper, P. E. Blackwood, E. G. Hone & T. P. Fraser, 1972, New York: Harcourt Brace. Reprinted by permission.

Finally, the student can actually use experimental situations as analogous exploratory tasks. By altering conditions, as this example suggests, new information can be generated on the relationships among the various parts of the experiments. By organizing the emergent results of the experiment, rules can potentially be generated relative to constants or consistent patterns that might be possible in the relationships. The basis for establishing causal effects is laid and a new thinking category is reached. The student is able to say, "If these situations pertain to these materials, then this happens......" a new level of thinking is achieved. Simpler skills become the more complex processes of higher order reasoning and problem solving.

V. CAUSATION: Example 1

7. The statement that fits the main concept of this section is

   a. Friction is a force that has no usefullness.

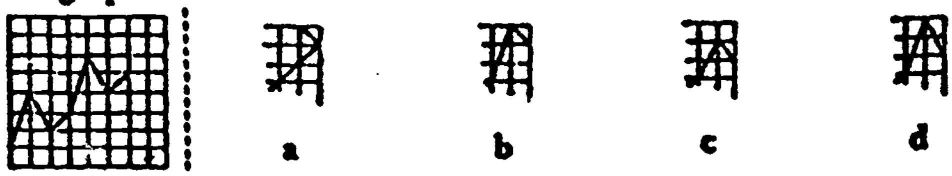
   b. The amount of friction depends on the kinds of surfaces that are in contact.

From Concepts in science (3rd ed.) (p. 240) by P. Brandwein et al., 1972, New York: Harcourt Brace. Reprinted by permission.

Causation involves assessments or evaluations that can be verified. There are controlling reasons why particular relationships are so: the proofs in a geometric solution, interpreting a writer's implications in a particular passage, determining a juror's decision about a prisoner's guilt or innocense as related to technical evidence presented.

CAUSATION: Example 2

If the present sequence continues, what will the remainder of the graph look like?



From Thinking skills (p. 122) by R. W. Samson, 1975, Stamford CT: Innovative Sciences. Reprinted by permission.

Once students determine why something is so, and give evidence of such proof, they can infer instances into the future when conditions will cause similar results to occur. Thus, students can be asked to predict outcomes in stories where only the initial circumstances are known. Completing the plot of a novel, writing the final act to a play, forecasting what will happen to economic conditions 20 years from a certain date can challenge the imagination of a youngster, but also test his or her powers of judgment, perception, and prediction. In so doing, basic thinking skills move to more complex and sophisticated levels of thought.

Cognition: Definition of Complex Thinking Skills

Many researchers on thinking acknowledge there are both essential thinking skills and more complex, "macro" processes that apply the initial abilities (Beyer, 1984; Nickerson, 1981). Unfortunately, there is a great deal of confusion about what are the complex processes and the purposes of each. This design proposes there are four complex processes to be included in the curriculum: problem solving, decision making, critical thinking, and creative thinking. Cohen (1971) suggests a fifth, chimerical thinking, which is concerned with imaginations of the inner person such as fantasies and dreams. Although these may be very influential on other forms of thought, they are not generally considered central to rational work at school --

albeit young students may spend a great deal of classroom time engaged in such activities! The four processes are depicted in Figure 6.

HIGHER ORDER SKILL	PROBLEM SOLVING	DECISION MAKING	CRITICAL THINKING	CREATIVE THINKING
TASK	Resolve a known difficulty	Choose a best alternative	Understand particular meanings	Create novel or aesthetic ideas/ products
ESSENTIAL SKILLS	Relationships Transformations Causation	Classifications Relationships	Relationships Transformations Causation	Qualificiation Relationships Transformations
YIELDS	Solution Conclusion Generalization (potentially)	Response Best alternative	Sound reasons proof, theory	New meanings, pleasing products

Figure 6. A Model of Advanced Thinking Skills: Complex Processes

The four complex processes can be seen to represent distinctly different tasks:

- <u>Problem Solving</u> - using basic thinking processes to resolve a known or defined difficulty; assemble facts about the difficulty and determine the additional information needed; infer or suggest alternate solutions and test them for appropriateness; potentially reduce to simpler levels of explanation and eliminate discrepancies; provide solution checks for generalizable value.

- <u>Decision Making</u> - using basic thinking processes to choose a best response among several options; assemble information needed in a topic area; compare advantages/disadvantages of alternative approaches; determine what additional information is required; judge the most effective response and be able to justify it.

- <u>Critical Thinking</u> - using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; to develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; to attain a credible, concise, and convincing style of presentation.

- Creative Thinking - using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or products, related to percepts as well as concepts, and stressing the intuitive aspects of thinking as much as the rational. Emphasis is placed on using known information or material to generate the possible, as well as to elaborate on the thinker's original perspective (Presseisen, 1984, pp. 8-9).

The emphasis on problem solving in the current thinking skills movement draws a clear distinction between rote learning and learning with understanding. The better problem solver not only works hard at what he or she does, but does it with understanding. Simon (1980) points out that the better problem solver works at carefully structuring the problem and at representing it. Information from memory, both short and long-term, is utilized more effectively. The better problem solver works extensively at functional analysis -- making operations explicit and seeking to understand various relational constraints. It seems that a great part of powerful problem solving is developing heuristics where no known algorithms exist. Frederiksen (1984) cites Rubinstein's (1975) list of 10 heuristics, which is also noted in Cyert (1980):

1. Get the total picture; don't get lost in detail.
2. Withhold judgment; don't commit yourself too early.
3. Create models to simplify the problems, using words, pictorial presentations, symbols, or equations.
4. Try changing the representation of the problem.
5. State questions verbally, varying the form of the question.
6. Be flexible; question the credibility of your premises.
7. Try working backwards.
8. Proceed in a way that permits you to return to partial solutions.
9. Use analogies and metaphors.
10. Talk about the problem (Frederiksen, 1984, p. 372).

Much seems to depend, too, on turning what is tacit knowledge into explicit information, information about which one is consciously aware (Reif, 1984). Lochhead (1981) has designed a classroom method of problem solving for students working in pairs to concentrate on verbalizing how they know what they know; this method is extensively described in Segal, Chipman & Glaser (1985). When information becomes so available to the learner, there is a better chance both for recognizing common pattern systems and for triggering successful problem solutions.

Although much of the problem solving literature seems to be focused on mathematical and scientific learning (Schoenfeld, 1985), this can be understood partially because problems may be easiest to clarify in these fields. Where problems follow old and tested patterns, instruction by example is often the traditional mode and familiar algorithms suffice. But, in more emergent areas, problems may not be so identifiable; then, says Simon (1980), problem solving strategies invented by the student may be the most powerful learning devices. Other academic areas besides mathematics and science are beginning to note the importance of developing problem solving abilities. Ackoff (1978) proposes bringing the art of problem solving to graduate business school students about to face complexities of management in the corporate world.

Decision making might be looked upon as a subset of problem solving, as one particular kind of resolution for specific problems. But others see the ability to decide on something and live by the consequences of such choice as a different kind of thinking entirely. Decision making involves making "reasoned choices among several alternatives, choices based on judgments which are consistent with the decision maker's values" (Cassidy & Kurfman, 1977, p. 1). The outcome of such decisions may or may not be generalizable under all conditions, because there is an assumption in circumstances requiring decision making that conditions will surely change. Decision making involves making tentative decisions -- the best alternatives at a particular moment in time -- which are relevant to incomplete evidence. Better decisions, it is proposed, will last longer and may be more anticipatory of future happenings, but they are not expected to last forever. Better decisions can be made when more is known about the topic area of discussion; the greater the certainty that can be established, the greater the chances for sound decision making.

Beyer (1984) suggests a six-step method of decision making relative to the instruction of social studies:

1. Define the goal.
2. Identify obstacles to achieving the goal.
3. Identify alternatives.
4. Analyze alternatives.
5. Rank alternatives.
6. Choose the "best" alternative (p. 19).

His method is not unlike a sequence suggested by Fair (1977) in which she also considered how the more basic thinking skills were related to stages of coming to a decision:

	STAGES	SKILLS IN THINKING
1.	Recognizing and clarifying the decision to be made, the issues to be decided.	Bringing knowledge to bear on the situation. Simple analysis of the situation, raising questions.
2.	Proposing alternatives, two or more courses which might be chosen.	Analysis in the sense of identifying key concepts, issues, value conflicts. Synthesis in the sense of proposing hypothetical courses of action.

3.	Tracing the probable consequences of each of the alternatives.	Interpreting data. Analyzing data. Developing requisite concepts and generalizations. Application in the sense of projecting or predicting consequences for each alternative.
4.	Recognizing values at stake and evaluating consequences. and qualifying values.	Evaluation of each set of consequences. Prioritizing
5.	Settling upon a choice, ready to follow as the occasion requires.	Evaluation as making the judgment. Application (p. 50).

It is not surprising that decision-making skills are often emphasized in the social studies, areas where alternative choice making related to value dimensions are common. Klausmeier, Lipham & Daresh (1983) emphasize decision making skills at the secondary level both for academic reasons and personal needs. Adolescents, they say, are especially in need of practice in making wise choices, being responsible for such choice making, and learning to live with the consequences of such decisions. To improve the student's performance on the underlying essential skills and to maximize their interaction in the complex processing of decision making becomes, then, a central focus of secondary instruction in particular.

The renewed interest in critical thinking rivals problem solving as the major focus of higher order cognitive operations in the current movement. Like problem solving and decision making, critical thinking represents a particular approach to rational thought processing. Critical thinking stresses the understanding of meanings and has a particular emphasis on relationships between language and logic (Paul, 1985). Advocates of critical thinking see it as reasoned judgment, essential to fighting confusion and prejudice, as well as an antidote to holding an opinion based on inadequate evidence or sustaining a position based on self-contradictory beliefs. Critical thinking deals primarily with interpretive judgments and stresses the thinker's obligation to suspend an evaluation, wait for evidence, and carefully weigh arguments.

Critical thinking is not a recent contender for the school curriculum. Ennis (1985) points out there has been interest in the area for over 20 years. He raises the question of how to handle this form of complex thinking in the school's program and concludes that although teaching critical thinking requires some reference to subject matter, that does not make it necessary to be taught only within one standard course or discipline. Ennis (1985) proposes that there are general principles of critical thinking which actually have application to many subject areas. At least four of these principles are:

> 1. A person's having a conflict of interest is a ground for regarding that person's claim with greater suspicion than would otherwise be appropriate.
>
> 2. It is a mistake to misdescribe a person's position, and then attack the position as if it actually were the person's position (the "strawperson" fallacy).
>
> 3. Given an "if-then" statement, denial of the consequent implies the denial of the antecedent.
>
> 4. The ability of a hypothesis to explain or help explain the facts lends support to the hypothesis, if the hypothesis is not otherwise disqualified (p. 29).

There may be instances where a principal of critical thinking works better in one subject matter than others, as in humanities or social studies, but Ennis maintains relationships can usually be drawn to a number of school subjects. One can see the relationship, too, to many of the basic thinking skills proposed earlier.

Beyer (1984) highlights ten aspects to critical thinking:

1. Distinguishing between verifiable facts and value claims.

2. Determining the reliability of a claim or source.

3. Determining the accuracy of a statement.

4. Distinguishing between warranted and unwarranted claims.

5. Distinguishing relevant from irrelevant information, claims or reasons.

6. Detecting bias.

7. Identifying unstated and stated assumptions.

8. Identifying ambiguous or equivocal claims or arguments.

9. Recognizing logical inconsistencies in a line of reasoning.

10. Determining the strength of an argument (p.20).

His list parallels Ennis' (1984) goals for a thinking skills program which stresses the students' ability to observe nuances of change and meaning in the world around them. Critical thinking encourages students to challenge assumptions in order to clarify situations, then to use the logical and psychological powers they have to determine accurate judgments. Paul (1984) suggests that the affairs of everyday life -- where critical thinking is much needed -- differ from technical domains like mathematics, physics, and chemistry in that concepts and assumptions in those fields are largely given. Not so in the happenings of the everyday world, he says; assumptions here need to be taken apart, clarified, and carefully reasoned by criteria that the learner understands and supports. He advocates a place for such thinking in the school's program and encourages educators to alter the curriculum in their application. Cornbleth (1985) suggests the social studies program is an excellent area for critical thinking instruction.

As one might assume, helping students become critical thinkers is not something that can happen overnight. Many theorists in this area advocate starting youngsters as early as possible in actual educational studies, preferably in the elementary school (Benderson, 1984). Paul (1985) points out that California has begun a statewide effort beginning with the primary grades and going through university programs. What insights on teaching critical thinking can be offered to the nation's teachers? Ennis (1985) suggests:

> ...use many examples of many different sorts; go slowly; be receptive to questions and to students' original thoughts; press for clarity; arrange for students to engage each other in discussion and challenge; arrange for them to assume progressively greater control over and responsibility for their learning; encourage students to be aware of what they are doing and review what they have done; ask for a focus (often a thesis) and for reasons in any discussion, and encourage students to do likewise (p. 30).

Like critical thinking, creative thinking is an area that has been long studied in human performance. Guilford, Torrance, and Hadamard are names of researchers whose work focused on what it means to be creative and inventive. Stages of creativity have been proposed and the idiosyncratic characteristics of artists or scientists or inventors have long been established. How can creativity influence the thinking skills curriculum? Again, some researchers suggest creativity is a particular human characteristic that ought to be encouraged in all youngsters because it is different from problem solving, decision making, and critical thinking, and it might be important to develop on its own, as well as a influence on the other forms of complex thought. Perkins (1984) notes that creativity develops particular attention to purpose and places emphasis on originality. Creative thinking helps students develop their subjective taste and intrinsic motivation, based on aesthetic principles. The importance of mobility of thought and the flexibility of ideational fluency are two additional characteristics of creative thinkers. Perkins (1984) points to the ability of creative thinkers to use analogies productively, stressing that characteristic as mutually valuable to both writers and problem solvers.

Raudsepp (1983a) suggests the creative thinker

> can scan more alternative thoughts, ride the wave of different associative currents, and think of more ideas in a given span of time than can people who are less creative. Capable of tapping his tropical imagination and producing ideas in volume, he stands a good chance of selecting and developing significant ideas (p. 173).

Together with originality and curiosity, the fluent, flexible thinker is well armed to attack the world of learning.

Eisner (1985) sees creative thinking as a major underpinning of cognitive education. Creativity enables learners to develop multiple solutions to identical problems; with Paul, he sees a great necessity for freeing students from the "one-right-answer" syndrome. Creativity helps students formulate unique solutions to problems, and to learn to formulate questions and problems themselves. Creative thinking encourages the use of intuition and perception and the development of personal standards. Creative thinking strives for insight and the realization of imagination.

Education has long been fascinated with exceptionally gifted persons. The current interest in creativity as a particular kind of thinking skill enables educators to examine giftedness as a potential characteristic of any youngster in a particular field or art. Feldman (1983, 1985) suggests that giftedness, the realization of potential, can be achieved by any learner who selects and moves through a particular domain achieving greater levels of sophistication in the domain by acquiring skills and understandings in it. He acknowledges that support by teachers and parents is important to this achievement, but the most critical aspect is the child's creative involvement with the domain itself.

The cognitive level of the program design obviously reflects a rich heritage of mental processing. The overwhelming problem for the school's curriculum is to achieve success in a comprehensive way. Not only must basic processes be mastered by the end of elementary school, but the roots of complex processes ought to have been planted as well. Two other levels of thinking must still be addressed in this design, and discussion of those, which may not be as extensively developed as cognition, must now follow.

