Thinking Maps as Tools for Multiple Modes of Understanding

by

David Nelson Hyerle

B.A. (University of California at Berkeley) 1978
M.A. (University of California at Berkeley) 1982

A dissertation submitted in partial satisfaction of the

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Abstract

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This study is an introduction to the theoretical foundations for and practical classroom uses of thinking maps as student-centered tools for constructing personal, interpersonal, and social understandings. Thinking maps are eight graphic organizers based on fundamental patterns of thinking. These graphic forms are presented in the context of the present thinking skills movement in schools, cognitive science research, and an alternative view of thinking and knowing called "connective." This background research-- along with an analysis of different types of graphic organizers presently being used in schools --supports the introduction of thinking maps as a language for facilitating students' thinking and content learning. As a language of interrelated graphic patterns, thinking maps are shown in this study to have a visual lexicon based on four distinct characteristics: theoretical breadth, graphic consistency, flexibility, and reflectiveness. These

characteristics are revealed by thinking maps applications created by students and teachers at both elementary and secondary school levels. Thinking maps are also introduced in this investigation as interactive tools for use in key areas of educational change at the turn of this century: for the development of students' thinking and metacognitive abilities, perspective-taking and multicultural education, organization for research and writing, and for interdisciplinary learning. In addition, an assessment rubric based on holistic scoring of thinking maps is presented as a framework for viewing the development of students' thinking and content learning over time.

James L. Jarrett

Dr. James L. Jarrett, Chair

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CHAPTER 1: INTRODUCTION

Focus and Purpose

The focus of this investigation is on the use of thinking maps as tools for students and teachers in classrooms from kindergarten through graduation. Thinking maps are eight fundamental thinking processes represented and activated by semantic maps (see Appendix A). This distinct set of visual tools is used for inter-actively connecting, sharing and reflecting on information for personal, interpersonal, and social understandings. I will give reason for believing that students who are taught how to use this set of tools will be helped in becoming independent and interdependent learners. After students are given guided practice for using thinking maps they then have a common visual language in the classroom for connecting and seeing what they are thinking, for deepening dialogue, and for assessing how they are thinking and learning.

There are three central purposes of this work. One purpose, developed in the next chapter, is to investigate how the thinking skills movement, new cognitive science research and the changing views of human reasoning and knowledge support the need for tools such as thinking maps. The third and fourth chapters address a second purpose: to define the maps and to explore the practical ways to enable students and teachers to use the maps for teaching, learning, and assessment. The last chapter is devoted to a third purpose: to present a synthesis of the research in Chapters 1 and 2 and applications of thinking maps in chapters 3 and 4 showing that thinking maps are a common visual language for generation and organization of ideas, problem-solving and concept development, and for dialogue and reflective thinking.

The Present Problem and the Shift Toward Interactive Learning

This investigation of thinking maps as student-centered tools is, in a broad sense, a practical response to a continuing educational problem that is fundamental, historical, and inherently controversial: defining the relationship between teachers and students in classrooms within the changing context of American society. Since the advent of public school education this relationship has been securely entrenched in teacher lecture and the rote repetition of lessons by students. As society has changed, so have many of the classroom strategies for teaching and related student strategies for learning, but the root of this fundamental relationship has remained unchanged.

A comprehensive study of schools in America in the early 1980's by John Goodlad provided a clear picture of the primary teacher-student relationship, and a message:

> If teachers in the talking mode and students in the listening mode is what we want, rest assured that we have it.
>
> Clearly the bulk of this talk was instructing in the sense of telling. Barely 5% of this instructional time was

> designed to create students' anticipation of needing to respond. Not even 1% required some kind of open response involving reasoning or perhaps an opinion from students.
>
> (Goodlad, 1984, p. 229)

The tone of this passage is as revealing as the statistics themselves: there has been little change in the fundamental relationship of teachers talking and students listening, and that educators need to face themselves and decide how soon, not if, this basic relationship is to be transformed.

Goodlad was writing at a time when it had become clear that there was an untenable discontinuity between this important relationship in the development of our children and an American society which had entered the "information age" in "multi-cultural schools" within a "global village" wherein the active processing, interpreting, and communicating of information had become central. The Goodlad research shows that above all the teacher-student relationship has remained rooted in a state of passive learning. This passive relationship is reflective of a time of industrialism, behavioralist psychology, and the "melting pot" view of the assimilation of minority cultures into society. Alternatively, it is not a relationship that supports students in the age of complex technology, constructivist psychology, and the heightened awareness of the multicultural mosaic that is American society . . . or for an American society that is itself a tile within the larger global picture.

The Goodlad research was just one of many reports and commentaries in the early eighties revealing that teachers were not engaging students to respond, and specifically to reason. A longitudinal study by the NAEP even stated that there had been a *decline* in students' reasoning abilities in the areas of reading and writing during the previous ten year period (NAEP, 1981). The event that stirred the most interest was the extensive media exposer about a government commission led by Secretary of Education Terrell Bell, announcing that the whole nation was "at risk" because of foundering educational progress. This announcement touched a nerve in educational circles in an analoguous way to the "Sputnik" challenge of the early 1960's which spurred the nation to reconsider its technological and educational position in the world. The 'at risk' reports attempted to establish that our schools were failing to bring our students into the age of global communication and high-technology and linked this situation directly to our lack of economic competitiveness and future well-being as a nation. One of the central recommondations of this report called for increased efforts to transform schools to meet the "high-tech", problem-solving age of the late twentieth century.

Thus the early 1980's were a time of facing the teacher-talk and student-listen relationship that had been accepted as normal in times gone by, but that had all of a sudden become antiquated. From a historical perspective of public education, there was suddenly "a problem" and thus a "need" for interactive teaching and learning. Students were not being challenged to communicate, to reason, to solve more than a one-step problem. Computers- so-called "thinking machines" -were being brought into schools as a step toward "high-tech" education, but most software reflected and still reflects past practices of rote learning rather than supporting reasoned responses. Thus, the call came from many quarters for teachers to begin developing students' reasoning and thinking abilities, or "higher-order" thinking, to reflect the changing needs of a post-modern society.

The nascent thinking skills movement, which had beginnings with such early efforts as Hilda Taba's concept development work (Institute for Staff Development, 1971), quickly rose in response to these calls. Seemingly, just another educational bandwagon was passing through, but the movement had solid support from recent research in the area of cognitive pyschology. Practitioners, publishers, and teacher trainers translated Benjamin Bloom's "Taxonomy of Educational Objectives" in the Cognitive Domain (Bloom, 1956) into a basic model for identifying lower and higher-order cognitive skills to promote more higher-order, interactive questioning by teachers. Articles on cognitive processing, analytical thinking, creative thinking, thinking skills, critical thinking, thinking and writing, philosophical thinking, and teaching for thinking classroom strategies regularly appeared in educational journals.

One of the largest professional educator organizations in the country, the Association for Supervision and Curriculum Development, promoted thinking skills instruction. By the mid-eighties this organization could publish a comprehensive guide to a wide range of thinking skills theories, methods, and programs (ASCD, Costa, ed. 1985). In response to this surge of interest, school districts began instituting thinking skills staff development training and implementing published programs for direct instruction to students.

This movement also began to influence the way educators viewed standardized testing. Multiple-choice testing had remained focused on rote recall of content information and the testing of "basic skills", thus legitimizing the primary teacher-talk student-listen relationship in classrooms. By the mid-eighties, educators also began to pilot alternative assessment tools based on students having to respond to problems requiring multi-step processes to solutions. With such interest it became clear that this movement was more than a superficial idea.

Yet as the thinking skills movement progressed, some researchers and school-based educators challenged the new focus on thinking skills. There was a range of responses: that "thinking" did not exist as a set of "skills"; that thinking skills did not transfer across subject areas; that this new emphasis on thinking processes was an unnecessary addition to daily instruction and lessened the attention to students' basic skills learning; and, that the approach bypassed the development of students' prerequisite content knowledge base. Some critics, such as Richard Paul, labeled most thinking skills approaches as "weak" compared to philosophers' methods such as Socratic dialogue for cultivating "strong sense" critical thinking that come from decades, and, of course, centuries past (Paul, 1985). From a much different view, E.D. Hirsch published "Cultural Literacy" (Hirsch, 1987) and promoted the idea that our national cultural, educational quality, and economic equity for disadvantaged youth depended upon teaching all students a common knowledge base as a prerequisite to critical thinking instruction.

From an economic and political empowerment perspective, educational critics such as Henri Giroux stated that this new public philosophy so narrowly based on thinking skills placed "an undue emphasis on specific cognitive and technical outcomes" and economic preparedness, thereby diminishing dialogue about meaningful issues in classrooms (Giroux, 1984). Gintes and Bowles (1976) had previously argued that this narrow attention to training a workforce to merely process information without a critical perspective partially reproduces through the schools the inequalities of the existing economic class structure. The outcome from this point of view is that the lack of critical reflection in a purely information processing approach limits the possibilities for students to address important questions about their economic, political, and civic lives. Jonathan Kozol's recent investigation, "Savage Inequalities" (Kozol, 1991), partially supports this view. He presents evidence of large funding discrepancies between public schools within the same geographical area- and intellectual tracking within single schools -that reflects the idea that economic and intellectual reproduction of socio-economic class is linked to our educational system.

As shown by the range of critical responses, the thinking skills movement is complex in its different approaches and problematic. Though the thinking skills movement may have lost some of its initial surge of interest, there are unique, sophisticated and enduring qualities of this continuing post-modern educational shift. There has been a shift in perception of the need for more teacher interaction with students for the purpose of explictly and systematically facilitating students' thinking and interactive learning. The shift toward the thinking skills area also overlaps with such teaching methods as process writing and cooperative learning that have similar goals of interactive teaching and student-centered learning. This transformation, though still in its first stages, may be irreversible: the teacher-talk and student-listen relationship that had been criticized by progressive educators for generations has finally become recognized to be at the heart of our educational problem.

Seeking Connection: Dewey in the Present Context

The heightened level of understanding of the problem of passive relationships in classrooms *coupled with* the urgency to find solutions is a recent event, though a similar critique and alternatives have been provided by progressive educators since the beginning of public school education in America. The system-wide lack of meaningful intellectual relationships between teachers and students was one of the centerpieces of John Dewey's attack on traditional education. Dewey looked for the connection between "self" and "world" by recognizing the importance of students' actively taking control of their own thinking by making connections to their experiences. A key word that surfaces throughout "Democracy and Education" (Dewey, 1916) is the connecting of thinking and doing. In his chapters "Experience and Thinking" and "Thinking and Education" Dewey uses this word in several contexts: *connections* between words and the things as they become represented in experience, making *cross connections* between subject areas, and identifying the *interconnections* of school work and social situations as a dimension of reflective learning. For Dewey, the emphasis on students' actively seeking connections of different kinds is directly tied to his idea, if not definition, of thinking:

> Thinking, in other words, is the intentional endeavor to discover specific connections between something which we do and the consequences which result, so that the two become continuous. (Dewey, 1916, p. 145)

This view is distinctly different from the seemingly everpresent isolating nature of learning as many students sit in defined rows facing the teacher and are tested on discreet skill use and the retention of bits of information. It is also different from some of the present thinking skills approaches. For Dewey, thinking does not mean simply seeking only the logical organization constructed of cognitive connections. The connections in learning are found by way of linking the immediate educational experience to past actions and to expected future possibilities and imagined ends:

> To "learn from experience" is to make a backward and forward connection between what we do to things and what we enjoy or suffer from things in consequence. Under such conditions, doing becomes trying; an experiment with the world to find out what it is like; the undergoing becomes instruction- discovery of the connection of things. (Dewey, 1916, p. 140)

This view moves beyond one present cognitivist tendency to understand learning as efficient mental processing, isolated problem solving, and assimilation of information by a "solitary knower" who is enhanced by way of rote human and now computerized forms of instruction, yet disconnected from the world of experiences. Learning as thinking is understood by Dewey as a connective, reflective *and* projective experience that is personally active and linked to the interpersonal and social world. Thinking becomes, as Sartre suggested, a "project" that is taken up by the individual over a lifetime and projected forward and backward within interpersonal and social histories (Sartre, 1968). Dewey suggests two conclusions for education that proceed from this view:

> (1) Experience is primarily an active-passive affair; it is not primarily cognitive. But (2) the measure of the value of an experience lies in the perception of relationships or continuities to which it leads up. It includes cognition in the degree in which it is cumulative or amounts to something, or has meaning. In schools, those under instruction are too customarily looked upon as acquiring knowledge as theoretical spectators, minds which appropriate knowledge by direct energy of intellect. The very word pupil has almost come to mean one who is engaged not in having fruitful experiences but in absorbing knowledge directly. (Dewey, 1916, p. 140)

These conclusions and Dewey's definition of thinking as stated above provides a historical marker and foundation for this investigation. Of course, Dewey's ideas also must be seen in the context of the late twentieth century and new research in cognitive science and alternative paradigms for defining knowledge.

Cognitive science research within the past twenty years generally supports Dewey's ideal of students actively taking control of their own thinking and making connections through the reconstruction of experience. The development of interactive teaching strategies by educational researchers and practitioners which focus on students' learning processes, including direct instruction in the "skills" of thinking, are based on a view of learning as constructive. The support for these approaches comes from early cognitive development researchers such as Jean Piaget. More recent research in cognitive science, including some that reject certain of Piaget's conclusions, focus on concepts such as representation, mental modeling, frame semantics, and conceptual metaphor. This new direction, along with work in artificial intelligence, has provided alternative views of human reasoning and intelligence.

Linked to some of these findings in the cognitive science area is the challenge to positivism and the search for objective truths as the predominant philosophical paradigm for knowledge. Looking back, the shift away from positivism supports Dewey's notion that students should not remain spectators who passively absorb, without reflection or projection, the objective categories containing content information within each discipline. There are clear indications from across academic fields that a fundamental shift is taking place away from the western philosophical tradition of the kind of rationalism and empiricism that promotes the reification of objective knowledge and the search for objective truths. This shift has roots in Wittgenstein's later work (Wittgenstein, 1953) and is presently being supported by research conducted in philosophy, biology, cognitive (and moral) psychology, and social-political theory. At this time, the impact of this shift may be felt in only subtle ways by school-based practitioners, but it provides the theoretical foundation necessary for the long-term transformation in how knowing is defined, knowledge is communicated, and inquiry is learned in classrooms.

The ideas and ideals introduced above, philosophically grounded in Dewey's view of thinking as making different kinds of connections, will serve as the context in this investigation for establishing the practical and theoretical foundations for thinking maps as student-centered learning tools for personal, interpersonal, and social understandings. Each of these areas- the thinking skills movement, cognitive science research, and alternative knowledge paradigms -will be shown to be linked by a rejection of the teacher-talk and student-listen relationship and supportive of highly interactive learning techniques and tools. Each of these areas is also grounded in a view that knowledge is not atomistic, static, and based on explanations of objective knowledge: knowledge is constructed of various connections, sometimes stable yet also dynamic and changeable, and may be represented in different ways through multiple modes of understanding. Thinking is thus revealed, as Dewey suggests, to be not confined to the airtight "cognitive domain" altogether disconnected from attitude, feeling, emotion, and cultural experiences. Indeed, for Dewey, learning is intimately bound up with interest- thus with feeling and value.

Design and Chapter Summaries

The design of this investigation is a conceptual analysis linking the practice of thinking skills in schools and research in cognitive science and philosophy to thinking maps as tools for students and teachers in classrooms.

This design begins in Chapter 2 with a brief section highlighting interactive "process" learning methods that overlap with most thinking skills approaches. The second section is an analysis of the thinking skills "movement" in schools which began in the mid 1970's and continues to this day. The context then broadens in two ways in the next two sections: first, through an analysis of recent research within cognitive science that shows alternative ways of defining cognition; and, second, through a view from across disciplines of the rejection of the positivist tradition with its focus on explanation and the search for objective truth as the paradigm for knowing. This chapter closes with a view of the constructivist paradigm for knowing and an offering of the term connective as an additional metaphor for conceiving of personal, interpersonal, and social understandings.

On the foundation set in the second chapter, the thinking maps will be presented in Chapter 3 as a language of theory-embedded tools for personal, interpersonal, and social understandings. An overview of the various types of graphic organizers will be presented and the efficacy of the use of visual tools in classrooms. The history of the model of thinking (Upton, 1960) which provides the basic linkage of the maps to thinking skills will then provide an introduction to the eight basic thinking maps. This introduction will include the theoretical foundation for each map based in cognitive science research.

Given the definitions of each map in Chapter 3, a range of different types of examples showing applications of thinking maps will be shown in Chapter 4. The first application of thinking maps is most appropriate for high school students and is called "What is Culture?" The purpose of this activity is to initiate a continuing dialogue in classrooms on how students find personal, interpersonal, and social understandings of culture. The second example shows how middle school students use thinking maps for organizing and interpreting ideas for writing a research paper. Though analogies are used in these first two curriculum examples, the next example helps students to see how metaphors provide structure for their thinking and writing. Based on George Lakoff's work, this secondary level writing assignment guides students to use simple metaphorical analysis as an exercise in metacognition. The fourth application shifts from the single content area emphasis of the previous examples to interdisciplinary learning. An overview of an elementary level unit called "Watching the Time Go By" shows how varying configurations of one thinking map (in this case the flow map) may be used by students for flexibly transferring thinking processes across disciplines and for investigating a rich, interdisciplinary theme. As a closure to these units of study, the uses of thinking maps for assessment purposes, including self-assessment by students, will be presented. This section will focus on a rubric called "MAPPER" that is used for assessing students' thinking about content using thinking maps.

The final chapter will provide a synthesis of this investigation of thinking maps for personal, interpersonal, and social understandings. In particular, thinking maps will be presented as a *language* for teaching, learning, and assessment. The four characteristics that make thinking maps a language-- theoretical breadth, graphic consistency, flexibility, reflectiveness --will be described. These four characteristics will reveal that thinking maps, as compared to other approaches and uses of graphic organizers presented in Chapter 3, offer students (and teachers) a comprehensive set of learning tools for perspective taking and dialogue, organization and interpretation, concept development, interdisciplinary learning, and for self-assessment within a "connective" paradigm for knowing.

Scope and Limitations

The primary goal of this investigation is to show one practical means of effecting the cognitivist turn in educational theory: the use of thinking maps as a language of student-centered tools for thinking, learning, and assessment. This work is influenced by multiple histories, long and short: of the intellectual history of knowledge and thinking, of western philosophic traditions, of the historical socio-economic conditions that have influenced schooling in America, of the new science of cognition, of the thinking skills movement, and of this investigator. There is no attempt here to fully delineate all of these histories and interrelationships, but rather to draw from the most essential research and ideas that support thinking maps as tools for multiple modes of understanding. In this blossuming information age a problem (and an opportunity) springs forth from the abundance of information, contradictory evidence, and multiple interpretations from different cultural perspectives.

Admittedly, the design of this investigation could be kept at a much more manageable level by staying focused on thinking maps as cognitive strategies for rote information processing and retrieval, or even "higher-order" processing. Many educators who have been using traditional diagrams, and graphic organizers, such as Venn diagrams and flow charts, have found success in motivating students to organize and remember prefabricated information. But the challenge of this investigation will be to go beyond this narrow focus to seek uses of thinking maps for personal *and* interpersonal *and* social understandings in classrooms. Thinking maps will be defined and investigated as more than information-processors or logic diagrams for establishing "objective" knowledge, but as interactive tools for constructing knowledge and connecting ideas in visual forms. Thinking maps are useful as practical tools for students completing routine assignments, yet most effective for students as they face complex and controversial problems that are framed by personal and cultural values. When used interactively and with an open environment in the classroom, thinking maps are practical philosophical tools for negotiating meanings and entering the interrelationships within the belief systems of others.

The linkage of a broad conceptual analysis to direct classroom applications in this work will be supported by various sources: samples of students' work using thinking maps, experiences of this investigator through work with students and teachers, and research from across disciplines. After the review of literature in Chapter 2, the focus will remain on identifying the practical uses of these theory-embedded tools for students and teachers.

This investigation will range over the ideas from Aristotle to Wittgenstein and Bruner, but not become a literature review of the history of thinking, or "knowledge." This study will identify the implications of the ideas of Piaget, Vygotsky, and Gilligan but not become a detailed analysis of cognitive, social, and moral development. The thinking skills movement will be analyzed in general terms, but there will not be an extensive overview of the wide array of approaches and programs. This work will address E.D. Hirsch's idea about cultural literacy and draw from the transformative pedagogy of Freire, yet back away from a point-counter-point discussion of "conservative" versus "liberal" versus "radical" educational traditions and details of supporting research.

In short, this work is an investigation of an interrelated set of visual-verbal tools-- a *language* for learning in classrooms --that are put into students' hands for developing their abilities for thinking, conversing, and for understanding. Support for the identified need for these tools will come by seeking common strands in the weave of researchers and practitioners. One of these strands, long ago developed by Dewey, is that the education of children is essentially bound up in the discussion and maturing of ideas within multiple experiences, and that the connecting of these ideas toward the making of meaning is a central dimension of this discourse.

CHAPTER 2: THE CONTEXT FOR THINKING MAPS

Introduction: Teaching for Interactive Learning

Educational historians of future generations may look back on the late twentieth century as a time when educators began the institutional transformation away from rote behavioralist instructional practices in schools, closed definitions of fundamental cognitive skills and human reasoning, and hardened perceptions of *the* structure of knowledge.

This chapter presents three interrelated areas that are supporting this transformation: the practice of thinking skills instruction in schools, the recent developments in cognitive science research, and the expanding views of knowledge paradigms. Section 2 is an overview begun in the first chapter of the thinking skills movement with an analysis of two important issues in the field: the transfer of thinking skills across disciplines and the framework of "higher-order" thinking that has guided the thinking skills movement. The third section draws from recent cognitive science research that reveals alternative structures for fundamental thinking processes (such as classification) and human reasoning. Section 4 presents an overview of the critique of the objectivist paradigm for knowledge made by researchers from across academic fields. The last section provides a summary of the chapter by offering the term "connected knowing" (Belenky, et al 1986) as an additional way to talk about thinking for personal, interpersonal, and social understandings. This chapter thus provides the broad foundation for new tools such as thinking maps for students and teachers who are working as interactive learners within a new paradigm for thinking and knowing.

Before turning to an overview of the thinking skills movement, it is necessary to recognize that this transition is one of several major efforts in mainstream education to shift from the traditional classroom model of didactic teaching that has been widely critiqued as a "banking" system of education (Freire, 1970) toward interactive teaching and learning. During the late 1970's and early 1980's when the thinking skills movement was beginning to influence the mainstream of education, process writing, cooperative learning techniques and recently "conflict resolution" were being developed and used as alternatives to traditional teacher-talk and student-listen relationships in classrooms. A brief overview of these areas will reveal that the thinking skills movement is not an isolated phenomenon and that each of these areas shares the goal of transforming classrooms and schools into more interactive communities.

The Bay Area Writing Project (U.C. Berkeley)-- later expanded to the National Writing Project --offered one of the early approaches for systematically focusing on teaching the processes of writing beginning in the late 1970's. Techniques such as brainstorming, using semantic mapping, prewriting activities, group editing and publication of student work were used. One of the central tenets of this approach is the importance of first supporting students' writing fluency before proceeding to formal training in the organization of ideas and correct grammatical usage.