Metacognition: The Consciousness of Thinking

It becomes obvious that many of the complex thinking processes are actually characterized by metacognitive associations. Heuristics in problem solving, anticipating probability in decision making, awareness in critical thinking and intuition in creativity are aspects of mental processes that can be made more tacit or real to the learner as he or she begins to study his or her own thinking. That grasp of consciousness, the cognizance of one's own actions and their effects, is the metacognitive component of learning, the second level of thinking in the proposed model. The current thinking skills movement maintains that the development of metacognition is crucial to the development of the cognitive processes themselves.

What is metacognition to the developing student? Based on Flavell (1976), it can be suggested that metacognition is a two-fold system that operates simultaneously as the student develops his or her cognitive abilities. Figure 7 depicts the two components of metacognitive thinking skills proposed in this design.

Monitoring of task performance is the first component and includes the "study skills" frequently cited as important to learning. The student knows what he or she must do: keep place, read directions carefully, use organizational systems (introductions, summaries, formats) to make sure the

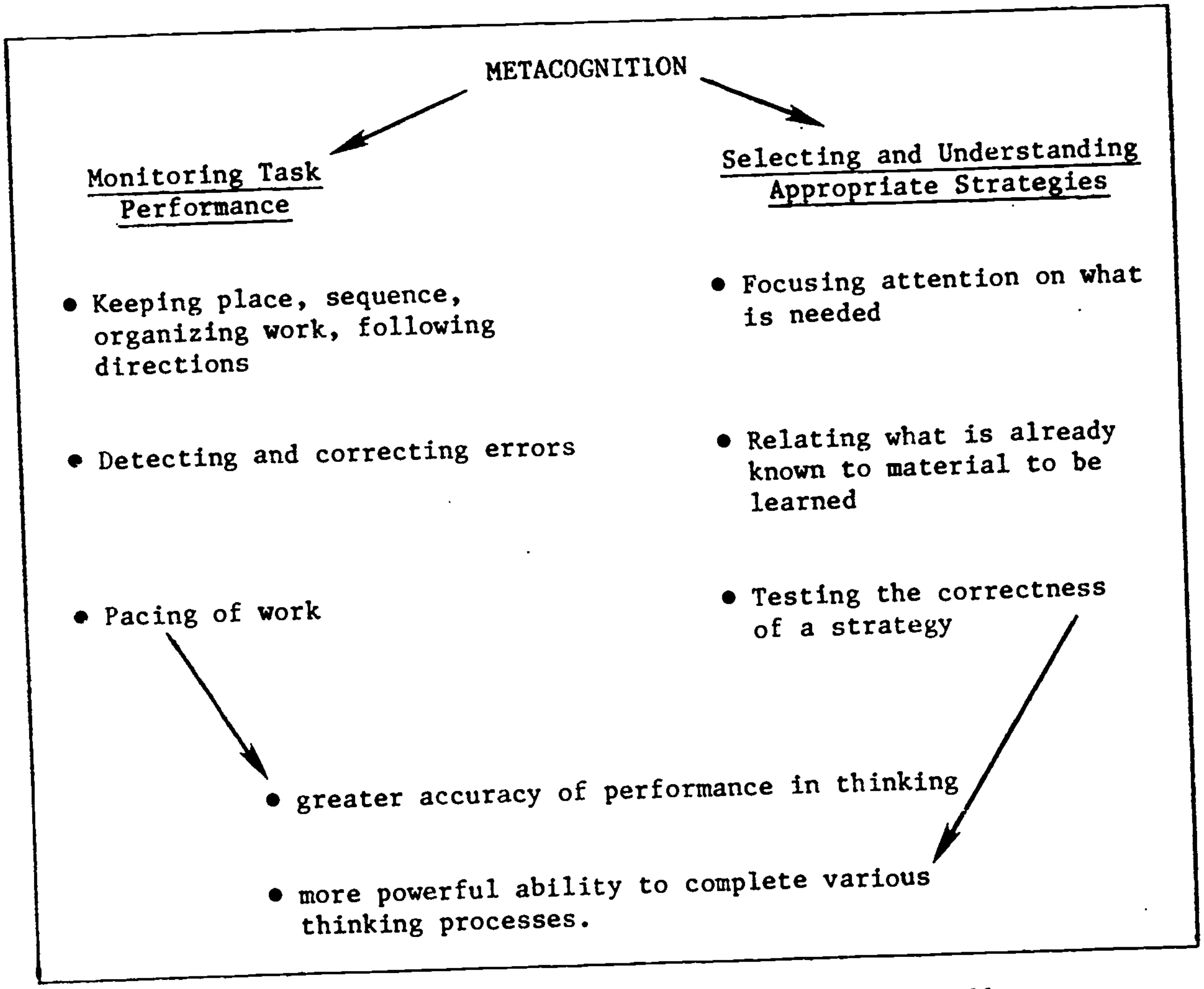


Figure 7: A Model of Metacognitive Thinking Skills

task is being approached accurately. Better student performers are keen at citing errors and correcting them; they pace their work carefully, especially on tests. Although these characteristics are rather mundane in learning, that does not mean they are trivial. Study routines, even at grade school level, are important to develop and maintain. More advanced routines make the high school student a skillful learner and thinker.

Selecting and understanding strategies used in learning is the second major thrust of metacognitive activity. It rests on a hidden assumption akin to the cognitive processing. Studying school work is not a general process; each content area or process has a particular sequence or set of strategies that makes work in that area efficient and significant. The student's best preparation in learning is to focus in on what these strategies are and how they interrelate with the content being studied. Armbruster and Anderson (1981) suggest a four-step process:

1. focus on relevant information;
2. relate to the material in a meaningful way, thus committing it to memory;
3. monitor comprehension; and
4. take corrective action when comprehension fails (p. 156).

In carrying out such metacognitive tasks, the student needs to know what _not_ to focus on and what _not_ to consider as cues; he or she needs to be aware of the importance of prior information and knowledge; he or she has to be a risk-taker -- to venture completely changing an initial approach if it appears to be a dead end. Power in metacognition means to do something efficiently and productively, not merely doing more of the same. Somehow, appropriate metacognitive tasks enable the learner to get at the key concepts or basic information more expeditiously.

One of the important aspects of learning that seems to appear relative to metacognition is the constructivist approach noted by Bruner (1985) and advocated by Piaget. The student needs to become responsible for his or her own learning and not be dependent on the interpretation of the instructor. Self-monitoring his or her own behavior begins with the awareness of focused attention, but it is also a necessary condition of being self-motivated to learn. That does not preclude running ahead and making mistakes, but that, too, can be fruitful. Reif (1984) maintains that finding the sources of one's errors is an effective way to find out why the problem or task needs to be approached with a different strategy. Such freedom to err is a first step in constructivist learning.

It is not surprising, too, that the current interest in metacognition has spurred parallel interest in neuroscience research and memory studies. Encoding is one of the first strategic thinking acts. There is an assumption about encoding that the way information is encoded determines how it is stored in the brain and, thus, how it can be retrieved. Simon (1980) speaks of how humans "chunk" the data they retain for either short- or long-term memory storage. Sylwester (1985) suggests that what and how the student studies can build particular patterns that create and connect concepts to be retained in the brain and, ultimately, retrieved. Studies of metacognitive strategies are beginning to address these issues, although many questions are still unanswered.

One of the most obvious strategies for enriching metacognitive learning seems to be associated with broadening the modalities at work when studying is actually taking place. Feuerstein (1985) notes the importance of moving from one modality to another in his Instrumental Enrichment Program and considers this transfer of modality part of the essence of learning certain interdependent cognitive tasks. Olson (1985) considers computers as tools of the intellect partly because they help the learner see and use information in another mode and, in so doing, help make tacit processes more explicit. In the same vein, Solomon (1979) finds television or film effectively intervening in a lesson because they help the learner represent certain mental skills or operations. He describes how a zoom-in camera technique helps the viewer divide a complicated scene into smaller parts and the reverse -- how a cut to a wide angle view actualizes the feeling of wholeness over parts.

Burns and Brooks (1970) have listed the transformations possible for translating skills in such modality shifts. Their list is challenging to the classroom instructor wrestling with the question of how to create student activities to implement such metacognitive practices.

> Most behaviors associated with translating can be either oral or written; and the majority are also reversible. The outline below lists the main transformations a learner could make in translating. The term "symbol" refers to any character other than a word, and the term "verbal" refers to word symbols.
>
> I. Verbal to Verbal
>
> A. One language to the same language
>
> 1. Rewording - finding a synonym
> 2. Converting to another form - poetry to prose
> 3. Rewording - idiom to general language
> 4. Rewording - simile to general language
> 5. Rewording - metaphor to general language
> 6. Abstracting (outlining) - lengthly to brief
> 7. Abstracting - concrete to abstract
> 8. Rephrasing - general language to general language
> 9. Substituting - example one to example two
>
> B. One language to another language
>
> 1. Rewording - finding synonym
> 2. Converting to another form - poetry to prose
> 3. Rewording - idiom to general language
> 4. Rewording - simile to general language
> 5. Rewording - metaphor to general language
> 6. Abstracting (outlining) - lengthy to brief
> 7. Abstracting - concrete to abstract
>
> II. Symbolic to Verbal
>
> A. Symbol to word
>
> 1. Converting - number to word
> 2. Converting - abbreviations to words
> 3. Converting - technical symbols to words
>
> B. Illustrations (two dimensional) to words
>
> 1. Converting - drawings to words
> 2. Converting - paintings to words
> 3. Converting - photographs to words
> 4. Converting - graphs to words

C. Realia (three dimensional) to words

1. Converting - objects to words
2. Converting - object system to words

III. Symbolic to Symbolic

A. Technical symbol to technical symbol

1. Converting - number to number
2. Converting - letter to letter
3. Converting - color to number

B. Symbolic to Illustration

1. Graphing - number to drawing

IV. Symbolic to Performance

A. Illustration (two dimensional) to performance

1. Constructing - drawing (plan) to scale model
2. Constructing - drawing (plan) to real object
3. Converting - music to playing

V. Verbal to Performance

A. Words or letters to performance

1. Converting - words to hand signals (p.10)
2. Interpreting - words to actions

It is interesting to note that whereas some metacognitive activities seek to bring to consciousness certain tacit dimensions of a problem, as in the pursuit of heuristics, once problems are resolved and successful routines are established, good thinkers transform this fluency into unconscious states again. Sternberg (1979) notes the importance of developing an "automatic pilot" which is whole strings of operations performed without conscious awareness after the learner has built up and practiced problem resolutions over a long period of time.

The question of developmental sequence seems significant to metacognition as well as to cognitive development. As the child moves through stages of growing cognitive awareness from a reliance on sensory data to a conceptualization of thought in formal operations, the learner becomes more sophisticated in metacognitive development, too. Initially, the student executes the task and he or she might try to represent what happens verbally -- as in Lochhead's (1985) paired problem solving technique, where the students learn from their own oral explications. Then they might try to visualize or create an image of the problem and study that concrete representation. Eventually, they may try to represent the problem symbolically, an abstraction which they can try to manipulate mentally, and create hypothetical explanations that lead to possible resolutions. "If this configuration is correct... then..." is the basis of formal understandings. The student becomes the predictor of strategies that work. It would seem that adolescence, as it appears to be a prime time for the shift from concrete to formal thinking, is also a period ripe for the refinement of metacognitive tasks, especially strategy development abilities. Monitoring task performance skills can be developed from grade school on and will need to be reinforced at each successive grade level. Metacognition also offers an explanation for why earlier intervention of specialized experience has long lasting effects on learners; the earlier the experience the more basic the associations and the greater the pattern of relationships developed across modal processes. Some patterns disappear at adolescence; Cohen (1971) notes that eidetic children lose that ability after the onset of puberty. Gardner (1983) discusses the success of Suzuki music instruction begun when young students are especially sensory keen.

In sum, the development of metacognitive abilities parallel to cognitive operations is at the heart of the current thinking skills movement. Everything is not known about these abilities, indeed questions like brain lateralization or the role of cultural influences are still very much in a research state. But designing a curriculum to enhance thinking ability in general cannot ignore the wealth of information about metacognition already available to the educational practitioner.

Epistemic Cognition: The Role of Organized Knowledge

A curriculum design needs to attend to questions regarding "What does one think about?" What role does collective knowledge, the extensive content of learned disciplines, play in the school's program? Obviously, content knowledge is central to curricular offerings. The third level of thinking in the overall model focuses on the relationships between knowledge content and cognitive processes in the school's program and their integration for the development of thinking skills.

One of the oldest concerns of schooling is determining "what knowledge is of most worth?" Endless discussions and reports focus on arguments about what content to include or exclude from the curriculum, now and in the future (Shane, 1981). Often these discussions wrangle with issues like what information do students need to know or what courses do students have to study -- what is basic, what is fundamental? By and large, at the elementary level, response to these questions has not changed a great deal. Recent reform reports (Presseisen, 1985) call for the same basic subjects of reading and writing, mathematics, science, and social studies that have been the major core of academic subjects for a long time. The new addition to the curriculum of the 80s is computer science which is a K-12 problem and which raises a second concern of curricular inclusion: What must students be able to do? This is particularly an issue for college admission, as a recent College Board publication reflects (The College Board, 1983). What competencies do students need to be able to demonstrate so that understandings in the content areas can be generated? It would seem this is fertile ground for bringing together the world of knowledge content and the emphasis on thinking skills.

Simon (1980) points out that research on cognitive skills has taught us there is no such thing as expertness without extensive and accessible knowledge. To be a student of history or geometry or literature, one needs to study a great deal of history, geometry, and literature. But coverage of the subject content is only part of the issue; the ways the historian, mathematician, or author thinks in his or her subject matter is another dimension. What issues or problems are the major concerns of their discipline, how does one work out these concerns? What problems are or are not solvable in this discipline? Over a period of time, how does the scholar develop concepts in the discipline and systems for adapting to new information or data? And there is a third curricular concern that must be considered when pedagogical constraints are placed on a subject matter and its methodology. In developing a curriculum that seeks to be meaningful to a developing student, what processes are embedded in the subject content that challenge the growing intellect of the student and enhance the structure of the subject matter at the same time? These three concerns -- knowledge, competency, and meaningfulness -- are the heart of epistemic cognition in this three-level model.

It is important to remember that the state of any discipline is constantly changing. Concepts and methodologies are in a state of flux and, in many academic areas today, technological developments more than ever are influencing the very nature of the discipline's progress. The major challenge to a curriculum developer is to build a coherent subject area reflective of all these possible forces, yet providing a balanced view of the discipline in the classroom. It is not expected that this can be done by any one teacher and it is not presumed that this can happen quickly. But the need for a continuing plan-of-action to work on this task is a requisite of curriculum planning for epistemic considerations.

Figure 8 provides a model continuum of tasks to be completed while seeking to integrate thinking skills into a subject oriented curriculum.

Step 1 - Identify key concepts and methodologies in a particular discipline;

↓

2 - Examine the discipline's concepts for their relevance to essential and complex thinking skills; and

Examine the discipline's methodologies for their relevance to metacognitive practices;

↓

3 - Develop a sequence of cognitive and metacognitive skills across various grades for instructing the discipline;

↓

4 - Focus on major clusters or patterns of skills at each grade level; Keep in mind articulation among the grades;

↓

5 - Plan and develop instructional units or materials of the discipline emphasizing the clusters of cognitive and metacognitive skills at that grade level;

↓

6 - Develop appropriate assessments of the skills in each unit as well as tests of content acquisition; and

↓

7 - Implement curriculum and testing and analyze outcomes for continued planning.