Through the process writing approach students (and teachers during training) are first asked to write about events and ideas that are personally meaningful, based on their background knowledge and experiences. The "I Search" research paper is an example: writers are asked to investigate their own lives and produce an autobiographic document. Grammatical usage and the development of structure in writing are taught within the context of one's own writing, rather than by learning rules first and then writing according to the rules.

Student-centered assessment is a continuous process in this approach. A holistic scoring rubric that includes grammar, spelling, and organizational points as well as an overall effectiveness score is used by teachers, with inter-rater reliability, so that the process has guidelines for consistency within a classroom, school, district, and/or state. Students are also taught to use holistic scoring so that they become more reflective about and self-assessing of their own and other students' writing processes. Thus the micro-processes of writing such as spelling, grammatical usage, and paragraph structure are taught within the macro-processes of generating personally meaningful pieces of writing, sharing and revising work with others, and publication for audiences other than the teacher.

A second development toward interactive teaching during the past fifteen years has been cooperative learning. Cooperative learning (Johnson, et al, 1988) is based on students working together to share ideas, learn content, and create group products while developing social skills. Within most cooperative learning approaches students are taught fundamental roles, rules, and processes for working in groups. Cooperative learning de-emphasizes teachers as the knowledge dispensers and heightens the focus on teachers as important resources and facilitators of students' activity. Students learn how to learn together using the structure provided and coordinated by the teacher within the boundaries of the scope and sequence of the curriculum. Importantly, beyond the practical intent of more meaningful content learning via interaction, cooperative learning facilitates the explicit development of students' interpersonal skills.

More recently, another area of social skills development similar to cooperative learning has entered the field: conflict resolution. Conflict resolution is based on students developing interpersonal skills and becoming mediators in disputes between fellow students. Students learn to see conflicts inside and outside the classroom as opportunities for learning and practice specific strategies for resolving conflicts peacefully between themselves. This is in stark contrast to the present role of the teacher as the sole powerholder in the area of classroom discipline and the primary mediator of classroom conflicts. A key element to one such approach is the importance of developing a peaceable classroom (Kreidler, 1984) within a wider view of teaching for social responsibility. From this perspective, conflict is seen as an interdisciplinary theme and a key dimension in local, national, and international affairs.

The overlapping goals in each of these areas are similar to some of the key goals of thinking skills instruction: a focus on teachers facilitating student-centered learning and students becoming aware of commonly shared learning processes, becoming fluent in articulating their ideas as interdependent participants in the classroom, and independently and consciously transferring "learning how to learn" skills to other learning environments. A core value of all of these approaches-- returning to Dewey --is nestled within a belief that students can become interactive learners who are connecting their experiences in the world to the learning context and reflecting on processes and behaviors, in contrast to being passive recipients of teacher, text, and/or computer-driven information and processes.

Teaching for, of, and about Thinking

Though driven by a few key goals about the need to develop interactional instructional practices and improve students' thinking abilities, the thinking skills movement is complex and difficult to describe. There are many and varied philosophical, psychological and political positions attending the practical approaches that are implemented in various ways in schools. The first edition of a comprehensive handbook on thinking instruction, "Developing Minds" (Association for Supervision and Curriculum Development, 1985), revealed the wide array of these positions, in theory and practice. The second edition, expanded to two volumes, presents an even wider array of different theories and an overview of nearly thirty different published programs (A.S.C.D., 1991). There have been several attempts to categorize these different approaches into specific areas. One of the best recognized efforts, initially outlined by Ron Brandt (Brandt, 1984), has been more fully developed by Arthur Costa (Costa, 1985). Costa was the editor of both "Developing Minds" editions and one of the educational leaders closely associated with the thinking skills movement. As summarized below, Costa focuses on three fairly distinct areas: teaching *for*, *of*, and *about* thinking (Costa, 1985; 1991).

After this summary, two issues of importance for the thinking skills movement are discussed: the controversial issue of transferability of thinking skills across disciplines, and the relatively unquestioned "non-issue" of thinking as based on a hierarchy of "lower" and "higher" order skills.

Teaching *for* Thinking

As described by Costa, teaching *for* thinking involves the focus by teachers and administrators on creating in a classroom and whole school a positive environment for fostering the development of students' thinking. This includes consistent problem-posing by teachers, facilitating of creative thinking, being open to and responsive to a range of student ideas, intelligences, and learning styles, modeling thinking strategies, and valuing and evaluating students' thinking processes as well as content learning. The intended outcome of these practices is that over time students will develop dispositions and attitudes characteristic of intelligent behavior (Costa, 1991).

Teaching *for* thinking in schools has been strongly driven by an emphasis on teacher questioning as related to Benjamin Bloom's "Taxonomy of Educational Objectives" (Bloom, 1956). Though developed in the mid-fifties as a foundation for curriculum and test development through the years, "Bloom's Taxonomy" became a guiding framework for implementing "thinking skills" in school districts around the country in the 1980's. Teachers in the early and mid-eighties around the country were provided teaching strategies, workshops, and materials which focused on asking more questions from the higher end of Bloom's Taxonomy (analysis, synthesis, evaluation) while creating a more positive, interactive intellectual environment for learning. Thus the thinking skills movement, though complex and multifaceted, often has been understood by practitioners as teaching for "higher-order thinking."

Teachers' response behaviors after asking questions also came into focus, as magnified by the research on wait time (Rowe, 1974). Mary Budd Rowe found that teachers often waited for less than a second for student response after asking a question before rephrasing or answering the question themselves. By teachers providing a "wait time" of just a few more seconds after asking a question, Rowe found significant results: longer and more complete responses, increased creativity and descriptiveness. A second wait time between the student's response and the teacher's response to the student also provided improved student performance. Over the past ten years the focus on teaching *for* thinking has produced a rich array of strategies and techniques for teachers (Costa & Lowery, 1989; Saphier & Gower, 1987) and for linking cooperative learning directly to thinking skills instruction (Fogarty & Bellanca, 1989). Simple methods such as "thinking aloud problem-solving" (Whimbey & Lockhead, 1984) and "think-pair-share" (McTighe & Lyman, 1988) have become basic strategies for teachers to help students verbalize their thinking and increase interaction in the classroom.

The increased emphasis on questioning and response behaviors by teachers, and paired student-to-student talk, have provided teachers with concrete ways of supporting efforts to move beyond the passivity of the teacher-talk and student-listen relationship that yield minimal attention to students' reasoning.

Teaching *of* Thinking

Whereas teaching *for* thinking is based on the teacher creating an enriching environment for improving thinking, teaching *of* thinking is based on teachers directly instructing students in skills and macro-strategies for thinking, including cognitive skills, steps in problem-posing and solving, and reflective thinking. Most often this occurs by teachers' defining specific cognitive skills or strategies for students, such as classification and summarizing, and then explicitly showing students how to apply these processes to content learning. The desired outcome of teaching of thinking is that students will be enabled to consciously apply thinking processes in a particular content area, to develop a metacognitive approach to their own learning, and also to independently transfer a certain skill or heuristic to other content areas and learning environments.

In the last decade, published programs have supported teachers in providing clear definitions, systematic introduction and practice activities to students so that the students will learn to apply isolated thinking skills and strategies. Some of the approaches are based on an array of general processes useful within any discipline, other programs focus on thinking skills and problem-solving within a specific discipline, and a few programs link thinking skills instruction to the teaching of writing and cooperative learning. Some of these materials are based on a hierarchy of higher and lower order skills, such as Bloom's Taxonomy. Additionally, teaching *for* thinking strategies are usually incorporated into the teacher's guide for a teaching *of* thinking program.

Hilda Taba was one of the pioneers of systematic training using the cognitive skills approach. Taba, an associate of John Dewey, drew insights from Piaget's research to focus on training teachers to use direct instruction to support students' concept development, primarily in the social studies area. Cognitive skills such as classification, labeling, description, and comparison/contrast were fundamental and linked together in her approach. Between 1968 and 1971, ten thousand teachers participated in the Hilda Taba Teaching Strategies Program (Institute for Staff Development, 1971). The rationale provided in the introduction of the program reads much like the programs that are still being used:

> Recent studies have suggested that thinking is learned and is learned developmentally; it is continuous development of an increasingly complex mental organization (including data processing skills) with which to view the world and to solve problems. Cognitive skills are seen as products of a dynamic interaction between the individual and the stimulation he receives rather than as a result of passive absorption of information.

> The task of instruction is to provide systematic training in thinking and to help students acquire cognitive skills that are necessary for thinking autonomously and productively.
>
> (Institute for Staff Development, 1971, p. xiii.)

Since Taba's work in the early 1970's the number and types of programs and strategies has expanded, especially as the thinking skills movement blossumed in the last decade. A brief review of the first generation programs reveals the range of ideas and the difficulty of defining the thinking skills movement. One approach, representing a rejection of a single kind of intelligence, is the Structure of Intellect design, developed from the research of J.P. Guilford (Guilford, 1967). Mary Meeker translated Guilford's initial 120 discrete "cells" or "components" of thinking into classroom use through a diagnostic test of students' abilities in twenty-six of the cells with short lessons for improving students' preformance in each area. Another approach was developed from research by Reuven Feuerstein who focused on mediating students' cognitive processes and thereby modifying these processes (Feuerstein, 1986). Feuerstein's "Instrumental Enrichment" program begins with students' simply thinking about the organization of dots on a page with direct mediation during the process by the teacher. Whereas these two programs may be described as centered on improving specific cognitive processes and dispositions, Edward de Bono's CoRT program (Cognitive Research Trust) taps students' general creative thinking abilities. Students learn "Lateral Thinking" strategies for breaking through hierarchical, dichotomous, and linear thinking (de

Bono, 1970; 1985). For example, instead of evaluating ideas as positive or negative, students search for the Plus, Minus, and Interesting (PMI) aspects of an idea. In the area of analytical reasoning, Arthur Whimbey has developed mathematical problem-solving and reading strategies based on linear thinking (Whimbey & Lockhead, 1984; Whimbey, 1989). These approaches develop the kind of systematic information processing that is often required for isolated, multi-step problems as well as for multiple choice reading and mathematics test performance.

Two early programs were also developed as complete first through eighth grade language arts and mathematics programs based on thinking skills instruction, called "THINK!" and "Intuitive Math", respectively. These programs were based on Albert Upton's and Richard Samson's model of six thinking skills, and J.P. Guilford's research. The THINK! program later evolved into the less ambitious "Strategic Reasoning" program (Citron & Glade, 1985). The Upton/Samson model and these three programs were the first generation work that have lead to the development of the thinking maps approach and the "Expand Your Thinking" program and a subsequent series of teacher resources (Hyerle, 1989; 1993).

Teaching *about* Thinking

The third area in Costa's outline, teaching *about* thinking, is focused on supporting students to become more conscious of their own thinking. Though many of the approaches within the teaching *for* and *of* thinking areas are concerned with students consciously applying thinking processes, the teaching *about* thinking area tends toward a much broader view. This array of approaches includes students becoming aware of how the human brain functions, how they as individuals think, and how knowledge is constructed, or what Costa calls "epistemic cognition." These areas, as briefly described below, have a common goal of having students thinking about their thinking through various forms of metacognitive activity.

Over the past two decades there has been increased interest in the structure and functioning of the human brain and how what we know about the human brain can lead to strategies which enhance learning. An early catalyst was research on left brain and right brain hemispheric specializations, with the left brain being characteristic of rational, linear, analytic, language expression and the right brain characteristic of holism, analogic, intuitive, and spatial expression (Edwards, 1979). Other research has identified specialized brain structures and roles. One example is Paul Maclean's model of the "triune brain", that reflect remnants of the evolutionary development of the human brain and different dimensions of reasoning: repetilian, old mammalian, and new brain (Maclean, 1978).

Maclean's research along with other brain research has been slow to make an direct impact on mainstream education. Leslie Hart has been a strong proponent of linking brain research to instruction by way of what he calls "brain compatible" instruction (Hart, 1983). Hart believes that Maclean's "triune brain" model and research that shows how the mind patterns information, and how it stores and selects information in memory "programs", are key to unlocking learning in the classroom instruction and curriculum design. Some of the features of brain-compatible learning are

> . . . active uncertainty or the tolerance for ambiguity; problem-solving; questioning; and patterning by drawing relationships through the use of metaphor, similes, and demonstrations. Students are given many choices for activities and projects. Teaching methods are complex, lifelike, and integrated, using music and natural environments. (Caine and Caine, 1991, p. 9)

The authors suggest that though some of the brain compatible techniques are being used in schools, few of these activities are done explicitly and consistently in most schools.

Whereas the work by Hart and others is focused on teaching *about* thinking from a psycho-physiological approach, teaching *about* thinking within the Costa outline is also understood as thinking philosophically about how we think and "construct" knowledge. Matthew Lipman's "Philosophy for Children" approach (ASCD, 1985) centers on issues that will promote having students think about how they are putting together their ideas, while also applying fundamental logic and cognitive skills. Lipman is interested in challenging and supporting students to grapple with social and ethical issues using stories that reflect events that might happen in their everyday lives. In this way, students are applying cognitive skills and moral reasoning to a "real-life" problem-solving situation, while reflecting on their thinking and facing multiple points of views.

Though the idea of metacognition (Costa, 1991) has been an undercurrent of teaching *for* and *of* thinking, there are few systematic approaches in this area of teaching *about* thinking. Most of the teaching *about* thinking outcomes may be a byproduct of the primary efforts by some teachers to focus on improving their questioning and response behaviors, and direct cognitive skills instruction. The idea of brain-compatible education is also very new, and the goal of students systematically reflecting on how they are thinking and constructing knowledge may be antithetical to the realities of most classroom situations: teachers "giving knowledge" to students.

Many of the approaches across Costa's outline overlap in basic beliefs about thinking skills instruction. There is a commonly held conviction by many educators in the thinking skills movement that students' intellectual abilities are not static and can be modified and improved through cognitive skills instruction. Closely linked to this view is that the primary relationship in the classroom is one of teachers mediating students thinking through interactive discussions and providing a positive environment for intellectual risk-taking. This intellectual posture by the teacher supports students so that they feel emotionally and intellectually secure enough to explore and share what and how they are thinking. This leads to a larger goal: developing independent and interdependent thinkers who can <u>transfer</u> "higher-order" thinking processes and positive intellectual dispositions to other situations.

The Critical Response to the Thinking Skills Movement

As the thinking skills movement gained momentum in the middle to late 1980's so did the critical response. There have been a wide range of concerns. From one side, Mortimer Adler has directly attacked the idea of "thinking" as embodied in "skills", stating that "the misconception . . . is that thinking is a skill that can be acquired in isolation from all the other skills that enable us to use our minds effectively" (Adler, 1986, p. 28). E.D. Hirsch, in "Cultural Literacy" (Hirsch, 1987), argues that students needed to learn a solid "cultural" content knowledge base before teachers attend to developing students' critical thinking abilities. One of the national leaders in the field of critical thinking, Richard Paul, though recognizing the need for cognitive skills development, devalues programs that remain focused on "weak sense" thinking, or repetitive cognitive skills instruction, and promotes "strong sense" critical thinking through which students are challenged to question important social and philosophical issues (Paul, 1985). Similar to Paul's critique, yet directed more at present socio-economic and political issues, is Henri Giroux's claim that the cognitive skills movement is an extension of a wider model of change based on economic rationality and focused on increasing productivity rather than "critical reasoning" and civic literacy (Giroux, 1984).

Returning to Costa's outline, we may notice that most of the critical response has been directed not so much at the general idea of teaching *for* thinking approaches or with the idea of teaching *about* thinking using metacognitive strategies, but with the workshops and published programs which focused on isolated instruction using so-called "lower-order", micro-logical thinking skills such as categorization. This is easy to understand, because many of the specific strategies in the teaching *for* thinking area (such as "wait time") and developing an open intellectual environment in the classroom have been understood by educators as a systematic extension of what most "good" teachers *should* do. Teaching *about* thinking approaches have not been critiqued mostly because these are evolving ideas that have not had extensive exposure. But the beliefs, approaches, promises, and claims of the creators and publishers of programs designed for the teaching *of* thinking have been criticized in harsh terms.

In a review of the research on several of these early programs, Robert Sternberg and Kastoor Bhana state in summary:

> Some thinking skills training programs are probably not a whole lot better than snake oil, but the good ones, although not miracle cures, may improve thinking skills. Although all but a few of the available evaluations have a great deal to be desired, there are enough positive results to suggest potential for gains.
>
> (Sternberg & Bhana, 1986, p. 67)

One of the problems with many of the thinking skills programs is that the "successes" of these approaches are still in question and the research support to this day remains scant. A more complex problem is one of defining and measuring success. What would success look like for these approaches in a system of schooling that places a high value on the rote recall of information, and evaluates students learning using closed, multiple-choice testing? With the exception of a few programs (Whimbey, 1989; Pogrow, 1991; Sinatra, 1990), most developers of the teaching *of* thinking programs would not identify increased standardized test scores as a primary outcome of implementation. Outcomes such as students becoming more flexible thinkers, better problem-posers, and more reflective philosophical thinkers actually may be counter-productive to the immediate outcome that many schools and school boards have established: increasing standardized test scores. This discrepancy between the present state of teaching and testing and the desired state identified by many in the thinking skills movement is a crucial issue.

Beyond the positive shift toward interactive teaching of, for, and about thinking and the critical response, there are (at least) two basic questions that the thinking skills movement must still address. One question that has yet to be resolved is based on an acceptance that there are fundamental cognitive processes such as classification and sequencing: Are these processes generic-- in the sense of being transferrable into every content disciplines in a similar way --or are thinking processes content specific? A second question, one that has been a non-issue in the past, but is now being addressed by educators, is: What does it mean for thinking to be defined in a hierachical structure from "lower" to "higher" order forms?

The Issue of Thinking Skills Transfer

There are several basic and complex problems that continue to plague the thinking skills movement at this time: (1) the continuing battle over the degree of emphasis teachers should place on content versus process teaching; (2) the rejection by some of the teaching of isolated thinking skills as an "add-on" set of "skills" parallel to content-specific "basic skills"; and (3) a deep skepticism about whether thinking skills can be used, or transferred by students as generic skills, in each content area. The first two questions are really connected to the third. A central belief of the thinking skills movement has been the idea that general thinking skills can be taught as explicit information-processing skills and over time would be *transferred* across subject areas and into interdisciplinary learning situations. As the reviews of the research by leaders in the thinking skills areas attest, this is a complex problem with inconclusive evidence.

Perkins and Solomon responded to the transfer question in their article, "Are Cognitive Skills Context-Bound?" (Perkins & Solomon, 1989). The authors first trace the history of the rise of heuristics by way of Polya's work in general mathematical problem-solving (Polya, 1957). They then describe how general problem-solving approaches fell from grace when research in artificial intelligence and studies in "expertise" showed the need for context specific knowledge for solving problems. The authors conclude their review by stating:

> Overall, research on transfer suggests the same conclusion as the arguments from expertise and weak methods: Thinking at its most effective depends on specific, context-bound skills and units of knowledge that have little application to other domains. To the extent that transfer does take place, it is highly specific and must be cued, primed, and guided; it seldom occurs spontaneously.
>
> (Perkins & Solomon, 1989, p. 18)

Allowing that transfer does occur, but in most cases with some content specific knowledge needed, the authors offer a synthesis by arguing against the strict dichotomy often made between general cognitive skills and the isolation of content domains:

> The heart of the synthesis we would like to suggest challenges this dichotomy. There are general cognitive skills; but they always function in contextualized ways, along the lines articulated in considering the philosophers' habit of mind.
>
> (Perkins & Solomon, 1989, p. 19)

Perkins and Soloman support this synthesis by showing successes as students learn to use, or "transfer" heuristics within isolated domains, such as learned strategies for mathematical problem solving, similar to Polya's heuristics (Shoenfeld, 1985). They also highlight the successful work in reading comprehension through which students transferred self-monitoring strategies to reading across different disciplines (Palincsar & Brown, 1984). As the authors admit, in neither of these cases is the central research and the practical question of the transfer of cognitive skills addressed: Do students transfer specific cognitive skills taught "in isolation" to learning in different disciplines?

The research conducted by Shoenfeld, and Palinscar and Brown, begins with the assumption of the need for domain-specific knowledge while focusing on general *strategic* approaches to the problem structures within those domains. For example, Shoenfeld finds success with students' transferring self-monitoring strategies during problem solving in mathematics and Palinscar and Brown show that students can transfer the strategy of prediction during reading comprehension. But they do not systematically study, for example, the transfer of an isolated cognitive skill such as classification across the disciplines of science and social studies.

In the absence of conclusive research to answer this fundamental question, Perkins and Soloman suggest two types of transfer: low road and high road. Low road transfer is attained through a developed automaticity in the use of a skill through repetition of the skill, such as classification, in a variety of situations. High road transfer is attained when the student is able to consciously transfer a learned, abstract principle from one situation and apply it to another, often by way of thinking analogically. Again, the authors suggest that this kind of transfer is rarely accomplished without support in the way of cues or direct instruction from a teacher.

Researchers Resnick and Klopfer seem to echo the synthesis offered above, that cognitive skills and general strategies are often deeply emeshed in content specific knowledge and "basic skills" processes. Yet, in an introduction to a collection of articles on cognitive research, the authors elevate the importance of curriculum as being fundamentally based on the development of the skills of thinking within each content area.

> The Thinking Curriculum joins content and skill so intimately that both are everywhere. Does this mean that skills learned in one subject will "transfer" to others? Perhaps. No answer to that question is possible on the basis of current research.
>
> (Resnick & Klopfer, 1989, p. 6)

Taken together, these reviews of the research seem to sound a closure to the first generation of the thinking skills movement. There is a deep skepticism and near rejection of the isolated teaching of thinking skills and the claims of transfer that came with many "add-on" teaching *of* thinking approaches. At the same time, there is a new level of awareness of the importance for the curriculum of the twenty-first century being grounded in the linkage of cognitive skills development and problem-solving strategies to a solid content knowledge base. Yet, a mystery that was identified during the rise of the thinking skills movement remains unresolved. Researchers have not been able to clearly describe for teachers in the field the specific linkages between a students' "local knowledge" in a specific "content" problem and the way to make general skills and strategies for "thinking" the foundation for learning.

The Non-issue of Thinking as Hierarchical

The issue of transfer described above has been a well defined, challenging, and unresolved question for practitioners and researchers. A relatively unquestioned assumption has been the acceptance of the definition of thinking as being structured hierarchically from lower-order to higher-order skills. The categorization of *educational objectives* in the cognitive domain by Benjamin Bloom (Bloom, 1956) has been miscontrued by many educators as a basic *model for thinking*. Though there are examples of approaches and models that do not depend upon a hierarchy of skills, the thinking skills movement has become synonymous with the term "higher-order thinking." The structure of lower and higher order skills suggests a step by step procession through a series of ever more complex sets of skills toward a higher plane.