Use findings for continued planning.

Figure 8: Integrating Thinking Skills into a Subject Curriculum

The first task requires the faculty to decide what is important in their subject content and to articulate it in fairly exact dimensions. Some disciplines may be more subject to change and fluctuation than others, such as a current controversy between calculus and discrete mathematics instruction at the college level recently reported (Kaplan, 1985). But the greater the flux, the greater the need for this conversation. Step 2 requires the faculty to consider the various thinking skills and the ways they are embedded in the disciplines. It is hoped that the sequence of how these skills develop in a discipline may emerge during discussion at this stage of the continuum, but by the third step the continuum calls for articulating this very progression. It is possible that staff will find that some subject areas may have been organized in ways that erroneously call for more advanced skills prior to building essential capabilities -- for example, generalizing before careful comparisons are made. If so, the sequence can be corrected at this step. The particular nature of students at a given grade level can also be focused upon at this time. Step 4 involves a selection process in the planning; everything cannot be taught or included in the curriculum. Select the most powerful skills at a grade level and focus students' work on them. Concern for balanced and adequate representation is an aspect of this step, and so is articulation among several grades. Step 5 is the heart of the development process; it may be possible to find ready-made materials for this step, but at least the prior steps will have prepared the staff to know what materials they need. Step 6 assumes that some kind of assessment will be expected and reminds the practitioner that instruments should be reflective of the curriculum's cognitive design, as well as be related to the particular subject content. By step 7, it is hoped that outcomes from assessment are being documented and used diagnostically for further planning. The overall design becomes a series of corrected approximations.

There is a growing body of literature in various disciplines that indicates scholars in the field have already began to work on various steps of a suggested thinking continuum. Language arts specialists are examining the teaching of reading with respect to its cognitive and metacognitive dimensions (Brown, 1984; Chall, 1983). Major program efforts already exist in grade-relevant curricula for teaching reading in terms of cognitive strategies (Jones, Amiran & Katims, 1985). Similarly, attention is also being focused on written communication in terms of its relevance to the development of higher order skills, particularly critical thinking (Olson, 1984; Scardamalia, 1984). Mathematics both at elementary (Ginsburg, 1982) and secondary (Schoenfeld, 1985) levels are directing curricular concerns to how students process information and how they work at mathematical problems. In various areas of natural science, the relevance of problem solving is seriously being debated (Larkin, 1980; Lochhead, 1985). Decision making and critical thinking are foci of several examinations of the social studies (Beyer, 1985a; Kurfman, 1977). There is little literature on the interrelationships of different disciplines across the instructional program, but that is definitely a goal of the thinking skills movement. Some interesting discussions are beginning to appear on the importance of the humanities and the liberal arts, as well as science and mathematics to thought development. Billington (1985) suggests that "in the third century of our nation's history, the most pressing problem in higher education is to integrate the ancient traditions of the liberal arts with the modern imperatives of our technological society" (p.1). In a sense, that is the essence of the school's epistemic problem: to teach the knowledge accumulated in the disciplines of the past in terms of the skills required for 21st century thinking. By approaching those collections of information in terms of essential and complex thinking, we are beginning to wrestle with that dilemma. To resolve it, the elementary and secondary educators will have to join forces with the scholars in higher education in a common quest of both practitioners and theoreticians. The elusive, ideal curriculum need not be a figment of an educational planner's imagination. It can become a real thing, if we are seriously committed to building it.

Discussion About the Design

The three-level model of thinking presented does not prescribe an exact design for organizing a curriculum for teaching thinking. It suggests the questions which ought to be answered in developing such a curriculum and indicates the parameters within which those responses might be made. Much must be left to actual implementation to resolve. What models of instruction are appropriate? Should instruction be content-free or content-based? If so, when? How should testing be organized? Those issues will be examined in the next section.

Finally, the question can be asked, what sequence of courses best presents thinking skills to the student? Again, there is no singular curriculum that can guarantee the teaching of thinking. Much depends on what happens in the individual classroom. But the program design developed in this study suggests some guidelines for developing a K-12 scope and sequence based on the nature of the essential and complex skills and their relationship to metacognitive and epistemic cognition.

These guidelines include:

- Initial emphasis in the primary grades (K-4) should be on the essential processes of qualification, classification, and relationships. To the extent that students can work at transformation or causation, those processes can also be introduced.

- Middle grades (5-8) students should continue to work on qualification, classification, and relationships but emphasis should be placed on the development of transformation and causation processes. To the extent that students can work on complex processes of problem solving, decision making, critical thinking, and creative thinking, those processes can be introduced.

- Upper grades (9-12) students should continue to work on the essential processes but emphasis should be placed on the complex processes and the special relationship of these processes in particular course work, that is, in specific disciplines and the problems and concepts of these disciplines.

- Metacognitive development should be stressed in all grades with an early emphasis at the primary level on task monitoring activity or study skills. Strategy development can parallel the introduction of the essential processes of transformation and causation and work in the four complex processes, mainly during late middle school or junior high grades.

- Specific courses required in the curriculum should represent various epistemological bases and opportunities for modality development. Course work should also be selected so that students in the upper grades have the opportunity to work in all the complex processes with in-depth discipline experience.

Figure 9 represents a K-12 continuum that seeks to apply these guidelines.

When considering the content dimensions of the curriculum, the influence of various modalities should also be kept in mind. Olson (1973) reminds us that in Western culture traditional schooling has been very verbal and prone to linguistic learning. Courses like English, reading, social studies and civics, and foreign language are verbal in emphasis. Mathematics is quantitative in nature and has applications in chemistry and certain aesthetic activities which stress measurement or tempo. Some subjects emphasize spatial learning, such as geometry, drafting, the graphic arts and computer

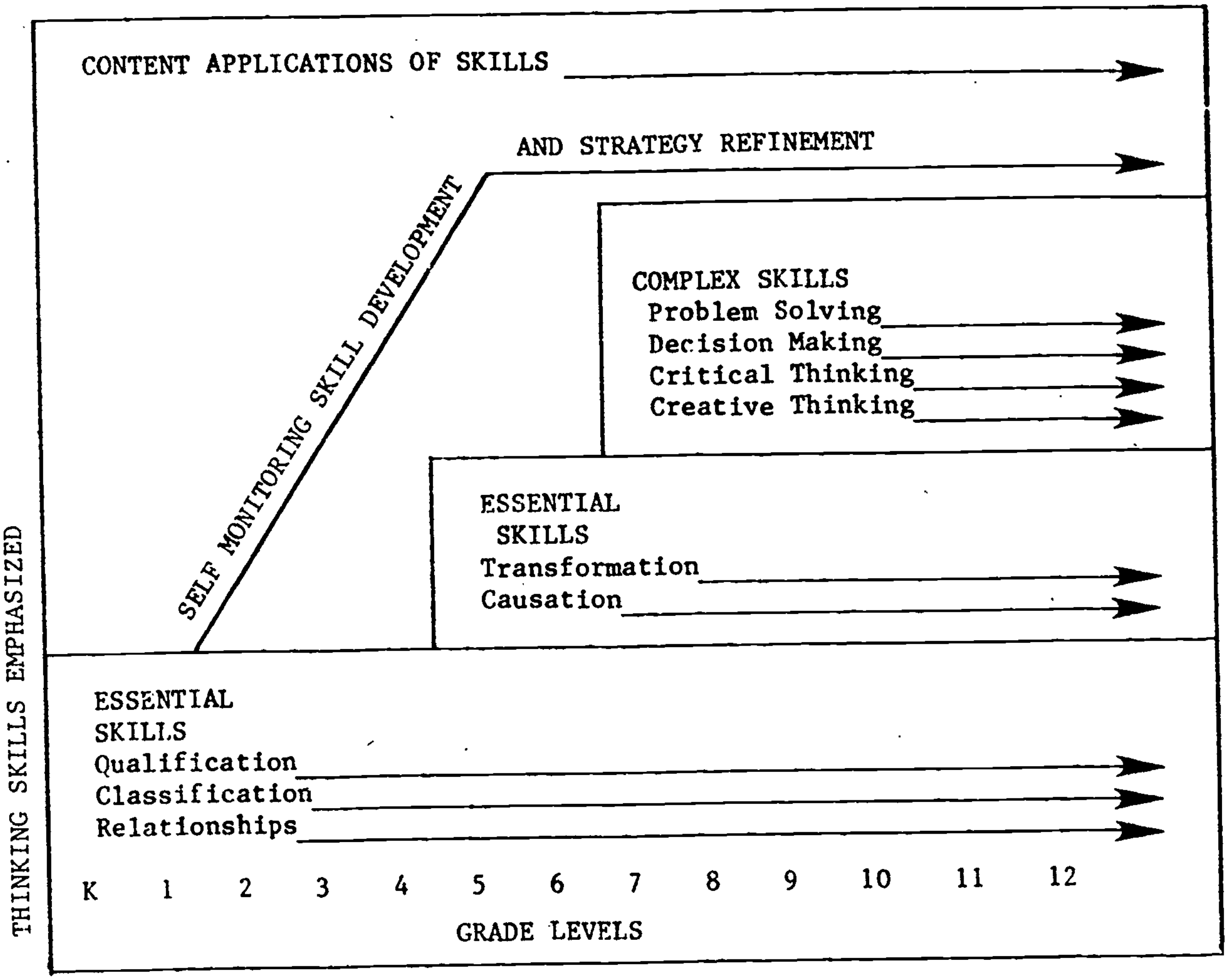


Figure 9: Thinking Skills Across the Grade Continuum

science. Students need to study in all the modalities and a full curriculum should include academic variety in a rich mixture. The several thinking skills can then be developed in-depth in the various contents and interrelationships can be sought. The question of transfer is the subject of much debate in thinking skills research; for instance, de Bono (1985) indicates it is notoriously difficult to achieve. Perkins (1985) suggests that technology and working creatively with computers might be able to assist teaching for transfer. Transfer <u>is</u> an ultimate goal of thinking skills development and it is potentially highly related to a broad-based curriculum which emphasizes a full exposure to multiple modalities and as extensive an experience in complex processing as possible.

The three-level model upon which this program design is based also has implications for the ways in which a thinking skills program is implemented. That is the subject of the next major section of this study.

3. IMPLEMENTATION

To have a program design for teaching thinking skills is the first and major step in organizing an effort to improve students' cognitive performance. Turning that design into reality requires the involvement of professional staff in various aspects of implementation, making the decisions necessary to create the instructional experiences required by the students. There are at least three key areas that need to be examined in this implementation phase: Classroom Instruction, Assessment, and Materials Development; Ongoing Staff Development; and Relating Thinking Skills Beyond the School's Program. In particular, each of these areas needs to be examined in terms of implications the proposed program design may have for making the planned curriculum an actuality.

Classroom Instruction, Assessment, and Materials Development

One of the most controversial issues in teaching thinking skills involves a decision about direct or indirect instruction. By and large, the current thinking skills movement advocates the direct instruction of thinking in the classroom and stresses the importance of metacognitive understanding of the processes involved (Beyer, 1985; Feuerstein *et al*, 1985; Nickerson, 1981). This is not to say that intuitive or indirect learning is not valuable or effective; many thinking skill advocates would probably praise much of the work of researchers two decades ago who called for "discovery learning" (Shulman & Keislar, 1966; Bruner, 1967). And there is no doubt that indirect instruction can be very motivating to students. But the current theorists are *functionally* oriented; they see these indirect approaches as inefficient and too time consuming in terms of the extensive list of thinking skills that need to be mastered. Some researchers

(Cornbleth, 1985) contend that indirect experience alone may not be sufficient for students to master the thinking task. The emphasis in the current movement is on direct instruction of these skills. Beyer (1983) has developed an instructional sequence for direct thinking skills instruction that includes:

1. Introduce the skill;
2. Explain the skill;
3. Demonstrate the skill;
4. Apply the skill; and
5. Reflect on the skill (p. 46).

How might this direct thinking skill sequence be applied to the processes presented in the proposed program design? The following exemplary lesson on analysis, based on Beyer's sequence, applies the steps of direct instruction in combination with selected available materials to engage the learner in an experience designed both to introduce the skill and to provide practice in using the skill on additional problems requiring concrete analytical thinking. This particular lesson can be used with adults or children; it is designed to introduce the major aspects of analysis using real world objects and applying metacognitive learning as well.

DIRECT TEACHING LESSON EXAMPLE

SKILL: ANALYSIS

Based on Robert Leighton's "Gone but Not Forgotten" page in Games Magazine, February 1985, 9(2), issue 60, p. 40.

1. INTRODUCE THE SKILL

Define: Separation of whole into component parts.

Examination of the relationship of parts to how something operates.

Emphasis on utility: the missing segment or part makes an object impossible to work; the segment or part is key to making the object utile.

2. EXPLAIN THE SKILL

In this lesson, there are several objects to be analyzed for their missing parts. They are all common, real-life objects that could be used by anyone.

What is missing in each object is directly related to the usefulness of that object.

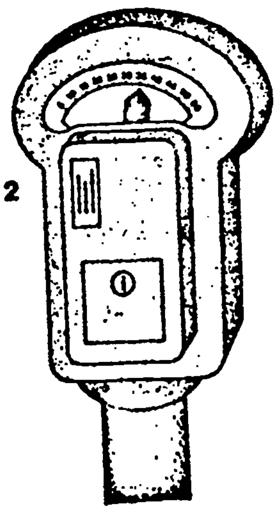
It may be useful to scan the various objects when you start to find one that you understand easily. Then go back and compare that object to the resolution of the other objects.

Try to develop a rule for your operation or solving of the task.

3. DEMONSTRATE THE SKILL

(Use an overhead transparency to show the initial example of an object to be analyzed. The same object will appear on the task sheet.)

12



1. What is the object?
2. What does it do? How do you use it?
3. Tell the sequence of the steps you would perform in using it.
4. Determine what is missing in this object? (Have you formed a rule?)
5. Explain how this deficiency makes the object useless (This is an application of the rule.)
6. Note the difficulties you might have (even temporarily) in analyzing this particular object.

Sample object to be analyzed.