Lauren Resnick, a researcher in cognition and education presents one definition of higher-order thinking as

> . . . a cluster of elaborative mental activities requiring nuanced judgment and analysis of complex situations according to multiple criteria. Higher order thinking is effortful and depends on self-regulation. The path of action or correct answers are not fully specified in advance. The thinker's task is to construct meaning and impose structure on situations rather than to expect to find them already apparent.
>
> (Resnick, 1987, p. 44)

Resnick also warns that the term "higher-order thinking" may be misleading, and that there is no lock-step process or sequence up a ladder of skills:

> The most important single message of modern research on the nature of thinking is that the kinds of activities traditionally associated with thinking are not limited to advanced levels of development . . . In fact, the term higher order skills is probably misleading, for it suggests that another set of skills, presumably called 'lower order," needs to come first . . . Research suggests that failure to cultivate aspects of (higher order) thinking may be the source of learning difficulties even in elementary school. (Resnick, 1987, p. 46)

This view reveals the complexity, contradictions, and problems apparent in this transition toward a thinking curriculum, especially in regards to child development issues. Reading the first passage alone might suggest that higher-order thinking is such a complex phenomenon that it is attained only by the most "gifted" of students and by those at an age group who are developmentally "ready." Resnick is clearly not promoting this view. In the second passage, she suggests that instruction in higher-order thinking should not be understood as confined to an elite few at a developmentally advanced mental age. In fact, Resnick is implying that those having learning problems at an early age may be in the greatest need of instruction in certain aspects of "higher-order" thinking.

Resnick's ideas highlight a central problem with the labeling of thinking along a continuum of lower and higher dimensions, and a crucial question: How does this view of a hierarchy of thinking fit with the widely accepted doctrine in schools of Piagetian development? Matthew Lipman provides an insightful and disconcerting summation of this dilemma:

> When Bloom's concepts penetrated the Piagetian empire in education, they were accorded an interpretation that allowed them to blend in perfectly with Piaget: The hierarchy was to be understood as a theory of developmental stages. Children's concrete thought processes in their early years allowed them to perform little more than memory tasks, but they could ascend, stage by stage, until finally they would arrive at the adult level, the pinnacle of the entire process, the evaluation stage. The net effect was to preclude teaching critical thinking to children. Given the longitudinal, developmental interpretation, young children were not capable of monitoring their own thought, of giving reasons for their opinions, or of putting logical operations into practice. (Lipman, 1991, p. 110-111)

There are important implications, as Lipman points out, for using this hierarchical (low to high) design for thinking skills when integrated into the predominant view of human development and reasoning based on stage development theories. But what are the implications when this blend of interpretations of Bloom and Piaget are implemented within the framework of actual schools? Unfortunately, issues of socio-economic status, class distinctions, race, and even school funding influence this otherwise theoretical "cognitive" issue.

Jonothan Kozol describes ability tracking within the public schools in "Savage Inequalities" (Kozol, 1991) while presenting evidence of startling funding and resource differences between schools within geographic areas across America. These differences are as high as seven thousand dollars per year per student between an upper class suburban district and a low-socioeconomic school in an inner city classroom. Kozol also finds tracking based on perceptions of intelligence, and ultimately race, within integrated schools in the inner city from the earliest grades. He describes a New York inner city school wherein three distinct tracks are described by the principal. One track includes 130 students in 12 "special" lower level classes, almost exclusively African-American. A second track consists of 700 mainstream students, mostly White and Asian. The third track is a pullout for the "gifted." Kozol states that these high level track students are

> provided with intensive and, in my opinion, excellent instruction in some areas of reasoning and logic known as "higher-order skills" in the contemporary jargon of the

> public schools. Children identified as "gifted" are admitted to this program in first grade and, in most cases, will remain there for six years. Even here, however, there are two tracks of the gifted. The regular gifted classes are provided with only one semester of this specialized instruction yearly. Those very few children on the other hand, who are identified as showing the most promise are assigned, beginning in the third grade, to a program that receives a full-year regimen. In one such class, containing ten intensely verbal and impressive fourth grade children, nine are white and one is Asian. The "special" class I enter first by way of contrast, has twelve children of whom only one is white and none is Asian. This racial breakdown proved to be predictive of the schoolwide pattern. (Kozol, 1991, p. 94)

Taken together, Resnick, Lipman, and Kozol present a critical problem with the hierarchical representation of thinking and with the implementation of "thinking skills" instruction in schools. A teacher who is working with low socioeconomic status students and/or minority students in groups who historically have been unjustly identified as having inferior intelligence, whether by genetics, environmental influences, and/or mainstream societal racism and classism may believe that these students will be frustrated by more difficult questions. The teacher, at each grade level, may finally decide that his or her *only* primary responsibility is to *give* students the basic knowledge in each subject area so that when each student is ready they will have the "knowledge" to answer higher-order questions. This may happen at every grade level to the point of a student becoming remediated by an institution of educators who are not mediating these students' thinking at a "higher" level.

While the previously discussed issue of transfer is interesting and important, the non-issue of accepting the definition of thinking as a hierarchical step ladder of skills and strategies is a deeply vexing and hidden problem that few educators have faced. The misappropriation of Bloom's hierarchy as a model for thinking has been both a helpful and simple framework for shifting attitudes and facilitating some students' thinking. Yet it ultimately may be misguided. As presented in the following section, new cognitive science research is providing alternatives to the present view of human reasoning as based on a strict stage-level development and redefining fundamental reasoning processes.

Cognitive Science: The Science of Mind

Beyond Intelligence as I.Q. to Multiple Representations

During the late 1960's when Hilda Taba's program for teaching concept development was spreading across the country, Arthur Jensen was arguing that intelligence is primarily determined by genetics, static over one's lifetime, and is testable to show individual and group differences (Jensen, 1969). Jensen's work may have been the last gasp from a society of psychometricists who had framed the debate as to the modern definition of intelligence since the early decades of this century. The modern academic and educational community had remained locked into a narrow focus on standardized testing of intelligence until recently. Though it has been shown that intelligence, as defined by Jensen's hypothesis, can be changed significantly (Whimbey & Whimbey, 1979) the beliefs of generations still influence what happens in schools. These tests are still used and respected as partial indicators of a slice of what may constitute "intelligence", yet the form and content of the tests have been found to be culturally biased, and critiqued as unfair gatekeepers for minority populations (Mensch & Mensch, 1991).

The thinking skills movement of applied psychological and philosophical research has been made possible by the fundamental belief by those in the field that human reasoning is multifaceted, can be improved, and that intelligence can be represented in many different ways, or comes in several forms. This belief became acceptable partially through challenges to the single definition of intelligence made by an expanding field of multi-disciplinary research that was focused on human and artificial intelligence, or mind: cognitive science.

The philosophical roots of cognitive science go far back into history, but some date its birth as September 11, 1956, when, at a symposium on information theory, three important papers were delivered (Gardner, 1985). Computer scientists Newell and Simon presented their "Logical Theory Machine", the first computer-based proof of a theorem; psychologist George Miller unveiled his "Magic Number 7" concerning the capacity of short-term memory; and linguist Noam Chomsky delivered "Three Models of Language", promoting the idea that language has the formal precision of mathematics.

The significance of the cognitive revolution is found in the shift away from early Pavlovian associationism and sophisticated behavioralist principles and toward the study of human thought as *representational.* Howard Gardner explains this change in his account of the brief history of cognitive science:

> Cognitive science is predicated on the belief that it is legitimate- in fact necessary -to posit a separate level of analysis which can be called the "level of representation." In opting for a representational level, the cognitive scientist is claiming that certain traditional ways of accounting for human thought are inadequate. The neuro-scientist may choose to talk in terms of nerve cells, the historian or anthropologist in terms of cultural influences, the ordinary person or the writer of fiction in terms of the experiential or phenomenological level. While not questioning the utility of these levels for various purposes, the cognitive scientist rests his discipline on the assumption that, for scientific purposes, human cognitive activity must be described in terms of symbols, schemas, images, ideas, and other forms of mental representations.
>
> (Gardner, 1985, p. 39)

The recent attention that cognitive scientists have given to the idea of human and/or artificial "mind" and mental models (Johnson-Laird, 1983) and the focus on a variety of representations have sent a signal to educators that the old framework for defining intelligence is breaking down. The most significant research for educators may have been the publication of a theory of multiple intelligences (Gardner, 1983). This work provided alternative options and a new language to educators for investigating, facilitating, and honoring different ways of thinking in classrooms.

More recently, Robert Sternberg has offered a wider analysis showing different conceptions for researching the human mind and human intelligence (Sternberg, 1991). Sternberg has proposed that there are seven basic "metaphors" for investigating these theories: geographic, computational, biological, epistemological, anthropological, sociological, and systems. These perspectives are grouped by Sternberg into three areas: understanding the mind as primarily inward (brain-based, genetic and in the body), outward (highly influenced by the environment outside the body), or interactive (a complex dynamic of both inward and outward structures and influences).

It is not within the reach of this investigation to analyze Gardner's or Sternberg's theoretical views, to analyze the vast array of definitions of intelligence, or to present even an overview of the field of cognitive science. It is important, though, to recognize that there is presently an open theoretical field concerning definitions of intelligence and human reasoning, and that each theory may be understood as being based on complex philosophical frames of reference and conceptual metaphors. Despite this openness, of course, schooling in America remains largely dependent upon the pre-existing paradigm: the computational measure based on the "inward" metaphor of intelligence as logical-deductive and quantifiable.

Constructivism and Cognition

What is most essential for this investigation is the new research that is extending and reformulating the work of cognitive science pioneers, such as Piaget, Vygotsky, and Luria. Recent research shows results that directly challenge some of the presently held assumptions about human reasoning, definitions of fundamental cognitive skills and the idea of explicit stages of cognitive development.

The view that Piaget and fellow researchers championed and that is still guiding cognitive psychology out of strict behavioralist principles is of children as active constructors of knowledge. Ernst von Glaserfeld defines the constructivist view of knowledge, and Piaget's central role:

> For constructivists . . . the word knowledge refers to a commodity that is radically different from the objective representation of an observer-independent world which the mainstream of the Western philosophical tradition has been looking for. Instead, knowledge refers to conceptual structures that epistemic agents, given the range of present experience within their tradition of thought and language, consider viable.
>
> The work of Piaget, the most prolific constructivist in our century, can be interpreted as one long struggle to design a model of generation of viable knowledge.
>
> (von Glaserfeld, 1989, p. 124-125)

Piaget and his followers have provided extensive research for shifting the focus in education away from behaviorism, but in the past ten to fifteen years Piaget's work in the area of children's classification abilities and concept development have been challenged, along with his stage theory of cognitive development. Frank Keil summarizes this past research and the general challenge made to Piaget and other stage theorists:

> Decades of research, both anecdotal and experimental, have suggested that dramatic shifts take place in children's competency and manner of concept representation in a wide variety of areas such as conservation, causal thinking, classification, and seriation.
>
> However, a host of more recent studies have repeatedly found that the apparent dramatic changes demonstrated in the older research were often due to task-specific artifacts or other failures on the young subjects' part to access knowledge that they actually possessed.
>
> (Keil, 1989, p. 3)

It is important to note-- as viewed through the lens of cognitive science --that Keil not only questions the task-specific procedures of the research but also how concepts are represented and thus defined by early constructivists. Keil's essential point is that though Piaget has been identified as a constructivist, his definition of categorization as the primary foundation of concept development is grounded in the objectivist paradigm for knowledge. In Keil's analysis, Piaget's research is based on the development of categories by children via essential properties held by *all* members of the category, and therefore concepts are merely being represented as being *re*constructed by children to fit objective categories. Keil points to a conclusion made by Inhelder and Piaget, concerning classification skills, that the young children

> . . . do not see how the similarities and differences which determine the "intension" of a class generate a set of inclusions which form its "extension" . . .making supper "belongs with" a mother although it is hardly an essential property which she shares with all mothers. True, most mothers make supper; and we could think of these "belongings" as similarities. But such similarities are accidental rather than essential, since not all mothers make supper. The child ...is lumping a not quite essential attribute along with the object it is supposed to define.
> (Inhelder & Piaget, 1964, p. 37)

Though this *re*constructivist perspective is much less visible in Lev Vygotsky's work, Keil finds evidence of a similar nature. For example, Vygotsky claimed that children move from thinking in complexes to conceptual thought by way of definitive, essential attributes of an object for inclusion in a category (Vygotsky, 1936/1986, p. 132). A. R. Luria, an associate of Vygotsky, also was faced with different ways of forming categories, not by children at different "developmental" stages, but by illiterate adults from Uzbekistan. After extensive classification activities with these people, Luria concludes:

> Subjects from remote villages who live almost exclusively off the land have had considerable experience working it, but are uneducated and illiterate, using a method of classification that differs radically from those we customarily employ. The procedure of isolating an attribute in order to construct an abstract category into which suitable objects can be subsumed is completely foreign to their way of thinking.
> (Luria, 1976, p. 22)

Luria found that most of these people would reject outright the classical "abstract" categories as irrelevant or wrong, though he found he could also teach some of the more literate people of this culture to learn "abstract" categories for their everyday objects.

The key point that Keil is making is that the basic assumption uphelp by early constructivists-- held even by those such as Vygotsky and Luria who investigated the interpersonal and social influences on cognition --is an acceptance of preconceived, objectivist representations of the structure of categories. It is from this view that young children or an illiterate group of adults' are identifying properties that do not correspond with the essential properties required for membership in the *pre-established* categories, bound by an "abstract" and objective category. Ultimately, these pre-established categories are bound by a classical theory of categories and not one's experiential relationship to objects and ideas in the world. Thus the child or the illiterate adult are found to be "underdeveloped."

Von Glaserfeld defends Piaget from what he considers to be a misinterpretation by critics such as Keil:

> In spite of Piaget having reiterated innumerable times that, from his perspective, cognition must be considered an *adaptive function*, most of his critics argue against him as though he were concerned with the traditional notion of knowledge as correspondence. This misinterpretation is to some extent due to a misconception about adaption.
> (von Glaserfeld, 1989, p. 127)

Von Glaserfeld argues that what Piaget meant by adaption was drawn directly from the basic theory of evolution: that a child is actively adapting conceptual structures within his or her experiential range just as an organism adapts to environmental factors.

Ultimately, von Glaserfeld and Keil would probably agree about the centrality of an adaptive view of category development, while discarding a definition of category structure which is based on a strict category definition. But constructivism in the Piagetian sense ultimately may have come to mean the active *re*construction of one type of category for all kinds of things, rather than the individual's actively making categories anew from experience and through experiences. Alternatively, as some recent research shows, beyond the classical category structure that the Uzbekistanis rejected there are radial categories in our natural language that are complex and constructed by humans from experience.

Beyond Classical Categories: Lakoff's Radial Categories

Linguist George Lakoff has presented a multi-disciplinary analysis of research showing that in addition to the hierarchical, closed system of classical categories there are categories in natural language that are *radial* in form. Lakoff's research in radial categorization and idealized cognitive models (ICM's) could radically transform how we perceive thinking and knowledge, cognitive development, and how children are educated. Lakoff's analysis of category structure, in Women, Fire, and Dangerous Things (Lakoff, 1987), is part of his much wider critique of the objectivist paradigm for knowledge and an alternative view which he calls *experientialism.* These ideas are addressed in more detail in the following section.

The example cited above showing how Piaget and Inhelder described the category *mother* provides a clear contrast between a traditional view of category structure and knowledge, and Lakoff's alternative. In the example, the authors dismiss "making supper" as a non-essential attribute of mothers. The child is thus understood as not having an advanced and/or abstract concept of the category mother. Lakoff finds through his analysis of natural language that the category <u>mother</u> does not have a hierarchical structure based on a limited number of essential properties shared by all members. Instead, the category has what Lakoff calls a radial structure with variants understood only by way of learned social conventions- not by a definition generated from "logical" rules:

> The category *mother* . . . is structured radially with respect to a number of its subcategories; there is a *central* subcategory, defined by a cluster of converging cognitive models (*the birth model, the nurturance model*, etc.); in addition, there are noncentral extensions which are not specialized instances of the central subcategory, but rather are variants of it (*adoptive mother, birth mother, foster mother, surrogate mother*, etc.). These variants are not generated from the central model by general rules, instead, they are extended by convention and must be learned one by one. (Lakoff, 1987, p. 91)

Piaget and Inhelder, as presented above, are guided by an assumption of a defined objective category, when in fact, these young children may have been identifying the variant *nurturance model* of mother as identified by Lakoff. While Piaget and Inhelder recognize that *making supper* is a property shared by many mothers, they reject this attribute because it is not shared by *all* mothers. Since this does not fit with the classical category of mother, where *all* mothers share the same essential properties, the child is understood to not have an abstract definition of mother rather than possibly showing a radial category structure using social conventions. Lakoff's addition of another kind of category structure to the classical category thus calls into question the basic definitions of a fundamental cognitive process that has been a grounding for developmental psychologists in this century, and for proponents of the thinking skills movement. This addition also suggests an alternative framework for human reasoning.

Human Reasoning via Idealized Cognitive Models

Lakoff recognizes that closed, classical categories exist in certain situations, and that knowledge can be relatively stable. Yet a wide range of research points toward an alternative view of categorization and human reasoning that is based on our complex, direct experiential relationships in the world as represented by natural language, rather than based on a highly developed framework of objective categories. The foundation for Lakoff's work is wide, but a starting point is Wittgenstein's later work, in Philosophical Investigations (Wittgenstein, 1953), wherein he questions the definition of classical categories. In an attempt to define the essential similarities of the category *games*, much like defining the category *mothers*, Wittgenstein wrote:

> . . . we see a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities of detail. I can think of no better expression to characterize these similarities than "family resemblances"; for the various resemblances between members of a family: build, features, colour of eyes, gait, termperament, etc. etc. overlap and criss-cross in the same way.--And I shall say: 'games' form a family.
> (Wittgenstein, 1953, p. 32)

Wittgenstein thus posed a problem that philosophers and cognitive scientists are still attending to: how do we understand and represent category structure when we no longer accept the objectivist categories bound by the positivist-essentialist tradition, and when category structure is understood as a complicated network of resemblances rather than explicit similarities?

Many years and phases of research related to this question by psychologist Eleanor Rosch brought insights into category structure through prototype effects. Her ground-breaking work first showed the possibility that by grading best and worst examples of members in relationship to central members of a category that the degree of prototypicality could then explicitly define category structure (Rosch, 1973). Rosch's own later research reversed the idea that exact category structure could be predicted using these prototype effects (Rosch, 1979). Lakoff draws from Rosch's later research that shows that the central "subcategory" and other extensions "radiate" from the center by varying degrees of protypicality, but that these extensions and thus category structure are not predictable from specific *essential properties* of the center. Thus, Rosch's research shows that prototype effects constrain yet underdetermine mental representations of categories.

A crucial point here, as Lakoff points out, is that prototype effects do not alone determine category structure and that "radial" structure is another source of prototype effects" (Lakoff, 1987, p. 90). Lakoff's research and extensive evidence from a wide range of disciplines shows that the structuring of categories and the organization of knowledge is much more complicated and based on what he calls idealized cognitive models. He posits that:

> . . . we organize our knowledge by means of structures called idealized cognitive models, or ICMs, and that category structures and prototype effects are by-products of that organization developed within cognitive linguistics. (Lakoff, 1987, p. 87)

Lakoff identifies four kinds of structuring influences for human reasoning: propositional structure, image-schematic structure, metaphoric mappings, and metonymic mappings. These four influences illuminate a new, comprehensive view of cognition, based on how our experiences in the world provide structure to categories in natural language.

Propositional Structure

One dimension of Lakoff's model, propositional structure, is partially drawn from research in frame semantics. Within this view, propositions are understood as being structured by social frames that are so much a part of our daily lives that the truthfulness of each proposition is rarely questioned. Lakoff gives a simple example from anthropology: Americans believe that a week consists of seven days, with a typical five day work week and a two day weekend. Yet a study of Balinese culture by Geertz (Geertz, 1973) reveals a different frame. The Balinese have multiple "weeks" of three, five, six, and seven-days which represent different events and overlap. There is no objectively truthful way to conceive of a week though we accept our frame as "real", just as the Balinese do with their multiple, overlapping cycles of time.

Charles Fillmore's research in frame semantics shows that some frames are innate, such as the features of a human face, and that most frames are socially constructed conventions and support our understandings of knowledge structures. He states, specifically regarding the interpretation of texts, that

> Interpretive frames can be introduced into the process of understanding a text through being invoked by the interpreter or through being evoked by the text. A frame is invoked when the interpreter, in trying to make sense of a text segment, is able to assign it an interpretation by situating its content in a pattern that is known independently of the text. A frame is evoked by the text if some linguistic form or pattern is conventionally associated with the frame in question.
>
> (Fillmore, 1986, p. 23)

Returning to the previous example of the category mother, our propositions and knowledge about mothers is partially defined by the conventional frame for *mother* in our society. This is quite apparent as the roles of some women, men and children within the changing structures of families have shifted in the past few decades in American society. Lakoff also suggests that like frame semantics, schema theory (Rumelhart, 1975), is related to propositional structure, but that a fully developed schema does not provide a one-to-one correspondence to, or structure for, a category. Schema theory has had a central role for educational psychology in describing concept development and categories in the past fifteen years. But category structure, as Lakoff asserts, is not simply a reflection of an identified schema, for if it were, then

> Every node in a schema would then correspond to a conceptual category. The properties of the category would depend on many factors: the role of that node in the given schema, its relationship to other nodes in the schema, the relationship of that schema to other schemas, and the overall interaction of that schema with other aspects of the conceptual system.
>
> (Lakoff, 1987, p. 87)

Accepting a view of the identification of a highly developed schema as *the* category structure would neglect Rosch's research and retain the correspondence view of classical category structure and objective knowledge.

Image-schemas

A second influence on idealized cognitive models is structuring by way of image-schemas (Lakoff, 1987, p. 271). Whereas frame semantics often reveals social influences, research in image-schemas reveals how our bodies as physical entities in the world provide structure for mental models. For example, our bodies have insides and outsides. Lakoff shows that the *container* schema is based on this primary relationship of interior to exterior and is a fundamental image-schema. Lakoff also draws from research on mental spaces (Fauconnier, 1985) as part of idealized cognitive models. Fauconnier shows how we conceptualize fictional, hypothetical, and abstract domains by connecting, or mapping, one space onto another space.

Other familiar image-schemas that are structured by our physical relationships in the world are: part-whole, linkage, center-periphery, source-path-goal, front-back, and up-down. Lakoff shows, as well, that research in basic-level categories (which are not conceptual primitives, but intermediate categories with internal structure) are embodied through our direct relationship with the world:

> The studies of basic-level categorization suggest that our experience is preconceptually structured at that level. We have general capacities for dealing with part-whole structure in real world objects via gestalt perception, motor movement, and the formation of rich mental images. (Lakoff, 1987, p. 270)

A clear example of these gestalt spatial images is our fundamental understanding of *categories as containers*. In natural language, we may ask, "which category does zebra go *into*?", as if the category were a box with defined sides that contain members of the category. As Lakoff emphasizes, in objectivist cognition, categories are understood as closed containers: members are either in or out of the box.

Metonymy

Metonymy is the mapping of one reference onto another in ordinary language so that there is a replacement and sometimes distortion of the initial object. Lakoff gives the example showing that in the phrase *the White House isn't saying anything*, the place (the White House) is standing for a person or institution (the president) (Lakoff, 1987, p. 38). Lakoff explains:

> Metonymy is one of the basic characteristics of cognition. It is extremely common for people to take one well-understood or easy-to-perceive aspect of something and use it to stand either for the thing as a whole or for some other aspect or part of it. (Lakoff, 1987, p 77)

Lakoff identifies several kinds of metonymic models that are usually understood merely as interesting dimensions of informal language, but not as central influences on category structure. These models include stereotypes (a mother as nurturing), typical examples (an apple as a typical fruit), ideals ('together forever' as a successful marriage), paragons (an 'Einstein' as a scientist), and salient examples (Somolia as a starving nation).