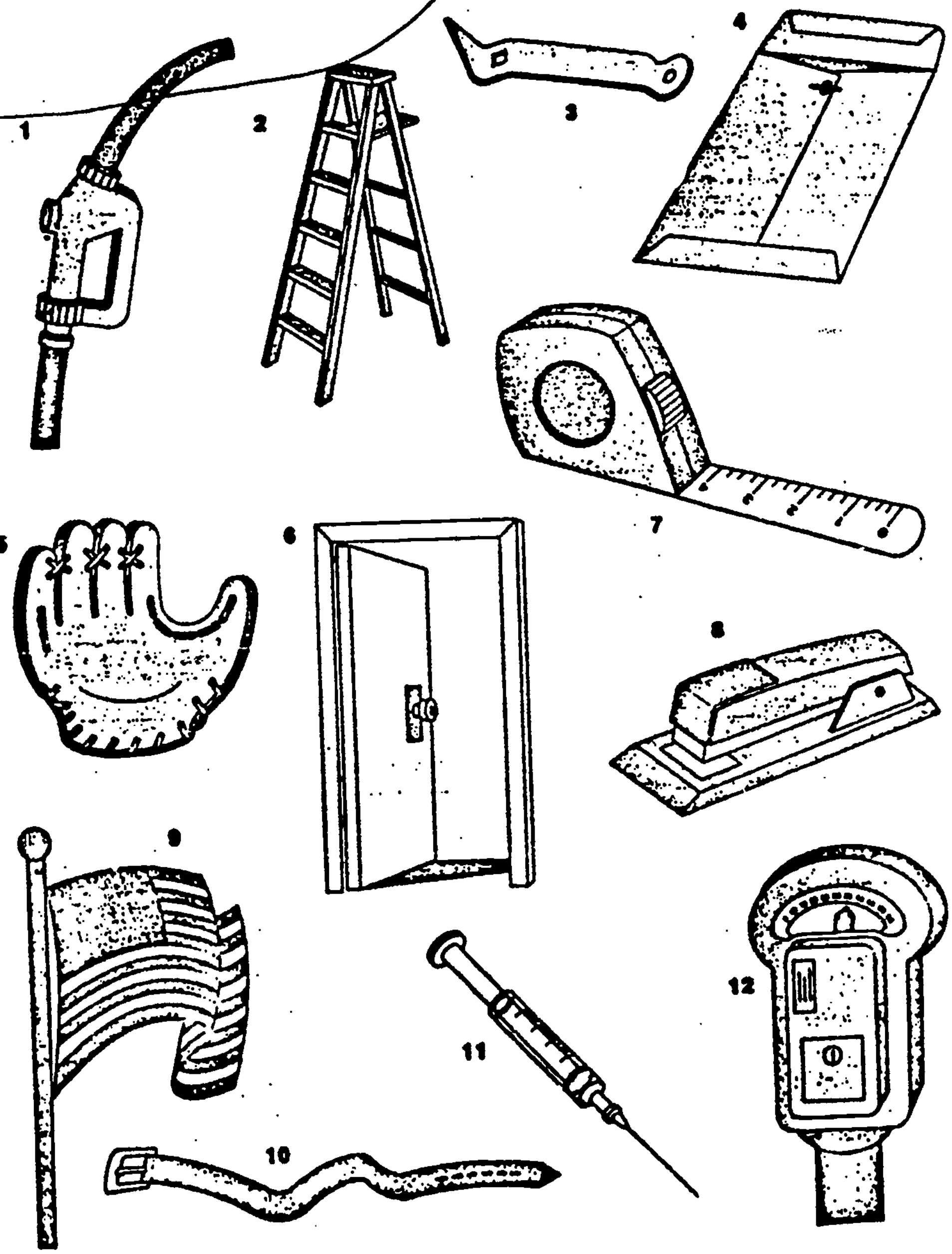
4. STUDENTS APPLY THE SKILL (Pass out the handout page; let the studnets work on the tasks -- alone or with partners.) Observe the skill being applied.

Gone but Not Forgotten **

by Robert Leighton

Each of the twelve items on this page is missing one important element that makes it very difficult, if not impossible, to use. Can you get a handle on just what's missing here?

Answer Drawer, page 64



From Games Magazine, 9(2), 1985, p. 40.

5. REFLECT ON THE SKILL

Were there compounding difficulties? What were they? Did prior knowledge seem important on any or all the objects?

What other classroom applications use "analysis"? How do they differ from this example?

Can you develop other examples of classroom work that use analysis? How are they like or not like this example?

What have you learned about your own ways of thinking? Could you improve on your thinking?

One of the interesting things to be noted when this lesson is used with adults is that they, like children, are very driven to find out what are the correct answers. They are not especially attuned to studying their own strategies and responses. This is a particularly concrete lesson experience. It is also culturally relevant; the objects familiar to adults may not be that common to inner city children, for instance. There are still symbolic or linguistic learnings to be made almost incidentally from the discussion of the correct answers. The lacing between the thumb and forefinger on the baseball mit is called "webbing." The rope that raises or lowers a flag is called the "halyard." This lesson is not designed to apply thinking skills to a particular content area. That is another issue in designing a curriculum that reflects thinking skills throughout the K-12 sequence and it is a topic to be raised, say some researchers, after the direct instruction of the skill itself has occurred.

The question of whether thinking skills should be content-based or not is a topic much discussed. At first glance, it appears there is little agreement among experts on this question. Feuerstein et al (1985) have built a curriculum noticeably devoid of content; the processes underlying Instructional Enrichment are pure in form, unfettered by the nuances of subject matter. Simon (1980), on the other hand, suggests that real command of thinking processes is ultimately embedded in the various contents of schooling. The expert performer knows intimately how the information of the discipline interrelates with the special ways of processing that data. The better thinker, says Sternberg (1981), is more able at figuring out how a problem is constructed and, once he or she has determined that relationship, is quicker and more accurate in working through to the solution.

But there is really more agreement here than first meets the eye. Feuerstein et al (1985) are addressing the instructional question, the pedagogical problem of how to help students overcome the deficits of learning which have not been mastered in the past. Simon (1980) is speaking in formative terms, by describing what ought to be on the basis of what has proven to be the past successful sequence of an expert performer. By the time a historian masters the art and craft of writing history, he or she has learned the unique and accumulated skills of a sophisticated discipline long after the particular process of of thinking, both in essential and complex terms, have been achieved. Simon sets an epistemological goal, where the best of thinking can ultimately be targeted; perhaps he describes what higher education should strive for. But it is necessary to see that goal at elementary and secondary levels through the eyes and minds of the novice students -- and that is a developmental question. Obviously, the content free skills are appropriate for a student's initial experience in working with a particular process; to identify it, to see how it works, to learn when and by what rules it operates. Once achieved at an elementary form, learning to use that skill in particular content areas can enrich the student's understanding of the skill and help the learner discover, through application, the nuances of relationships that make the skill more complexly operable. According to Sternberg (1981), the more expert performer learns to be less pedestrian in his or her strategy selection and, in doing so, becomes more efficient and productive in his or her work. As another example, in Instructmental Enrichment, Feuerstein et al (1985) have students learn what makes up a hierarchical classification. They study how to deal with the symbolic attributes of relating certain kinds of objects in particular ways:

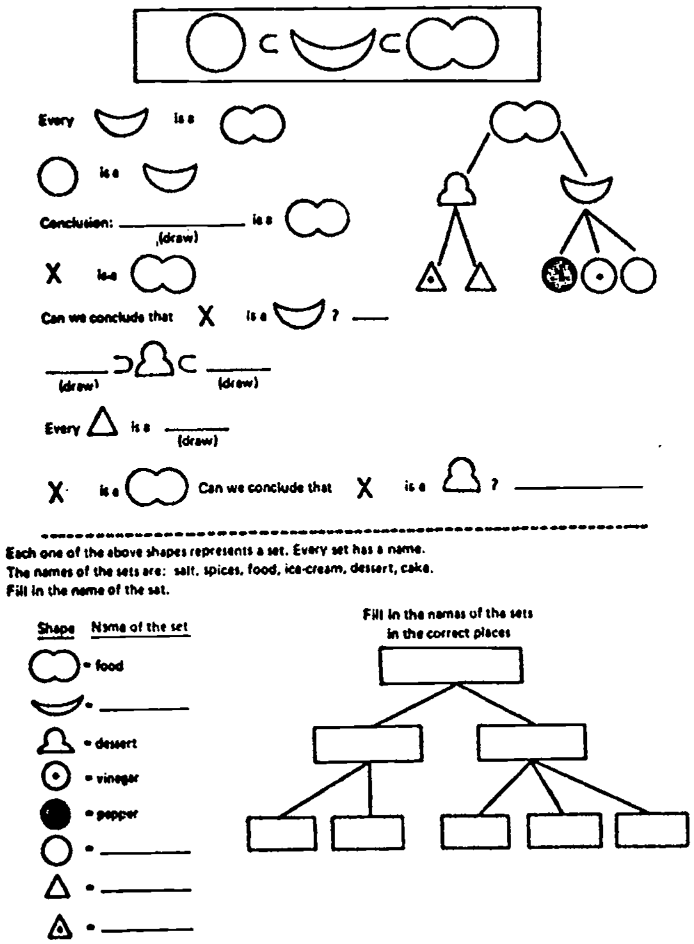


Figure 10: Instrumental Enrichment Task on Forming Hierarchies

From Instrumental enrichment, an intervention program for structural cognitive modifiability by R. Feuerstein et al, (p. 30). In J. W. Segal, S. F. Chipman & R. Glaser, (Eds.) Thinking and learning skills, 1985, Hillsdale, NJ: Lawrence Erlbaum. Reprinted by permission.

This Instrumental Enrichment task involves working with rules drawn from earlier learned cognitive processes based in classification and relationships. The learner has an experience in developing the abstract relationships of sets and subsets, as well as working with encoding and decoding, using signs, and choosing or processing relevant data. Feuerstein sees this lesson in forming syllogisms as content-free, but even here there is some level of content depiction. The success of the task is dependent on the learner knowing enough about the ingredients involved to work on the relationships called for by certain types of food. What is important regarding this instruction of thinking skills is that the content is not yet embedded in the subject matter of an academic curriculum (unless one is in culinary school!), but that the same cognitive operation, once learned, could be applied to understanding academic content. When students are ready for such content -- that is, when the student has worked through learning the initial thinking process -- and when that content is appropriate in the youngster's program, then it is important to relate specific content to the kinds of thinking the student is gradually learning to master. A K-12 curriculum, in effect, documents the growing cognitive sophistication of the learner and the gradual development of thinking in several parallel subject matters. As an example, Feuerstein's hierarchical task could be applied in either a biology curriculum or in a history course where learning hierarchical information is relevant. Consider what adolescents could do with the genealogy of the British royal house in tracing relationships among European nations before either World War I or II, or in raising question about the health of the tsarevich of Russia given what is known about the transmission of hemophilia through the family bloodline.

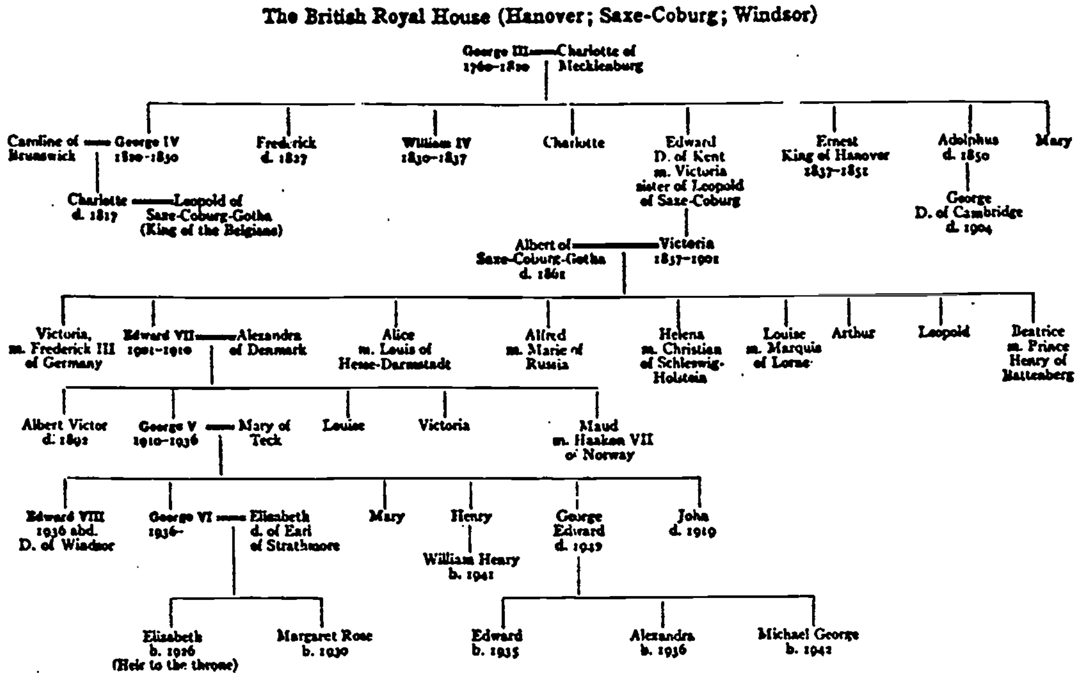


Figure 11: The British Royal House as a Basis for Hierarchical Applications

From An encyclopedia of world history (p. 610) by W. L. Langer (Ed.), 1956, Boston: Houghton Mifflin.

In terms of instruction, then, there is no conflict between content and process in the thinking skills curriculum. Current researchers are suggesting it is important that the student be able to complete the necessary cognitive tasks required by the level of sophistication of the discipline in question. They are advising that initially the student should learn the particular aspects of the thinking skill involved in relatively content-free experiences. Perhaps "content-incidental" is a more appropriate term. Learning the skill without the distraction of subject content may be the most effective initial lesson to be taught directly, followed by gradual applications to appropriate subject matters. One should not get the idea this instructional sequence is linear and in only one direction. As Piaget (1970) often reiterates, the learner must frequently go back and forth between his or her prior understanding and a new depiction, applying the differences to more and more instances until, finally, the latter form dominates. Beyer's direct instructional model calls for providing additional examples, after the first instance is learned, and particularly to introduce alternative media of presentation, as the student becomes more proficient in the use of the skill. Eventually, in the complex processes, subject matter in depth must be included in the curriculum so that the student can wrangle with problems similar to or anticipatory of those of the full-fledged historian or scientist. The essential instructional challenge, however, is to balance the teaching of a particular thinking skill with appropriate content in ways consistent with the learner's developmental level and prior cognitive experience.

The instruction of thinking skills can benefit, too, from recent findings associated with effective schools research and application. The importance of high expectations on the teacher's part is one of the variables often cited in this research (Purkey, 1984; Purkey & Degen, 1985). The heart of the constructivist approach to instruction is the teacher's belief that all students can learn the various thinking processes involved in the curriculum and are expected to do so. This attitude permeates much of the desired interaction in the classroom: designing lessons so that students can monitor themselves, organizing individual and group responsibility so that the students can work through difficulty and error, presenting information and materials in various formats for different learning styles and idiosyncratic meaning. Requiring the active participation of every student is another aspect of effective school research. Brown (1985) suggests that computers can be useful as tools of learning in such an active environment; furthermore, he stresses, the user-friendly quality of microprocessors enhances the positive learning climate of a successful classroom. Finally, seeing instruction as a cooperative venture between students and the teacher, as well as a collaborative enterprise among teachers and administrators, are further characteristics of sound thinking skills instruction that reach beyond the individual classroom. These characteristics touch on two associated aspects of instruction, the organization of assessment practices and the development of appropriate instructional materials. It is also useful to examine these topics in determining the instructional demands of teaching thinking.

Assessment is a much broader category than testing. The current thinking skills movement places a greater emphasis on assessing student progress, rather than merely checking it by examination. The emphasis is on diagnostic assessment, finding out how the student is doing, as well as what the student is thinking and, most importantly, why. The implication is that useful information should be gathered about student performance through assessment and fed back to the instructional staff so that teaching can be fine-tuned for the individual students's benefit. This approach to assessment reflects not only findings of effective schools' research (Purkey & Degen, 1985) but, more appropriately, meets the needs of metacognitive instruction, an immediate concern of the functional teaching of thinking. What do these different emphases mean to the classroom geared for the effective teaching of thinking?

Thinking skills need to be assessed in various ways, especially as associated with performance itself. Many published tests have been criticized for doing a poor job of checking performance (Darling-Hammond, 1984). Sternberg (1981) points out that very few standarized tests assess more than content, rarely asking students to consider what complex processes are involved in a test item. Pencil and paper instruments of short-answer variety are convenient measures for mass examination but uniform scoring practices associated with them often obliterate opportunities for really finding out what students think and why. Careful questioning sequences may be as useful a diagnostic device as an instructional tool -- but they require individual face-to-face contact between the teacher and the taught. Testing, Feuerstein would surely concur, is part of the mediation of learning.