Metaphor

A fourth dimension of idealized cognitive models as described by Lakoff is metaphorical mapping. Once accepted as the sole domain of poets and semanticists studying figurative language, Lakoff and Johnson (Lakoff & Johnson, 1980; Lakoff, 1987) show how metaphors are primary structures for ICMs and have developed a systematic way to analyze metaphors in ordinary language. Mark Turner has identified basic metaphors that recur as underlying themes in fiction (Turner, 1991).

Lakoff and Johnson have shown that image schemas, propositional, and metonymic structures are given additional coherence in an ICM by way of the complex overlapping of conceptual metaphors. The concept *argument* is a clear example: arguments are often understood as war (I demolished his argument; your claims are indefensible), and/or as buildings (I need a good foundation for this argument; we have constructed a good argument), and/or as journeys (So far, we haven't covered much ground; we're going round and round). Each of the three metaphors is also shown to be supported in some instances by other metaphors (such as our understanding of arguments as buildings, buildings as containers, and containers as holding ideas). Lakoff and Johnson also identify metaphors that have complex coherences which connect them together. For example, there is the overlap of the idea of *progression* within each of the metaphors for argument: *conducting* a war, *constructing* a building, and *proceeding* on a journey.

Using the *argument as war* as an example, Lakoff defines conceptual metaphor as distinct from the idea of "figurative" language:

> The essence of metaphor is understanding and experiencing one kind of thing in terms of another. It is not that arguments are a subspecies of war. Arguments and wars are different kinds of things- verbal discourse and armed conflict -and the actions performed are different kinds of actions. But ARGUMENT is partially structured, understood, performed, and talked about in terms of WAR.
>
> The language of argument is not poetic, fanciful, or rhetorical; it is literal. We talk about arguments that way because we conceive of them that way-- and act according to the way we conceive of things.
>
> (Lakoff & Johnson, 1980, p. 5)

The idea that metaphors are a foundation for human reasoning is in stark contrast to the classical view of representation that relies on the traditional dichotomy between figurative and literal language, a closed, hierachical category structure, and an objectivist view of knowledge based on logically deduced truth conditions.

The structuring of categories and idealized cognitive models as presented by Lakoff is a new cognitive stance in the sense that human reasoning may be understood as developed through the experiential relationship between the mind-as-body and the world. Rather than merely a mirror of pre-existing, transcendental, objective categories "outside" or "above" us, we generate cognitive models within the world, and over time: propositions are generated within the wider context of individual and social frames; our bodies and the physical world provide us with basic image-schemas through which we conceptualize things and ideas; we use the references of one object or idea to metonymically stand for another; and, we develop and stablize concepts by complex metaphors which draw from our daily interactions and ordinary language. It is through this structuring and reinforcement over time that these cognitive models become idealized and consciously and/or unconsiously become, in a sense, mythical truths. Knowledge, understood in this way, can thus become relatively stable, but knowledge can also change as people interact in society and nature.

From a practical point of view, this alternative view of cognition has striking implications for education, especially when one considers present definitions of categorization as a lower-order skill (meaning putting things into pre-existing pigeon-holes) and concept development is seen as confined to the "construction" of preset schemas. As presented in the following chapters, this view supports new ways of defining specific "thinking skills" and thinking skills instruction, and has deeply influenced the design and the use of the thinking maps as tools for understanding in classrooms. Before investigating the connections between these views and thinking maps in the next chapter, Lakoff's alternative may be seen within the broad theoretical critique of the objectivist paradigm for knowledge that has surfaced from across disciplines.

Knowledge Paradigms

Introduction

Since Wittgenstein's Philosophical Investigations (Wittgenstein, 1953) there has been a rising critique of positivism which has its roots in Aristotelean logic. One of the key tools of positivism is the use of the process of categorizing information into a hierarchy of groups that, when substantiated by research, become "objective" truth. Essential to this view is that the search for these truths can be established through systematic research, (human) logic and the establishment of a framework of undeniable "facts." Unsubstantiated facts are understood within this paradigm as less a matter of uncertainties and contradictions within an imperfect world and more a matter of the insufficiency of human reasoning and/or the methods of measurement.

The human mind is thus understood as a disembodied organ that acts as a two dimensional mirror of nature toward the attainment of absolute truths (Rorty, 1979). It is for the mind to manipulate arbitrary, abstract symbols in the brain in order to reflect an exact correspondence with the external world. Meaning is therefore regarded in the objectivist, classical view as directly tied to truth conditions formed of the correct reference of a strictly literal, formal language independent of the human mind and body. This paradigm is described by Jerome Bruner:

> At its most developed, it fulfills the ideal of a formal, mathematical system of description and explanation. It is based upon categorization or conceptualization and the operations by which categories are established, instantiated, idealized, and related one to the other in a formal system. (Bruner, 1984, p. 98)

This paradigm has been challenged and alternative views offered across many fields of research including cognitive linguistics, philosophy, mathematics, science, biology, psychology, moral development, and socio-political theory. Presented below is the haunting repetition by researchers within these fields of the constraints on research and reasoning because of the strictly held objectivist doctrines that focus on the search for a singular, unifying explanation of our world.

A second refrain is the identification of radical subjectivity as the false opposite held up by positivists as the only alternative to objective knowledge. Radical subjectivity is based on a view that everyone has a separate and self-generated view of the world that is not influenced either in thought, language, or action by others. There is also no clear way to value one view over another. Mary Belenky and her colleagues in Women's Ways of Knowing (Belenky, Clinchy, Goldberger, & Tarule, 1986) found that many women move through a phase in early adulthood during which subjectivism is a dominant view. The authors point out that objectivism, "received, absolutist knowledge", and subjectivism, though opposites in a dichotomy, hold a common assumption:

> . . . there are common remnants of dichotomous and absolutist thinking in the subjectivist's assumptions about truth. In fact, subjectivism is dualistic in the sense that there is still the conviction that there are right answers; the fountain of truth simply has shifted locale.
>
> (Belenky, et al, 1986, p. 54)

The terms "objective" and "subjective" are common in everyday speech. We praise "being objective" as a way of listening to other points of view and factual information in order to discover a "true" or "fair" interpretation. We also honor, to a lesser degree, the experiences and internal dialogue of subjective knowing. But in schools the objectivist pillar is clung to as if we are afraid that letting go might create a helter-skelter run toward the subjectivist pillar, and the chaotic nature of body and mind so often associated with adoloescence.

The problem hidden in this dichotomous way of conceiving of knowledge is, of course, much wider than just in the field of education, but it is in education that this paradigm of knowledge is most dangerously reified. Lakoff and Johnson state that these two paradigms are cultural myths, to which an alternative myth may be added:

> Either of these views would be a misunderstanding based on the mistaken cultural assumption that the only alternative to objectivism is radical subjectivity- that is, either you believe in absolute truth or you can make the world in your own image. If you're not being objective, you're being subjective, and there is no third choice. We see ourselves as offering a third choice to the myths of objectivism and subjectivism.
>
> (Lakoff & Johnson,1980, p. 185)

The importance of an alternative view cannot be underestimated for this investigation. Thinking maps are based on primary thinking processes, such as categorization, and the purpose of thinking maps is for multiple modes of understanding- personal, interpersonal, and social- and not explanation. Each map could be defined and used for explanatory outcomes- as visual schemata mirroring some "objective" correspondence of points. Instead, as will be shown in Chapters 3 and 4, embedded in the structure and function of each map is an alternative assumption and cultural myth of a view of knowing as connective. This view does not stand above us as a rigid, unmoving, singular pillar of objective truth, nor located as a multiplicity of disconnected, individual, subjective pillars of wisdom, stoically held within each of us. This additional myth of knowing and thinking may be best expressed as connected overlapping webs, elegant, strong, and changeable, which links our individual to understandings with the context of society. The grounding for these ideals is revealed in the research presented below.

Experientialism in Linguistics

We have already noticed that George Lakoff holds an alternative view of categorization and human reasoning that is based on a wide range of research and philosophical perspectives. Now it must be added that this position leads to an alternative view of knowledge. The alternative myth for knowledge that Lakoff proposes-- beyond the objective-subjective dichotomy --is called *experientialism*. Experientialism is introduced by Lakoff as centered in how human beings develop categories and thus understand things and act in the world. Central to this perspective is that categorization occurs in the unison of the human mind-body connection with the world. This view accepts that there can be categories with strictly marked boundaries much like those described by the classical objectivist view, but that these too are often constrained and constructed within the mind-body-world connection.

"Experience" is understood by Lakoff as being an interaction of humans' internal genetic makeup, sensorimotor structures, and symbolizing-language capabilities *in the world.* The categorization and reasoning processes are supported and constrained in the connection between the human internal system and the world as it exists, but the products are neither absolutely *nor* arbitrarily determined in or outside of this interaction. These processes are deeply influenced by imaginative aspects of human conceptualizing, such as through conceptual metaphors and metonymy, and by the mapping of concrete gestalt spatial structures (key image-schemas) onto more abstract mental images.

What is proposed is a different understanding of meaning. Meaning from the experientialist view is understood as what is embodied and motivated in relation to functioning humans. Thus "meaning" is not bound by contained, hierarchical categories. Lakoff argues that ultimately what the objectivist view supports, but does not explain, is the disembodied leap to rational correspondences of the representations of the mind to reality through the manipulation of arbitrary symbols. Lakoff states,

> The view of reason as the disembodied manipulation of abstract symbols comes with an implicit theory of categorization. It is a version of the classical theory in which categories are represented by sets, which are in turn defined by the properties shared by their members. (Lakoff, 1987, p. 8)

Of course, many categories become conventions between individuals and cultures, thus bringing relatively stable knowledge. But this is also because of the relatively stable structure of our bodies and minds, and the structures of the world. So the created and stable nature of categories-- whether hierarchical or radial --are not arbitrary nor at their root, relativistic and radically subjective. Instead, categories are motivated by our experiential connections to and action in the world.

Mathematical Quantification and Correspondence

> . . . I come to bury the idea that an account of meaning must be reductionistic. (Putnam, 1988, p. 55)

> What I used to find seductive about metaphysical realism is the idea that the way to solve philosophical problems is to construct a better scientific picture of the world. (Putnam, 1988, p. 107)

Above are the statements by Hilary Putnam revealing the shift away from his previous support of metaphysical realism and the objectivist theory of reference and meaning. Putnam-- the so-called father of functionalism --has had a significant impact on the field of philosophy by way of this shift of perspectives. Putnam's central point is that the objectivist view of reference cannot be supported because

> In sum, reference is socially fixed and not determined by conditions or objects in individual brains/minds. Looking inside the brain for the reference of our words is . . . just looking in the wrong place. (Putnam, 1988, p. 25)

An example that Putnam uses throughout a recent text, Representation and Reality (Putnam, 1988), is the problem of the word *gold*. Putnam argues that there is no exact "thing" or "object" that is what we understand to be gold. There is no pure gold in the world, experts have different criteria for gold, and beyond the qualities laypeople ascribe to gold, such as that it is a yellow, precious metal, there is no mental representation that is in our heads which corresponds directly to gold in the world. Of course, the word "gold" works as a useful reference for gold in the world, but this does not mean that this symbol is directly linked to some exact "thing" in our heads. Through this argument, Putnam is refuting the traditional view of category membership being defined by exact attributes and/or through precise measurement and quantification.

Two points which Putnam turns to as central for creating a new theory of reference and meaning are what he calls the Linguistic Division of Labor, and the Contribution of the Environment.