It might be said, then, that criterion-referenced testing is more promising than norm-referenced testing in the thinking skills curriculum (Pratt, 1980). Criterion-referenced testing, directed toward what the student knows about the content and what he or she can do with the content, is much more appropriate for encouraging the student to work on his or her own than is a system that is normed for built-in failure. If 30 or 40% of the student population falls below accepted levels of performance, the assessment question is why this happens on academic tests? In what ways can instruction be altered to help students make the mental connections required by the test? That is the essence of a classroom climate that is conducive to learning. As Piaget (1970) said years ago, the problem is not why did the student miss the question and create error, but what question did the student answer? The assessment concern is not one of minimum competency but of maximum productivity -- how can we find out how well the student thinks or how fertile are his or her abilities in terms of developing higher order reasoning? Bracey (1983) notes the confusion between "minimum competency" and the "basics"; in the proposed program design, the essential thinking skills are basic -- basic to being able to progress toward the mastery of higher order, more complex processes. Evaluating that development lies at the heart of assessment in teaching thinking. For the classroom teacher, this challenge ought to reflect both cognitive and metacognitive performance. It suggests that competent teachers are those who are cognizant of the potential patterns of error in their subject area and knowledgeable of different ways to remediate poor learning that might occur in the classroom.

The current thinking skills movement has some implications for assessment in the classroom relative to a student's potential success. Tests should be geared to particular student's level of thinking complexity; test items should be appropriate for cognitive as well as content objectives. Teachers might want to consider more than one measure of a particular skill and some consideration to testing in varied modalities should be given. Attention to how students work through a problem should be a focus as well as concentration on the "one-right-answer." The background knowledge required to answer a question should be carefully weighed. Tests need not be solely idiosyncratic devices; sometimes group examination experiences can teach more and enable students to learn from their classroom peers. Teachers should consider the relationships between classroom or departmental testing and standardized examinations used by a district's central office. And finally, grading should be designed to capture the greatest potential for student progress and not serve as a sorting system of ascertained failure.

The selection or development of appropriate instructional materials is a third aspect of classroom implementation that needs to be addressed when planning for teaching thinking in the K-12 curriculum. Within the context of the instructional model desired, teachers develop actual classroom lessons to teach thinking. The concerns for learning noted in Figure 2 (p. 11) pertain to planning these actual instructional events; none is more important than the best materials to inspire and guide the student's action. Beyer (1985b) notes the significance of the curriculum guide to this task. Curriculum guides are the visible documents that advertise what is being taught in school and, hopefully, what is being learned. These documents most often include the goals and expectations of learning, the list of specific subject matter to be covered, and suggested or available instructional resources. Beyer (1985b) calls for some other specific additions to a curriculum guide that seeks to include thinking among its objectives: explication of the thinking processes which are part of the lesson or unit, the developmental sequence of the particular thinking skills across the grades or subject matter area, careful definitions of these skills and appropriate procedures to teach them, and rules associated with the skills' most effective application. What is most significant in his direction is that decisions concerning these curricular tasks must be made <u>before</u> materials can be sought or lessons designed. In other words, teachers, to be masters of the learning in their classroom, must think through all these steps in planning for thoughtful student performance, and materials are to be located because teachers know what they need to carry out the instructional design. For educators who recall the "teacher-proof" materials of the 1960s, this model of teacher competency is about as opposite a notion as one can find. The current thinking skills movement seeks the professional autonomy of the teacher as much as it strives for the student's growing independence in learning (Presseisen, 1985).

What implications are there for seeking appropriate instructional materials for teaching thinking? There is an enormous potential market of materials. Pratt (1980) provides an excellent list of over a hundred kinds of resources to be translated into classroom activities (see Figure 12 in Chapter 4). In the teaching of thinking, the significance of sound selection seems all-the-more important. Hunkins (1985) refers to Scheffler's list of six criteria of materials selection which can be applied by staff leaders working on thinking:

- <u>Economy</u> - Does the learner attain maximum self sufficiency in the most economical manner by using these materials?
- <u>Significance</u> - Do these materials contribute to the main emphases of teaching thinking, and to the targeted skill(s) in particular?
- <u>Validity</u> - How authentic is the content of the materials selected and how congruent are these materials in light of the objectives of this lesson/unit?
- <u>Interest</u> - How likely is it that these materials will capture the interest of the students and cater to or foster their participatory activity?
- <u>Learnability</u> - Are these materials appropriate for the particular students who are to experience the curriculum?
- <u>Feasibility</u> - Can the materials be used in the time allowed, with the current funding resources, and by the available staff? (p. 24-25)

Obviously, over time, a body of materials can be located and original materials can be generated which provide a viable base for thinking skills instruction. This is not a task to be completed overnight or in one or two weeks. Finding such material is a challenge to the instructional staff but it is also enjoyable and constructive. What counts is what happens with the materials in the classroom. It is essential that teachers take note of the effects of the materials as students use them. Teacher-made materials can be improved. The best match of materials to student needs can lead to re-ordering and elaboration of already-produced items. A recent publication of the Center for Performance Assessment (1985) suggests the same teacher task of keeping track of test items and of building a file bank of good items as one of the best ways to amass useful assessment materials for teaching higher cognitive skills. Ideally, instructional and assessment materials should be simultaneously coordinated.

The emphasis on selecting sound materials for thinking skills instruction does not preclude buying a published program for teaching thinking. Numerous programs already exist and the materials, as well as staff training packages included with them, are available to schools across the country. The program design presented in this study calls for a curriculum package that would serve the entire design. Some programs address only the essential skills or perhaps focus on only one of the complex skills. It is important that potential consumers know what their school population needs, what a particular program offers and how well it provides for or meets all their objectives, and if the cost of such a program is appropriate for their school or district's resources. Then decisions can be made to build the best possible materials base for the students whom they serve.

The Selected Resources section of this study contains exemplary materials that might be employed to serve the requirements of a comprehensive thinking skills program, such as proposed. Appendix B provides a sample teacher check list/evaluation form for selecting materials for a thinking skills program. Educators are encouraged to use this check list and to adopt it for their own purposes.

Ongoing Staff Development

Perhaps no more critical task challenges the development of a good thinking skills program than the preparation of staff to carry it out. Berman and Milbrey's (1978) research on implementing and sustaining educational change emphasizes that the fate of most improvement practices rests in the hands of those who implement them -- teachers and administrators at the school level. Further, they determined that changes are more enduring when they are not imposed from the top nor generated solely by the workforce itself. An important tenet of the current thinking skills movement is that building a sound thinking skills program within the K-12 curriculum requires collaborative planning and dialogue among participants at all levels of a school system. Ongoing staff development, in-service, and staff committee responsibilities are excellent mechanisms to make this collaboration real events in the life of a teaching staff. Moreover, such mechanisms are the basis for developing a particular structure within a school or district to lead the effort of developing thinking skills instruction. Kirst and Meister (1985) emphasize that such new structures are important for long-term reform.

The implication of the position on staff collaboration for planning thinking instruction is that staff development is not a "quick-fix" endeavor. It is also not entertainment either; programs developed for teacher development need to be well planned, should lead to actions or decisions that need to be worked with and followed up, and probably will involve the school leadership's being aware of research literature and policy formation. Ideally, a core committee of interested school staff should emerge to lead the program in a school; in districts large enough to have research personnel, these offices may have individuals who can serve as spokespersons across multiple buildings. Support from the superintendent's office and the curriculum staff, as well as from the union's leadership in districts where collective bargaining is organized, is important to a successful united effort.

What might a staff development program look like to support thinking skills instruction? Dorr-Bremme (1983) emphasizes that conjointly planned programs should strive to meet four criteria. Practices should be:

1. proximal to the everyday instructional tasks teachers need to accomplish: planning their teaching, diagnosing students learning needs, monitoring their progress through the curriculum-as-taught, placing students in appropriate groupings and instructional programs, adjusting their teaching in light of students' progress, and informing parents and other about how students are doing;

2. consonant, from teachers' perspectives, with the curriculum that teachers are actually teaching;

3. immediately accessible to teachers, so that teachers can give them to students when the time seems appropriate and have results available promptly;

4. designed to include a variety of performance "contexts," i.e., different types of response formats and tasks (p.10).

Initially, a program design should be developed for a particular school or district. Teachers need to be involved in this endeavor as a grassroots relationship. Lieberman (1984) stresses that "teacher-to-teacher links" are an essential part of building teacher ownership of a program. This is a prerequisite for program success. Involvement not only develops an important constituency, as Kirst and Meister (1985) advocate, but it mirrors an important aspect of the thinking skills design itself -- teachers, through their participation in the planning of the program, become more involved in the decision making process. Purkey and Degen (1985) see this as a basis for ownership, but more so see such involvement as the "most effective way to generate a sense of commitment to the innovative process and [to] create the necessary flexibility to address local conditions and needs" (p.2).

In dealing with the issue of a program design, certain important questions central to how the staff envisions thinking will come to the fore: What is meant by thinking processes or skills, are these already accounted for or addressed in our existing program, what scope and sequence supports it, what deficits do our students have in essential or complex processes, and how adequate is our current curriculum guide for meeting our thinking skill needs? The point to be made is that the instructional staff needs to talk to one another about these questions, not just once or twice a year but on a continuing basis. They ne' :o consider their own responses to these issues and, in some cases, ' may need to gather data or to survey their own membership to come to a general resolution. Their answers will shape the kind of staff development program they will want to participate in. They will also recast the curriculum guide that documents the school or districts' intent to the larger school community.

There are several topics that in-service programs regularly address that will also need to be part of effective staff development for teaching thinking. Beyer (1985b) suggests that instructional techniques and strategies, sharing materials, and testing and grading practices are of perennial interest to classroom instructors. But thinking skill instruction raises additional issues that can be pursued through staff development:

- What questioning techniques enhance classroom learning?
- How can grouping and assignments in class be made more effective?
- How do thinking skills apply to my particular discipline?
- How can we make better use of available test data in our school/district?
- How can teachers work more cooperatively to improve classroom effectiveness? Is there technology available (e.g. video recording material) to assist this?

Resources or even outside expertise may be needed to deal with these issues adequately in a staff development program, but it is important to work on obtaining them. A thinking skills program will build credibility if it works on answering such questions, not in a threatening way to existing staff, but as a means of motivation and encouragement that such change is valued.

One of the great dangers of any curriculum development task is the possibility that the new practice can become a plug-in, automatic frill. Bereiter (1984) cites the possibility of reducing thinking skills to mere subject matter, something to be covered and rather quickly forgotten. To avoid this danger, it is important that staff development programs address the dual question of compliance and evaluation. If a system really means business regarding the development of thinking skills instruction, then it expects honest responses and desired change with the effort, and it seeks to find out what happens in the classroom when the program is implemented. More importantly, it provides services and materials along the way to help the change occur. This would seem to call for the staff development programs to help teachers deal with three important aspects of curriculum development: The development of an exemplary or generic lesson plan to show teachers how thinking might be instituted in a classroom; determination of a general teaching algorithm, a model of good teaching that a teacher could use to monitor him-or herself; and elucidation of the questions that might be posed to the students themselves, as the consumers of a program, to see if they can earmark areas for change in particular classrooms and in the curriculum. It is emphasized that the reason for developing these materials is to assist staff in doing their tasks more effectively; used punitively, such materials could not only destroy the collegial atmosphere that is desired among staff, but it could undermine the spirit of trust that binds the very ethos of the school. In Appendices C, D, and E exemplary materials are presented for these staff development concerns. Obviously, they might be adapted for any particular school's needs.

Finally, staff development should not ignore the influence that materials and past practice have on influencing educators and getting them to consider new approaches. Large publisher displays at national meetings attest to the attraction American teachers have for the things produced by educational purveyors. The sharing of curriculum guides and networking regarding what other schools are doing in the teaching of thinking skills are natural fodder for staff development programs. As in the perusal of all resources, examining these kinds of materials calls for knowing what is needed for a particular school population and what actually constitutes practical success; the functional side of the current thinking skills movement suggests looking at such resources, hearing their purveyors tell what they do and why, is an excellent place to begin staff development. Perhaps, John Dewey would say there's no better way to perfect staff performance than to engage them in doing it.

Relating Thinking Skills Beyond the School's Program

The last concern of implementation in advancing thinking skills has to do with relating thinking and its instruction beyond the school's program. There are at least two major emphases of this concern. First, is the necessity to create alliances between school practitioners and professional improvement efforts to support better instruction. The second thrust is to connect thinking with the real world and activities that go on there.

Thinking is not the preserve of only elementary and secondary education. Obviously, it is also a central focus to the university world and to the many disciplines that make their home in academe. Common subject matter and its instruction should be a mutual concern of American teachers and professors. Unfortunately, there are not the most cordial relations among these instructors, as Schwebel (1985) has recently discussed. But cooperation with regard to at least the nature of subject content and concerns of teaching it must be sought, if thinking skills are really to be understood and pursued at higher order levels in schools and colleges. The rejuvenation of teacher education could be built on such an agenda (Presseisen, 1985) and, perhaps, interdisciplinary understandings across the curriculum might well be explored at the same time. The whole concept of the classroom or the school utilized as a "laboratory," in the original Deweyan sense of the word, can perhaps no better be applied than in the teaching of and about thinking. Particularly the professors of future teachers should examine the direct instruction of thinking and gauge its success or failings. Honig (1985) calls for these professors to provide the intellectual leadership necessary for "designing curricula for a variety of children" (p. 678). As the superintendent of instruction for the first state in the union whose majority population will soon consist of minority background citizens, it is easy to understand Honig's concern. It is appropriate, then, that California develops an extensive thinking skills program (Kneedler, 1984).

Educators interested in teaching thinking have other professional associations to work with beyond universities and teacher training institutions. Organizations like the American Educational Research Association, the Association for Supervision and Curriculum Development, the National Council for the Social Studies, the National Council of Teachers of Mathematics, the American Association of School Administrators, the National Association of Secondary School Principals, and the National Council of Teachers of English have all begun to address the teaching of thinking. Teachers should examine materials produced by these groups, consider the training programs and seminars they offer, attend meetings and conferences held both regionally and nationally. The national teachers' unions, the American Federation of Teachers and the National Education Association, have also begun to work in the higher order areas of critical thinking skills. All these efforts are potential resources for classroom instructors seeking the best materials and the most useful advice on how to organize a thinking skills program. There is no singular "one way" to teach thinking; the dialogue and the exchange cannot help but enrich a school's program and a teacher's expertise.

It is also important to connect a school's thinking skills program with the real world of work and society beyond the school. Thinking is not merely a concern of the college-bound student; every youngster needs to be cognizant of what abilities, what competencies, or what strategies are required by a particular job or a special interest. No area seems more relevant to this aspect than the need to find one's way in the sophisticated technology of the emerging industrial scene. The recent reform report of the National Science Board (1983) speaks to the "new basics" of the 21st century:

> we must return to basics, but the "basics" of the 21st century are not only reading writing and arithmetic. They include communication and higher problem-solving skills, and scientific and technological literacy -- the <u>thinking</u> tools that allow us to understand the technological world around us (p. v).

Besides emphasizing the need to address these skills as early as possible in elementary school and continuing their development through high school, the Commission's report emphasizes that youngsters need a healthy exposure to the kinds of thinking that real workers do when they are on the job. Students need to become aware that higher level performance and good study skills are not only the concerns of the classroom teacher but the critical ingredients of an employer's interest, the basis of a worker's compensation, and lifelong deficits if they are not developed when in school early in one's academic career. Teachers need to build linkages between the community and the classroom to place thinking skills instruction in such reality-oriented settings.

At the heart of preparing today's students for a growing technological future, is the issue of the role of computers in learning and thinking in today's world. The significance of computers, computer literacy, and information technology on the school's curriculum is a topic much discussed in both popular and professional education literature (Brown 1985; Turkle, 1984; Walker, 1983). There is no perfect agreement among experts on what the educational impact of computers ultimately will be. Some like Pogrow (1985) see computer technology helping increase students' higher order thinking skills, while others, like Sloan (1984), fear that microprocessors can deprive learners of much-needed direct experience with real happenings. However correct either position may be, the fact remains that computers are classroom tools that can transform data into useful information, they can extend the students' thinking with speed and accuracy, but the user's level of thinking is the major ingredient of their most successful interaction. Computers are excellent adjuncts to formal thinking, as the world of artificial intelligent systems is currently finding out (How to clone an expert, 1985). They cannot replace human thinkers -- yet -- they may make them more productive. Today's microprocessors may be strong complements to problem solving, decision making, and even critical thinking. They may be a tremendous resource for graphics generation in creativity. But imagination and dreaming and unpredictable insights are uniquely human characteristics that can enrich all the thinking processes. Schooling, while it capitalizes on prospects of the technological revolution, needs to develop these aspects in youngsters through the school's curriculum, and the implementation of a thinking skills program needs to address this curricular concern, too, as it seeks to work with the real world beyond the school.

Implementation, then, requires that educators be ever alert to ways of relating the thinking skills program to the world in which students live, the abilities they need to master the tools and technologies of that world, and to intelligently operate in society (Olson, 1976). With a program design in mind and with the essentials of implementation in place, the task that seems to emerge as the practitioner's real challenge is finding resources upon which to build both the teachers' and the students' activities for instructing thinking skills. That is the focus of the next section of this study.

4. SELECTED RESOURCE GUIDE

Education in the 20th century is marked by the growing importance of varied media for classroom instruction. Until the turn of the century, chalk, the hand-carried slate, and very few published items -- like McGuffey's Eclectic Readers -- were the hallmarks of a child's educational materials. The availability of multi-colored multi-media, including audio and video technology, are really relatively recent happenings in the school's instructional paraphernalia. These advances are a virtual smorgasbord for the classroom teacher.

Instructional materials have also become increasingly personalized or user-focused over the years. The significance of the standard pencil as a tool for student participation in the learning process is a point not often emphasized, but it is a fascinating factor, as Ecenbarger (1985) maintains, and it has major implications for curriculum development. Student workbooks have extended the potential of "paper and pencil" tasks with the use of writing. The correctability of erasing responses was perhaps the first metacognitive characteristic in education; Ecenbarger notes it was an American invention. Of course, computers carry the self-correction notion beyond the cursive page, but not yet for every student in the classroom.

The problem of the selection of appropriate resources for teaching thinking throughout the curriculum is a major practical issue of planning instruction. There are many ways to approach this concern. As in planning any aspect of instruction, one could choose to purchase a ready-made program, design original materials, or do both by mixing and matching lessons or activities with the desired objectives of the program design. The important question, it would seem, is which type of resource meets the needs of the students and provides an appropriate experience worthy of classroom time? As Nickerson, Salter, Shepard, & Herrnstein (1984) see the matter, when one is deciding whether to use a program or resource, one should carefully compare it to whatever else could be done in parallel time:

> Whenever one raises the question of whether a particular thing should be done, one should consider whether it is better to do the thing in question than the other things that might be done in the same time. It is not a matter of the advantages of doing something rather than nothing; it is a matter of how best to allocate limited resources and, in particular, limited time. In judging the merits of any educational program (or materials) then, one must consider not only its benefits relative to its costs, but in estimating its costs, one must include not only the direct costs involved in effecting that program but also the opportunity costs, i.e., the opportunities for other types of instruction that are lost by virtue of the time and resources that are devoted to the program in question (p. 135).

The decision to purchase and use one of the published thinking skills programs should follow careful decision making on a faculty's part and serious examination of what the target population of students needs to develop in ways of thinking. Consideration of teachers' skills and interests are also important in making the selection to use one published program or another. As pointed out elsewhere (Presseisen, 1984), different published programs have different emphases in terms of the thinking skills. Some programs stress essential skills, others highlight one or more of the complex processes. Few programs address all the aspects of the program design proposed in this study nor how to balance a curriculum that seeks to incorporate all these aspects. It would seem that knowing about the various published programs for teaching thinking is very important to the leadership of a thinking skills project -- teacher leaders, administrators, and supervisors should be well informed of these programs and, particularly, of their research findings. Such information, combined with a knowledge of the general resource field, is essential for those whose responsibility it is to develop the instructional activities that are the heart of a thinking skills program.

There is a great need, then, for a bank of exemplary instructional materials to be available to the persons responsible for developing the day-to-day activities of teaching thinking. These materials may be the actual materials used in class or they may be used as exemplary resources to help instructors adapt their own activities for teaching, especially in their own content areas. Beyer (1985) proposes that a professional library collection of research studies, how-to-do-it articles, and instructional materials on the nature of teaching cognitive skills should be a regular part of a school's support services. At the school level, or at a district level, it would seem extremely valuable to collect exemplary materials in a systematic way. Supervisors could refer to materials in such a collection to help instructors develop more effective lessons; teaching staffs would have a local resource -- including materials from their fellow teachers -- for ongoing planning. Obviously, budgetary support for the development and maintenance of such a collection demonstrates the school's commitment to the improved teaching of thinking. Just as obvious is the need to use such a collection, as little improvement accrues from the accumulation of dust!

What would a resource collection for teaching thinking look like to provide an adequate base for the proposed program design? Apart from the bibliography of this study, which speaks to the conceptual bases of the program and which continues to be informative to the overall design, there are a number of resource topics to pursue. The following resource guide proposes sixteen such topics and gives limited illustrative examples of the

album anecdote
apprenticeship
aquarium
artifact
audio record

book
brainstorming
bulletin board

card game
cartoon
case study
chalkboard
charade
chart
chip talk
club
collage
collection
coloring book
comic book
community
competition
computer
computer-based instruction
cooking
correspondence
crossword
cutout

dance
data sheet
debate
demonstration
design
diagram
dial-a-lecture
dialogue
diary
diorama
discussion

drama
drawing
drill

electric map
essay exercise
exhibit
experiment

fascimile
feel bag
feltboard
field research
field trip
filmstrip
flashcards
flow chart

game
globe
group project
guest

hand calculator
holograph

imitation
improvisation
interview

jigsaw

kit
laboratory
language master
lecture
library

magazine
magnetic board
map
microfilm
microfragrance
microscope

mnemonic
mobile
mock trial
model
modeling
montage
motion picture
movie photography
mural
museum music

newspaper
notebook

opague projection
outdoors
overhead transparency

painting
pamphlet
panel
pantomime
parents
participant observation
pegboard
photography
play
poem
poster
printing press
problem
programmed instruction
project
psychodrama
puppets
puzzle

questionnaire
quiz
quotation

radio

real-life experience
replica
research paper
role playing

sandtable
scrapbook
sculpture
seminar
silkscreen
simulation
sketch
slide transparency
song
source material
sports
stamps and coins
sticker book
story
student lecture
survey

tachistoscope
task cards
teacher
teacher aide
team competition
team teaching
telephone
telescope
television
terrarium
test
textbook
time-lapse photography toy
treasure hunt
tutorial
typewriter

videotape
vivarium

word game
workbook

Figure 12: Pratt's Learning Resources and Teaching Methods

kinds of materials that might be selected for that topic. There is no claim to comprehensiveness in the selection, obviously many items can be located for each topic and none is mutually exclusive. Neither is their an evaluative implication in the selection. There is a need to examine materials suggested for thinking skills instruction and to make summary judgments of their usefulness, but that is not the goal of this task which is primarily illustrative. What may be the most significant contribution of this guide are the categories under which one groups thinking skill resources, as they suggest the range of information that a staff must be cognizant of in planning thinking skill instruction in terms of this design. The check list for materials considered for teaching thinking, Appendix B, may also be useful to persons seeking exemplary classroom materials. Pratt's (1980) list of learning resources and teaching methods is presented in Figure 12 and may also serve as a guideline of the full range of possibilities toward which resources can be directed. It seems the only thing he failed to list was a rebus as a particular kind of puzzle, and one most useful to modality interplay.

Topic Areas for Thinking Skills Resources (with exemplary materials)

1. Published Programs for Thinking Skills Instruction

    1.1 Instrumental Enrichment. (Reuven Feuerstein)

    Contact: Curriculum Development Associates
    1211 Connecticut Avenue, N.W.
    Suite 414
    Washington, DC 20036

    1.2 Philosophy for Children. (Matthew Lipman)

    Contact: Institute for the Advancement of Philosophy for Children
    Montclair State College
    Upper Montclair, NJ 07043

1.3 Strategic Reasoning

Contact: Innovative Sciences, Inc.
Park Square Station
P.O. Box 15129
Stamford, CT 06901

2. Resources That Emphasize Essential Thinking Skills

2.1 Black, H., & Black, S. (1984) Building thinking skills (series).

Contact: Midwest Publications
P. O. Box 448
Pacific Grove, CA 93950-0448

2.2 High Scope Resources for pre-school and primary grades.

Contact: High/Scope Press
600 North River Street
Ypsilanti, MI 48198

2.3 Hudgins, B. B. (1977). Learning and thinking. Itasca, IL: F. E. Peacock.

3. Resources That Emphasize Complex Thinking Skills

3.1 Cognitive levels and matching project.

Contact: Dr. Martin Brooks
Shoreham-Wading River School District
Shoreham, NY 11786

3.2 Project Intelligence (Raymond S. Nickerson)

Contact: Bolt Beranek & Newman, Inc.
10 Moulton Street
Cambridge, MA 02238

3.3 Whimbey, A. (1983). Analytical reading and reasoning. Stamford, CT: Innovative Sciences.

4. Resources That Emphasize Metacognitive Thinking Skills

4.1 Novak, J. D., & Gowin, D. B. (1985). Learning how to learn. New York: Cambridge University Press.

4.2 Reutzel, D. R. (1985). Story maps improve comprehension. The Reading Teacher, 38(4), 400-404.

4.3 Yussen, S. (Ed.). (1985). The growth of reflection in children. New York: Academic Press.

5. Resources That Elaborate Problem Solving

5.1 Sheffield, L. J. (1982). Problem solving in math. New York: Scholastic Skill Books.

5.2 Walberg. J. (1980). Puzzle thinking. Philadelphia: Franklin Institute Press.

5.3 Whimbey, A., & Lochhead, J. (1982). Problem solving and comprehension. Philadelphia: Franklin Institute Press.

6. Resources That Elaborate Decision Making

6.1 Draze, D. (1982). OPTIONS: A guide for creative decision making. San Luis Obispo, CA: Dandy Lion Publications.

6.2 McKisson, M. (1983). Chrysalis: Nuturing creative and independent thought in children. Tucson, AZ: Zephyr Press Learning Materials.

Zephyr Press Learning Materials
430 S. Essex Lane
Tucson, AZ 85711

6.3 Rierson, J., & Claiborne, M. (n.d.). Extending thinking abilities (No. 8112). Buffalo, NY: D.O.K. Publishers

D.O.K. Publishers
71 Radcliff Road
Buffalo, NY 14213

7. Resources That Elaborate Critical Thinking

7.1 Halpern, D. (1984). Thought and knowledge: An introduction to critical thinking. Hillsdale, NJ: Lawrence Erlbaum Associates.

7.2 Harnadak, A. (1976). Critical thinking (series).

Contact: Midwest Publications, Inc.
P. O. 448
Pacific Grove, CA 93950

7.3 McPeck, J. E. (1981). Critical thinking and education. Oxford, England: Martin Robertson & Co.

8. Resources That Elaborate Creative Thinking

8.1 Books that illustrate using language creatively such as:

Terban, M. (1982. Eight ate: A feast of homonym riddles. New York: Clarion Books.

Terban, M. (1983). In a pickle: And other funny idioms. New York: Clarion Books.

8.2 CoRT Materials (Edward deBono)
Cognitive Research Trust

Contact: Pergamon Press
Fairview Park
Elmsford, NY 10523

8.3 Epstein, S., & Epstein, B. (1956). The first book of codes and ciphers.

Contact: Franklin Watts, Inc.
875 Lexington Avenue
New York, NY 10022

9. Resources That Apply Thinking to Language Arts

9.1 Hays, J. N., Roth, P. A., Ramsey, J. F., Foulke. (1985). The writer's mind: Writing as a mode of thinking. Urbana, IL: National Council of Teachers of English.

9.2 Suhor, C. (1983). Thinking skills in the English language arts. Problem Solving, 5(6), 1-4.

9.3 Twista-A-Plot Books

Scholastic, Inc.
730 Broadway
New York, NY 10003

Example: Otfinoski, S. (1984). Midnight at monster mansion.

10. Resources that Apply Thinking to Mathematics

10.1 Chisanbop: Original Finger Calculation
(Sun Jin Pai & Hang Young Pai)

Contact: American Book Company
135 W. 50th Street
New York, NY 10020

10.2 Nuffield Mathematics Project

Contact: John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 100

10.3 Willoughby, S. S., Bereiter, C., Hilton, P., & Rubinstein, J. H. (1985). Real math (series). LaSalle, IL: Open Court Mathematics and Science.

11. Resources that Apply Thinking to Social Studies

11.1 Cornbleth, C. (1985). Critical thinking and cognitive process. Chapter 2. In Review of research in social studies education 1976-1983. (Bulletin 75). Boulder, CO: Social Science Education Consortium.

11.2 Maps, documents, vocabulary, writing, tests.

Educational Masterprints Company
Box 269
Garden City, Long Island
New York, NY 11530

11.3 In search of a scope and sequence for social studies. (1984). Social Education, 48(4), 249-261.

12. Resources that Apply Thinking to Science

12.1 Arons, A. B. (1984). Computer-based instructional dialogues in science courses. Science, 224(4653), 1055.

12.2 Lawson, A. E. (1983). Investigating and applying developmental psychology in the science classroom. In S. Paris, G. M. Olson, & H. W. Stevenson (Eds.), Learning and motivation in the classroom (pp. 113-135). Hillsdale, NJ: Lawrence Erlbaum.

12.3 Stevens, L. A. (n.d.). Thinking tools: A young person's guide to problem solving. Stockton, CA: Stevens & Shea Publishers.

Stevens & Shea Publishers
325 E. Wyandotte St.
Stockton, CA 95204

13. Resources that Apply Thinking to the Arts

13.1 Edwards, B. (1979). Drawing on the right side of the brain. Los Angeles: J. P. Tarcher, Inc.

Distributed by Houghton Mifflin Co., Boston.

13.2 Chapman, L. (1985) Discover art. (Series). Worcester, MA: Davis Publications.

13.3 Murray, J. J. (1984). Art, creativity, and the quality of education. Independent School, 43(3), 23-27, 60-66.

14. Resources that Apply Thinking to Computer Science

14.1 Hunter, B. (1983). My students use computers: Learning activities for computer literacy. Reston, VA: Reston Publishing Company.

14.2 Martorella, P. H. (1983). Interactive video systems in the classroom. Social Education, 47(5), 325-327.

14.3 Writing to read system.

Contact: International Business Machines
IBM Building - Room 600 A&B
100 E. Pratt Street
Baltimore, MD 21202

Attn: Mrs. Joyce D. Zeh

15. Testing and Assessment Materials

15.1 Cognitive Abilities Test (CogAT)

Contact: The Riverside Publishing Company
8420 Bryn Mawr Avenue
Chicago, IL 60631

15.2 Cornell Critical Thinking Test Level X (1982). (Robert Ennis and Jason Millman)

Contact: University of Illinois Press
Box 5081, Station A
Champaign, IL 61820

15.3 Watson-Glaser, Forms A&B (Goodwin Watson and Edward M. Glaser)

Contact: Psychological Corporation
757 Third Avenue
New York, NY 10017

16. Teacher Planning Materials for Curriculum and Instruction

16.1 Furth, H. G., & Wachs, H. (1974). Thinking goes to school: Piaget's theory in practice. New York: Oxford University Press.

16.2 ASCD Resource Materials and Study Institutes (print, audio, and video materials)

Contact: Association for Supervision and Curriculum Development
225 N. Washington Street
Alexandria, VA 22314

16.3 ASCD Thinking Skills Network (newsletter and directory)

Contact: Dr. John Barell
210 Chapin Hall
Montclair State College
Upper Montclair, NJ 07043

Building a resource collection around these suggested topics is a challenging task. If well done, it can become the centerpiece of a successful thinking skills program.

IN CONCLUSION

There are numerous ways to organize a thinking skills program for elementary and secondary instruction. To develop a specific program design for teaching thinking forces the educator to examine these options and to assess them for potential benefit in the long-term curriculum. How has the experience of developing the design presented in this study influenced responding to the following questions often asked when planning a thinking skills program?

- Should there be a separate thinking skills course?
- Should a particular published program for thinking be adopted?
- Should thinking skills instruction be infused throughout the existing curriculum?

A separate course on thinking could be developed and time allotted to teaching thinking as a particular subject area. Such an arrangement would certainly highlight the specific processes of thinking and would probably elucidate the metacognitive operations as well. In curriculum development, however, experience suggests that the separate course approach may be effective for immediate remedial outcomes, but generally fails as a long-lasting curricular improvement (Kirst & Meister, 1985). Pressures to expand the already extensive course offerings are met with general resistance. What is even more critical, and which derives from the epistemic concerns raised in this study, is the lack of a teacher constituency for teaching thinking as a separate subject matter. Teachers are interested in cognitive development, but they generally need to approach that interest through the content or the grade level they consider their personal expertise. When interests from that perspective are linked to everyday curriculum and to regular instructional tasks, teaching thinking can be significant to a teaching staff. Then common bonds can be built to other disciplines or across the school's general program.

Buying a published program for teaching thinking is probably the most expeditious way to move quickly into instructing thinking in America's classrooms. It is the way the "new curricula" of the 1960s were introduced to America's students and teachers. Some very creative programs for teaching thinking are currently available (see Materials Guide section 1), and some of them offer good teacher preparation packages and have been judged effective in terms of their outcomes on student learning (Sternberg, 1984). However, as has been suggested in this study, few of these programs are comprehensive in their design, most concentrate on only one or two of the complex processes of thinking and in limited subject matter; almost none consider the development of thought processes from the kindergartener's level through senior high school. Only some of the published programs are explicitly tied to specific course content and, when they are, there are few links to other subject matters actually presented. Adopting such programs as the major means of including thinking in the curriculum will probably offer limited, but fragmented, success as an overall strategy of improvement. Curricular leadership will be required to move on to the next step, to help a staff see the importance of a thinking skills approach in their entire instructional endeavor.

The experience of developing this program design has highlighted the importance of infusing thinking skills throughout the entire K-12 curriculum. Thinking is not an "add-on" to the school's program, a subject matter to be included or removed as the whim arises. Thinking is the raison d'être of schooling, and the significance of higher order cognitive processes in the technological world facing young people is the main impetus of education's current concern. The generic thinking skills suggested in the proposed program design are important for every student to develop while in school, for without them the deficit will carry on for a lifetime. It is equally important that all instructional departments in elementary and secondary schooling see these skills as their common concern, for these processes are the building blocks of a cohesive school program. From setting the objectives in any course, to selecting textbooks or making day-to-day lesson plans, thinking should have a high priority in curriculum development.

The proposed design and its implementation plan highlight four important aspects as major contributors to a successful comprehensive thinking skills program:

- the importance of early and continued intervention in thinking;
- the significant of intrinsic motivation;
- the potential of metacognitive learning; and
- the challenge of multiple modalities.

Children, even in pre-school years, have the ability to think, to make certain discriminations, to develop memory and perceptual skills (Berrueta-Clement et al., 1984). That ability requires specific instruction in the early grades of public instruction, in fact, for disadvantaged children, some say this may be the most critical period (Council for Economic Development, 1985). A number of the reform reports advocate early intervention of cognitive development in specific content areas (National Science Board Commission, 1983). Other thinking skills specialists call for the continued role of specific intervention in teaching thinking, regularly offered content-free or content-incidental instruction that explicitly teaches students how to think and what thinking is about (Beyer, 1984, 1985a; Nickerson, 1981).

There is an emphasis on intrinsic motivation that also emerges from the proposed program for teaching thinking. Both the constructivist instructional strategy and the sheer enjoyment of working out problems or solutions in meaningful ways help make learning positive for both students and teachers. There is affect in the thinking skills movement as much as cognition. Researchers in video game technology (Perkins, 1985) are mindful of Adler's (1982) charge that youngsters are curious when they come to school, but that they often lose that quality in dull instructional environments. The need to build a thinking skills program that intellectually stimulates learners is tied to the very precepts of a thinking skills curriculum. What is key to responding to the motivation task is keeping the student's interest paramount in the mediation. As Gardner suggests, educators should remind themselves, "musically inclined preschoolers...easily learn to play simple instruments not only because they found musical patterns easy to learn, but because they found them almost impossible to forget" (Gardner quoted in McKean, 1985, p. 28).

The role of metacognitive thinking must also be emphasized as an important aspect of the proposed program design. The complexity of human thinking and its development is underlined in this aspect. The growing significance of heuristics and tacit knowledge are now seen as factors in the development of higher order skills like problem solving and critical thinking. This places much greater emphasis on the teacher's professional expertise in particular content areas, and assumes a capability for working with students on basic skill remediation in the context of subject matter. This emphasis also raises concern for developing study skill routines over the learner's entire academic career and suggests that articulation among staff, especially between levels of schooling (primary, middle, junior high, high school), is a necessity for sound instruction.

Finally, the challenge of dealing with multiple modalities in the school's curriculum becomes an important aspect of building a comprehensive thinking skills program. American schooling has long focused on linguistic and quantitative modes of thought. Recently, and with the advent of television and video technology, the importance of spatial-visual understanding has become more of an issue in learning. There is now some concern that high school seniors' visual skills have declined alarmingly (Hilton, 1985). Concern for figurative and symbolic understanding may well be part of the explanation of why students taking the recent NAEP reading tests have not progressed in higher order cognitive development (Maeroff, 1985; Olson, 1985). Recent advances in teaching writing to young students indicate that youngsters with ideational fluency, often inspired by modality maximization, do better at both writing and test performance (Hechinger, 1985). These issues raise questions about how multiple modalities are handled in the curriculum. To conceive of thinking skills only as the prerogative of so-called academic courses -- language arts, science, mathematics, and social studies -- may create a serious deficit in terms of the potential contributions of the arts, including graphic, performance and industrial studies, to students' understanding. It seems that the greater the interrelatedness of modalities, the greater the opportunities for an interdisciplinary base to the overall curriculum.

Developing the proposed program design draws attention to the real needs of what must be pursued to develop a sound thinking skills program.

These needs can be more clearly seen, perhaps, when the dimensions of the program are clarified:

- Teachers and administrators must work together to build a sound thinking skills curriculum. Time and funds need to be provided to make this collaborative effort possible.

- Teachers and administrators need to take a serious look at the existing program and consider what knowledge about thinking skills can help improve instruction as well as content development in that program.

- Teachers and administrators need to work together to create or adopt classroom experiences, including testing, to help students improve their cognitive performance through a better understanding of thinking skills development.

Unfortunately, there is much that can deter the building a sound thinking skills program in many districts. Time and money are not easily available commodities in public education. Understanding the fine points of a particular curriculum or a specialized subject matter requires a teaching staff well prepared in academic fields. Current concern for misassigned teachers across the country suggests that is a condition that requires attention in many American schools (Robinson, 1985). Most important of all, thinking may be little valued in a community, even by the educators themselves, suggesting that the leveling process sometimes associated with television and fast food chains is possible in schooling, too. How odd that the richest nation in the world -- with more books, more teachers, more computers -- could be subject to what Perkins (1985) calls "the dark side of the fingertip effect." Educators are encouraged to start work right in their own schools and districts to assess what is needed in terms of thinking skills and to build on the curriculum that already exists. (See Appendices F and G for a sample survey instrument and a district's model skills continuum K-12.)

There is at the base of the thinking skills movement a question about how schooling is related to preserving and upgrading the culture of a society. Some see this challenge as primarily a concern with literacy in a linguistic sense (Hirsch, 1985). Those involved in the thinking skills movement see it even more broadly as incorporating the perceptual and kinaesthetic beginnings that shape thought itself (Olson, 1976). What this study suggests is that the practice of schooling is intimately involved with preserving the essence of civilization, for, as Epstein (1985) suggests, the patterns of improved thinking -- the higher order skills which are the main objects of study in this examination -- can be reversed. Epstein maintains the Third Reich sought to reverse the symbolization of Abraham back to the literalness of actual behavior, to reduce symbolic thought to banal existence, mindlessness and a life without imagination. That may seem dramatic and overdrawn, but it is a possible explanation to consider in terms of understanding teacher malaise and educational frustration in current society.

The challenge to develop a comprehensive thinking skills program for all youngsters reminds us that schools are invaluable to a society not because they are the repositories of accumulated information to be spoon-fed to young students, but because they are institutions that teach the skills that make the generation of knowledge possible. Teaching thinking is far from a momentary fad. The reoccurring challenge is to prepare each generation to think for itself and every student to reach his or her highest potential.

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Appendix A

A Glossary of Thinking Terms

A GLOSSARY OF THINKING TERMS

Barbara Z. Presseisen

Although there is no one glossary of thinking terms that serves the many nuances of meaning associated with cognitive operations, a working definition is a useful base to further understanding. The following terms and their definitions are drawn from the discussion in Thinking skills: Meanings, models, and materials (Presseisen, 1984). It is hoped that they will provide some guidance to practitioners who seek to integrate thinking skills into their curricular and instructional tasks.

Algorithm. A problem solving procedure that, if followed exactly, will always yield the solution to a particular problem. Compare with heuristic.

Ambiguity. When there is more than one meaning or underlying representation in a communication or utterance.

Analogy. A problem solving strategy in which linguistic or figural similarities are noted between two or more situations, while simultaneously discerning that there are also differences in the relationship.

Analysis. Separation of a whole into its component parts.

Brainstorming. A group or individual method for generating solution paths for problems. The goal is to produce multiple possible solutions.

Causation. The act or process that occasions or effects a result.

Cognition. Related to the various thinking processes characteristic of human intelligence.

Categorical Reasoning. Also known as syllogistic reasoning. Use of such quantifiers as "some," "all," "no," and "none" to indicate category membership.

Comparison. The juxtaposing of items to establish similarities and dissimilarities.

Comprehension. The arrival at the speaker's (or writer's) intended meaning by a listener (or reader).

Conclusion. An inferential belief that is derived from premises.

Conditional Logic. Also known as propositional logic. Logical statements that are expressed in an "if, then" format.

Contrasting. To set objects or ideas in opposition or to compare them by emphasizing their differences.

Consequent. In "if, then" statements, it is the information given in the "then" clause.

Contingency Relationships. Relationships that are expressed with "if, then" statements. The consequent is contingent or dependent upon the antecedent.

Contradiction. A problem-solving strategy in which the problem solver shows that a goal cannot be obtained from the givens because of inconsistencies.

Convergent Thinking. The kind of thinking in which you are required to come up with a single correct answer to a question or problem. Compare with divergent thinking.

Classification. To sort into clusters objects, events, or people according to their common factors or characteristics.

Creative Thinking. Using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or products.

Critical Thinking. Using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; also known as directed thinking.

Decision Making. Using basic thinking processes to choose a best response among several options.

Deductive Reasoning. Use of stated premises to formulate conclusions that can logically be inferred from them.

Divergent Thinking. The kind of thinking required when a person needs to generate many different responses to the same question or problem. Compare with convergent thinking.

Epistemic Cognition. Related to the collective knowledge produced by thinking and the development and extension of this body of information.

Error. Something produced by mistake.

Estimating. To form a judgment about worth, quantity, or significance on rather rough calculations.

Evaluation. To make an examination or judgment.

Extrapolation. The estimation of a value from a trend suggested by known values.

Fallacy. An error or mistake in the thinking process.

Generalization. (a) A problem solving strategy in which the problem is considered as an example of a larger class of problems. (b) Using the results obtained in a sample to infer that similar results would be obtained for a larger population if all cases or situations were assessed.

Heuristic. A general strategy or "rule of thumb" that is used to solve problems and make decisions. While it doesn't always produce a correct answer, it is usually a helpful aid. Compare with algorithm.

Hypothesis. A set of beliefs about the nature of the world, usually concerning the relationship between two or more variables.

Hypothesize. To construct tentative assumptions that appear to account for observed effect or conditions.

Identity. A sameness of essential or generic characteristics.

Illogical. Reaching conclusions that are not in accord with the rules of logic.

Inductive Reasoning. Making observations that suggest or lead to the formulation of a conclusion or hypothesis.

Infer. To derive as a conclusion from facts or premises; to guess, surmise.

Inquiry. Seeking information about a problem or condition.

Insight. Sudden knowledge of a solution to a problem.

Interpretation. Explanations of the meaning of a situation or condition.

Intuition. The power or faculty of attaining to direct knowledge or cognition without rational thought and inference.

Judgment. The process of forming an opinion or evaluation.

Knowledge. The fact or condition of having information or of being learned.

Lateral Thinking. Thinking "around" a problem. Used to generate new ideas. Compare with vertical thinking.

Logical. Reaching conclusions that are in accord with the rules of logic, that is derived from valid (correct) conclusions.

Memory. The power or process of reproducing or recalling what has been learned and retained.

Metacognition. Related to how humans acquire thinking processes and are enabled to use those processes; conscious knowledge about our memory and thought processes.

Metaphor. Linguistic comparisons formed when we note similarities between things that are basically dissimilar, often used in creative thinking.

Mnemonics. Memory aids or techniques that are utilized to improve memory.

Ordering objects. To arrange according to predetermined criteria.

Pattern. An artistic or mechanical design revealing constant traits or replicable characteristics.

Perception. Awareness of the elements of environment through physical sensation.

Prediction. Foretelling on the basis of observation, experience, or scientific reason.

Premises. Statements that allow the inference of logical conclusions.

Problem Solving. Using basic thinking processes to resolve a known or defined difficulty.

Qualification. Finding unique characteristics of particular identity or description.

Reasoning. Has two forms: deductive and inductive. Deductive - use knowledge of two or more premises to infer if a conclusion is valid. Inductive - collect observations and formulate hypotheses based upon them.

Recall. Remembrance of what has been learned or experienced.

Relationships. Detecting regular operations.

Rules. The principles that underlie some problems or relationships.

Sequence. To arrange in a continuous or connected series based on a particular property or characteristic.

Strategy. The art of devising or employing plans toward a goal.

Syllogism. Two or more premises that are used to derive valid conclusions.

Synthesis. To put together or to form a composition or combination of parts so as to form a whole.

Thinking. The mental manipulation of sensory input to formulate thoughts, reason about, or judge.

Transformations. Relating known to unknown characteristics, creating meanings.

Vertical Thinking. Thinking that is logical and straight-forward. Used in the refinement and development of ideas. Compare with lateral thinking.

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Appendix B

Check List for Materials Considered in
Thinking Skills Program

CHECK LIST FOR MATERIALS

CONSIDERED IN THINKING SKILLS PROGRAM

RESOURCE TITLE ______________________________

AUTHOR(s) ______________________________

PRODUCER/
PUBLISHER ____________________ DATE ____________________

PAGES/
DISKS ____________________ MEDIUM ____________________

GRADE LEVEL ________________

CONTENT AREA ________________

Directions: Circle the number of the response you consider most appropriate for each item below.

5=Excellent 4=Good 3=Average 2=Fair 1=Poor

1. Materials help define or delimit a particular skill (specify skill below).

____________________	5	4	3	2	1
____________________	5	4	3	2	1
____________________	5	4	3	2	1

2. Materials help develop the model form for instructing a particular skill (specify skill below).

____________________	5	4	3	2	1
____________________	5	4	3	2	1
____________________	5	4	3	2	1

3. Materials are conducive to student use with peer interaction while practicing a skill (specify skill below).

______________________	5	4	3	2	1
______________________	5	4	3	2	1
______________________	5	4	3	2	1

4. Materials enable student to practice skill independently (specify skill below).

______________________	5	4	3	2	1
______________________	5	4	3	2	1
______________________	5	4	3	2	1

5. Materials enable student to practice skill heuristically (specify skill below).

______________________	5	4	3	2	1
______________________	5	4	3	2	1
______________________	5	4	3	2	1

6. Materials provide adequate assessment of specific thinking skills (specify skill below).

______________________	5	4	3	2	1
______________________	5	4	3	2	1
______________________	5	4	3	2	1

7. Materials provide for appropriate cognitive development level of students being instructed (specify cognitive level).

pre-operational level	5	4	3	2	1
concrete operational level	5	4	3	2	1
formal operational level	5	4	3	2	1

Appendix C

Thinking Skills Lesson Plan

THINKING SKILLS LESSON PLAN

Teacher *G. Jones*

School *Hubbard Elementary*

Grade *4*

Course *Science*

Lesson/Topic *Physical and Chemical Change*

Date(s) *October 9, 10*

CONTENT/ RESOURCES	PUPIL PERFORMANCE OBJECTIVE(S)	METHODS/ACTIVITIES	THINKING SKILLS AND RELATED INFORMATION
I. Content: Changes in Nature *A. Physical* *B. Chemical*	*I. The pupil will be able to differentiate between a physical and a chemical change by:* *A. Constructing his or her own definition of each.* *B. Citing at least 5 examples of each kind of change.*	*I. Introduction of Concept: Change* *A. Key Questions* *1. What do you think of when you speak of change?* *2. Select any object or organism and list or show the different ways it could change.* *3. How do we know that something has changed?* *4. What do you think a physical change is? A chemical change?*	*Prior Knowledge-Qualifications* *Classification/Comparison* *Analysis-Relationships* *Transformation*
II. Resources *A. Text(s)*____ *B. Demonstration Items* *C. Worksheets*		*II. Silent Demonstration by Teacher Directions for Student Processing* *A. You will now observe a series of ten demonstrations of changes; the first five will be physical changes; the last five will be chemical changes.* *1. Observe carefully.*	*Observation-Qualification*

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THINKING SKILLS LESSON PLAN

Teacher ______________________ Course ______________________

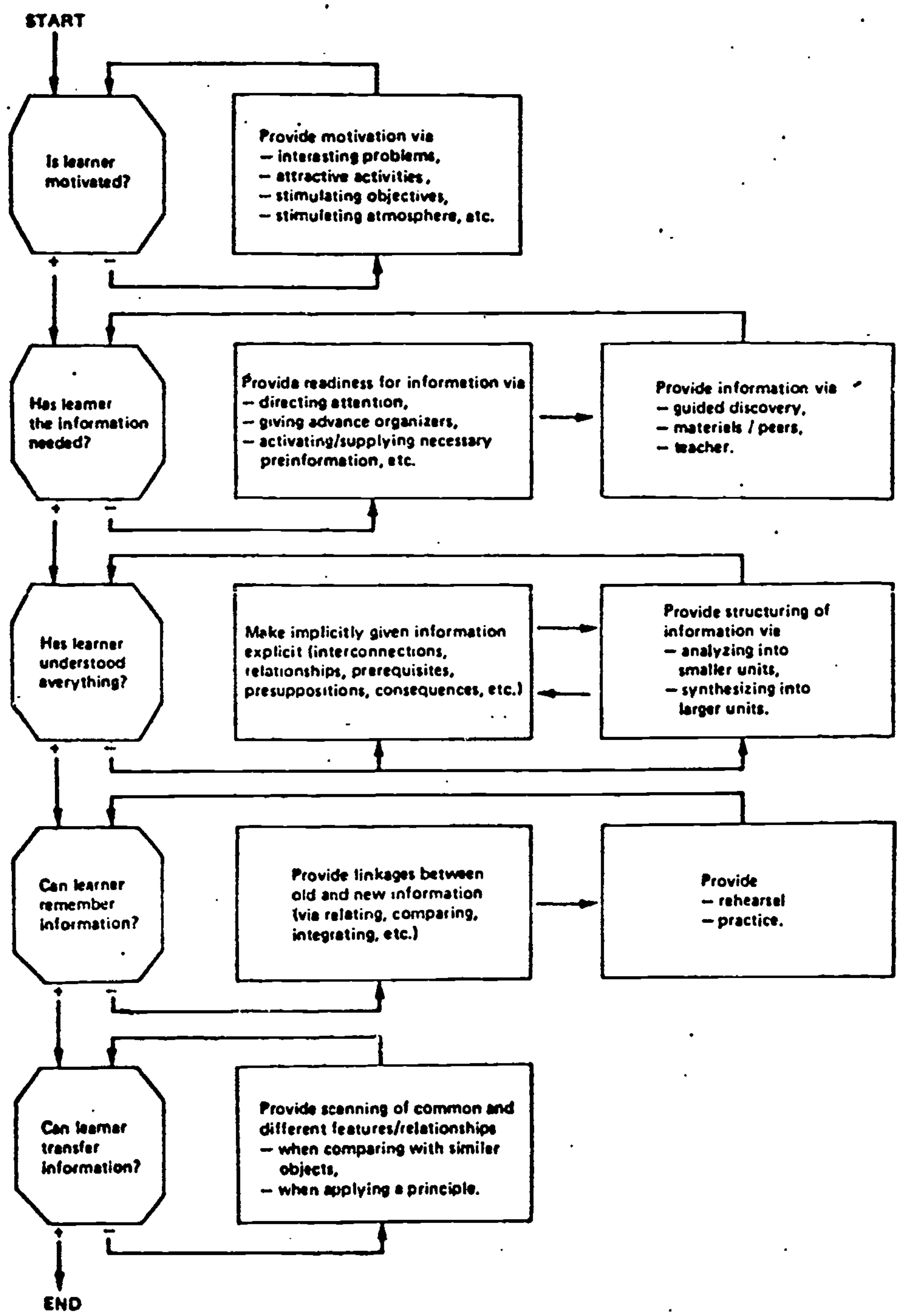
School ______________________ Lesson/Topic ______________________

Grade ______________________ Date(s) ______________________

CONTENT/ RESOURCES	PUPIL PERFORMANCE OBJECTIVE(S)	METHODS/ACTIVITIES	THINKING SKILLS AND RELATED INFORMATION
		2. *Note or draw your observation on your worksheet - part 1.*	*Classification*
		3. *Form small discussion groups and consider:*	
		a. *How was each object changed?*	*Analysis*
		b. *What actually did change?*	*Analysis*
		In your group, try to arrive at a common definition of a physical and chemical change.	*Generalization*
		4. *Complete parts 2, 3, and 4 on your worksheet by yourself.*	
		a. *Review in words or symbols how objects changed - part 2.*	*Expressive-Modality Shift*
		b. *Tell or show your own definition of a physical and a chemical change - part 3.*	*Deduction*
		5. *Was this assignment easy, medium, or hard? Mark the box in part 4. Tell why. How would you do it next time?*	*Judgment/Causation* *Metacognitive Reflection*

Appendix D

A General Teaching Algorithm



A General Teaching Algorithm*

*From "Framework for a theory of teaching" by K. K. Klauer, 1985, Teaching and Teaching Education, 1(1), p. 12.

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Appendix E

Student Curriculum Evaluation Form

Student Curriculum Evaluation Form*

YES	NO		Comments
		1. Do you believe the goals and objectives of this class are important and worthwhile to you?	
		2. Are the materials we use interesting, usable, and in ample supply?	
		3. Is the content of this unit (or lesson) important, understandable, and worthwhile to you now? Will it be useful to you in the future?	3.
		4. Are the activities we engage in helpful to you in achieving the goals and objectives of this course? Are they interesting and stimulating or boring and repetitive?	4.
		5. Am I able to facilitate your learning by what I do when I teach? What teaching strategies help you learn best?	
		Lecture	
		Discussion	
		Roleplay	
		Simulations	
		Media presentations	
		Assignments from the text	
		Small group sessions	
		6. What forms of evaluation do you think would be more useful to you -- self-evaluation, group evaluations, or teacher evaluation for projects? How do you feel when you have to take tests often?	6.
		7. How do you like the group you currently are working with? Do you think you were placed fairly for instructional purposes? Do you prefer working as a class, in small groups, or individually?	7.
		8. Do you believe you are using your time wisely in this class? Would you like more time for independent work on your interests? Would you like to have our class time shortened or extended?	8.
		9. Do you like the physical arrangement of our classroom? Would desks or tables and chairs better facilitate our work? Is the space we have available adequate for our classroom activities?	9.

*From "The use of a research model to guide curriculum" by E. M. Klein, 1983, Theory Into Practice, 22(3), p. 201-202.

Appendix F

Thinking Skills Throughout the K-12 Curriculum:
A Thoughtful Appraisal

THINKING SKILLS THROUGHOUT THE K-12 CURRICULUM

A THOUGHTFUL APPRAISAL

Barbara Z. Presseisen

TYPICALLY,

I. DOES YOUR SCHOOL COMMUNITY...

	YES	NO
1. Value thinking as a primary goal of education for <u>all</u> students?	___	___
2. Have an expectation that all students can enhance their intelligence by appropriate learning and experience?	___	___
3. Agree on major thinking skills/processes that are the basis of the school's program and provide an updated document to share this agreement among all staff?	___	___
4. Arrange learning activities in order of increasing complexity and greater abstraction across various grade levels and among different disciplines?	___	___
5. Organize instruction around a variety of modalities and thinking-oriented materials?	___	___
6. Encourage teachers to plan cooperatively for thinking instruction across the K-12 program?	___	___
7. Provide in-service or staff development to help teachers improve the inclusion of thinking throughout the school program?	___	___

I. DOES YOUR SCHOOL COMMUNITY ... (continued)

	YES	NO
8. Assess student growth of various thinking abilities and use results of such assessment in future planning and development?	___	___
9. Provide for the regular review and acquisition of thinking-oriented materials?	___	___

II. IN YOUR CLASSROOM, DO YOU...

	YES	NO
10. Use thinking skills as a base for lesson planning and development?	___	___
11. Teach thinking skills directly and carefully follow up on student application and practice?	___	___
12. Encourage students to reflect on thinking processes and share insights with their classmates?	___	___
13. Look for sources of student's error in work completed incorrectly or inadequately?	___	___
14. Enable better classroom performers to model skills for classmates and/or share effective strategies for learning?	___	___
15. Vary your questioning technique or discussion guidance according to student response?	___	___
16. Encourage students to help develop teaching and testing approaches?	___	___

II. IN YOUR CLASSROOM, DO YOU... (continued)

	YES	NO
17. Reflect on your own instructional approaches and change them for greater teaching impact?	____	____
18. Ask other teachers to share thinking-oriented insights/experiences with you?	____	____

III. DO YOUR STUDENTS...

	YES	NO
19. Settle down to work routines quickly?	____	____
20. Question or ask for additional information spontaneously?	____	____
21. Reply to direct questions with relevant and complete answers?	____	____
22. Check or proofread their work without a request to do so?	____	____
23. Take responsibility for make up assignments on their own?	____	____
24. Look for different or alternate ways to solve problems?	____	____
25. Show enthusiasm for solving problems about unknown contents or new materials?	____	____

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Appendix G

A Model of Thinking Skills: A Basic Process Continuum Pre K to 12

BALTIMORE CITY PUBLIC SCHOOLS
THINKING SKILLS PROGRAM

A MODEL OF THINKING SKILLS: A BASIC PROCESSES CONTINUUM PREK-12*

Qualifications	Classifications	Relationships	Transformations	Causation
basic identity; definition facts, problem/task recognition	similarities and differences, group sorting, comparisons, either/or distinctions	part/whole, patterns, analysis and synthesis sequence/order/logic deductions	analogies metaphor logical inductions	predictions inferences evaluation

	KNOWLEDGE	COMPREHENSION	APPLICATION	ANALYSIS	SYNTHESIS	EVALUATION
12				Identifying and clarifying problems	Integrating knowledge and process: from diverse areas	Evaluating strategies for problem solving, decision making, and critical analysis
11				Collecting, organizing and applying relevant evidence. Analyzing systems: i.e. economic, syntactic, scientific	Formulating conclusions	Evaluating evidence
10				Analyzing information: for example - distinguishing among causal, contingent, correlated relationships	Generating alternatives	Evaluating solutions: Relating premises to conclusions
9				Interpreting information: relating, taking apart	Stating problems and/or constructing analogies/ hypotheses	Justifying conclusion Choosing alternative conclusions
8			Testing hypotheses: experimenting	Drawing logical conclusions	Developing models	Devising alternative tests for hypotheses
7				Generalizing Identifying variables: Describing relationships among them; Predicting outcomes		
6	Collecting and organizing information - Identifying - Defining - Describing - Interpreting - Comparing			Interpreting/Reporting Information		Evaluating Inferences
5	collecting, processing, demonstrating information	summarizing		differentiating		
4					recognizing more complex analogous relationships	
3		interpreting	problem solving		predicting	
2		translating		recognizing part/whole relationships	recognizing simple analogous relationships	
1				recognizing similarities and differences		deciding
K	examining, characterizing	grouping sorting		classifying		
Pre	recognizing, labeling			ordering		

* Based on Bloom's Cognitive Domain of Educational Objectives and the Presseisen Model of Thinking Skills.

Developed by the Thinking Skills Program Curriculum Subcommittee representing the Offices of PreK-2, Cluster I, Cluster II, GATE; Fine Arts, Foreign Language, Language Arts, Mathematics, Science, Social Studies, Special Education, and Vocational Programs.

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