> There is a linguistic division of labor. Language is a form of cooperative activity, not essentially individualistic activity. Part of what is wrong with the Aristotelian picture is that it suggests that everything that is necessary for the use of language is stored in each individual mind; but no actual language works that way. (Putnam, 1988, p. 97)

Returning to the gold example, Putnam states that there is no one person or expert to whom we can turn for the definitive reference to the thing "gold" in the world. What is important is that within any speech community the reference for an object is established within the context of that community. The reference is often clarified, defined, and legitimized by an expert within the context-- or frame of reference --of that speech community. From Putnam's view, equivalence of meaning between people using different languages, or even between people speaking the same language, cannot be exact.

What is interesting and convincing about Putnam's examples, as with the one he uses to explain the Contribution of the Environment, is that all are common physical substances, such as "gold" or "water." Putnam asks: does the term "water" refer to the liquid that existed and was understood as pure in the year 1750 or the "water" that we now know to have varying degrees of mixtures of other elements? Putnam is showing that even if we had some universal agreement as to the mental representation or denotation of "water", the substance so-called *itself* lacks stability over time and in different environments.

Putnam thus concludes that there is no clearly defined, quantifiable dichotomy between that which is fact and that which is convention, and that

> the consequence is startling: the very meaning of existential quantification is left indeterminate as long as the notion of an "object in the logical sense" is left unspecified. So it looks as if the logical connectives themselves have a variety of possible uses.
>
> (Putnam, 1988, p. 112)

Putnam's rejection of pure mathematical quantification is consonant with Lakoff's view of the indistinct nature of the boundaries between categories, the structure of a category, and the definition of an object as a member of a category. Instead, the logical connections that are perceived between things support the construction of categories that are, as Lakoff suggests, structured by idealized cognitive models.

Normal Science in a Dynamic World

Putnam's reversal is reflective of another, earlier shift, this in the field of scientific research with Thomas Kuhn's departure from previously held conceptions of science as purely objective. One of Kuhn's central points in his often quoted text, The Structure of Scientific Revolutions (Kuhn, 1962), is that at any given time there is a sophisticated paradigm in any normal, mature science to which most research questions and observations are constrained. Of normal science, Kuhn states:

> Closely examined, whether historically or in the contemporary laboratory, that enterprise seems an attempt to force nature into the preformed and relatively inflexible box that the paradigm supplies. No part of the aim of normal science is to call forth new sorts or phenomena; indeed those that will not fit the box are often not seen at all. (Kuhn, 1962, p. 6)

Interestingly, Kuhn also uses the conceptual metaphor of objectivist categories as *container boxes* into which new phenomena fit, or that are rejected because they do not conform to the conventions of the existing paradigm. The way scientists have conceived of species is an example of how the classical, contained "boxes" of pre-evolutionary biology constrained understandings of the relationships between living organisms in a dynamic world. Ernst Mayr describes the transition:

> The development of the biological concept of the species is one of the earliest manifestations of the emancipation of biology from an inappropriate philosophy based on the phenomena of inanimate nature.
> (Mayr, 1984, p. 533)

For example, the pre-evolutionary Linnaean taxonomy fit the objectivist boxes of classical categories, based on a static, inanimate view of relationships between organisms. Biologists today do not have a unified, singular view of the taxonomy of species. The "cladists" school is the traditional objectivist form, as they sort organisms by way of shared common properties, whereas the "pheneticists" school sorts organisms according to overall similarity

(Lakoff, 1987, p. 187). Mayr proposes an integrated sorting factor based on multiple variables: reproductive isolation, ecological difference, and morphological distinctions. He also suggests that the reading of the genetic code may be the best way to decipher the ongoing effects of evolution. Without going much deeper into these various approaches- or expanding this controversial issue to include the creationist perspective, recently named by proponents "creationist science" -we can see that the complexities of studying the biological world partially depends upon one's frame-work and purpose, and not on objective certainty in tightly bounded categories.

The objectivist framework for establishing categories has been extremely useful in discovery of the structure and behaviors of our natural world. But as Stephen Jay Gould explains, a larger problem may be that the existing paradigm in any field prevents deeper understandings of human nature. In The Mismeasure of Man (Gould, 1981), Gould describes the fallacious and often malicious use of science to rank different racial and social class groups according to "normative" measures of men (rarely of women). The early measures of intelligence were based on cranium size, then cranium capacity, and brain size. More recently, human intelligence has been defined by a thin band of psychometric measurements of "I.Q." and Spearman's "g " or General Intelligence. After close readings of original scientific records of early craniologists, and then later through looking at the work of psychometrists, Gould concludes:

> Science's potential as an instrument for identifying the cultural constraints upon it cannot be fully realized until scientists give up the twin myths of objectivity and inexorable march toward truth. (Gould, 1981, p. 23)

The measurement and classification of races of people according to measures of a singular view of intelligence-- based on "scientific" findings --is a stark example of the powerful and paralyzing effects of the mixture of objectivist scientific research and cultural frames.

The New Psychology of Multiple Intelligences

Modern psychology has been so tied to the notion of being able to isolate and quantify a quotient for intelligence, that the concept of mulitiple intelligences comes as both dissonant and refreshing. Here it will be useful to return to Howard Gardner who, as we have seen above (pp. 44-45), brings forth the idea of different ways of representing and studying intelligence. He goes on to develop his theory of multiple intelligences under the title Frames of Mind (Gardner, 1983), Gardner proposes that people have a range of intelligences, through which we engage the world: linguistic, musical, logical-mathematical, spatial, kinesthetic, and interpersonal.

There are two controversial and intriguing dimensions of Gardner's research and theory. First, unlike most cognitive psychologists who conduct normative science so as to delimit categories and thereby gain statistical significance, Gardner investigates not only "normal" people, but a wide range of people:

idiot savants, brain-damaged patients, prodigies, experts from different fields, and individuals from different cultures. From this perspective he is able to suggest a second controversial point, that these frames of mind

> . . . are relatively independent of one another, and that they can be fashioned and combined in a multiplicity of adaptive ways by individuals and cultures.
> (Gardner, 1983, pg. 9)

By theorizing that there are quasi-independent frames and a multiplicity of adaptions, Gardner is moving beyond the information-processing view of many developmental psychologists, psychometricians, and others who use linguistic and logical-mathematical tools to study linguistic and logical-mathematical intelligence based on isolated, decontextualized research tasks. Gardner does not dismiss these views, but instead turns to focus on the tools of human symbol systems across various human activities. In giving greater attention to a variety of symbol systems, Gardner makes explicit the paradigm shift in twentieth century philosophy and the implications for psychology:

> . . . much of contemporary work in philosophy is directed toward an understanding of language, mathematics, visual arts, gestures, and other human symbols. We can observe the same trends at work in psychology. There, too, we discern a shift from external behavior to the activities and products of human minds and, specifically, to the various symbolic vehicles in which human individuals traffic. (Gardner, 1985, p. 2)

This theory of multiple intelligences fits within the metaphor of mind Sternberg defines as both 'inward and outward' as presented in the previous section. These different intelligences vary from the inward mental processing to the interpersonal, or social intelligence that develops explicitly through interaction in social settings. Gardner clearly states that other frames may be viable candidates to be included, and that ultimately, "intelligence" may be understood as a complex, connected montage of these multiple frames of mind.

Moral Development In Different Voices

The theory that "intelligence" could be derived purely from measures of mental agility on tests brings forth the question: What has been accepted as "normal" in moral reasoning? Just as Gould relates how males have constituted the sample for establishing norms for intelligences tests, Carol Gilligan shows that the sample for studying "normal" moral development has been white males (Gilligan, 1982). Gilligan states that a central problem facing traditional psychology is the dependence on "scientific" research based on the objectivist notion of meaning, truth, and morality. She believes that this approach has not understood the ways of women's moral reasoning as anything other than abnormality. Again, as with research cited above, Gilligan centers on one dimension of the problem as being the objectivist view of categorization, stating that

> the presumed neutrality of science, like that of language itself, gives way to the recognition that the categories of knowledge are human contructions.
>
> (Gilligan, 1982, p. 6)

Furthermore, Gilligan identifies the objectivist model as having a predominantly masculine voice and challenges the established views of the stage development of moral reasoning by researchers such as Lawrence Kohlberg. Gilligan describes how the girls and women who describe "webs of relationships" are rarely listened to, and when they are heard they are not understood, recognized, or respected as having legitimate forms of reasoning by psychologists trained in objectivist science. She points out that with the beginning of psychoanalysis, Freud was able to respect the intelligence of the young women whom he studied, but soon after was unable to describe their psychology and thus turned away from studying the psychological development of girls and women to focus on men. Gilligan thus charges that women from Freud's time up to this day "whose moral judgments elude existing categories of developmental assessment" (Gilligan, 1984, pg. 22) become targeted as irrational and abnormal since they don't fit neatly into the research findings.

Gilligan's research reveals what she calls the "feminine" voice for describing moral reasoning and action as different from the "masculine" voice. The feminine voice is based on webs of relationships in context rather than strict categories, caring rather than abstract definitions of justice, action rather than limitation of action, the preservation of relationships rather than adherence to rules, continuity and change rather than replacement and separation.

This feminine voice is understood in male dominated psychology as less advanced moral reasoning along hierarchical stage theories. The effects of this are that adolescent girls and women come to question their own world experiences, the meaningful and the context-bound categories they create, and the connections they make. On a most basic level, they question their ways of knowing (Belenky, et al, 1986). Ultimately, this voice is denied cultural significance:

> When the interconnections of the web are dissolved by the hierarchical ordering of relationships, when nets are portrayed as dangerous entrapments, impeding flight rather than protecting against fall, women come to question whether what they have seen exists and whether what they know from their own experience is true. (Gilligan, 1984, p. 49)

Gilligan does not perceive males and females to be biologically and thus categorically determined by their gender to behave and express their behaviors through confined voices, just as Gardner would not identify each individual as framed exclusively by a certain intellectual disposition. Seen together, these researchers may share a similar view that people may have complex blends of different frames of minds and voices that are created from biological and cultural influences.

Of course, there are remnants of the old paradigm even within Gilligan's work that reveal the difficulty of going beyond normative science. As a professor at Harvard College, Gilligan has broken the normative paradigm in the field of moral development, but she also has been criticized for not broadening her research beyond the bounds of her own position and culture milieu. Some of Gilligan's generalizations about *all* women have been challenged because most of her research subjects have been white, upper class girls drawn from private schools rather than from a cross-section of girls and women from different racial and socio-economic situations (Stack, 1991).

Social Science and Political Theory

In the previous sections we have entered the critique of the objectivist paradigm for knowledge from cognitive-linguistic, philosophic, biological, psychological, and moral development perspectives. Each of the researchers cited has a similar critique of how sophisticated objectivism in research has codified "facts" within idealized, hierarchical categories. Along with this critique is a common vision of questioning the boundaries of categories which support major theories and questioning how categories are structured, such as Gilligan does with Kohlberg's theory of stages of moral development. Each of these researchers is working in another paradigm that they consciously conceive of as other than one based on the objective/subjective dichotomy.

The social and political scientist, Richard Bernstein, poses the same problem in The Restructuring of Social and Political Theory (Bernstein, 1976), and calls for a unification of empirical, interpretive, and critical perspectives in social science research. He locates part of the problem in the effects of the paradigm of objectivism when applied by those conducting normative science. He also notes that the support for objectivism is propped up by the fear of "unbridled" subjectivism:

> The insistence on understanding human action with reference to the meaning that action has for agents is not a licence for unbridled subjectivism, although this is alleged by those who would classify all phenomena as either objective and physical or subjective and mental. One of the most dominant themes in analytic philosophy has been that language and human action are rooted in intersubjective contexts of communication, in inter-subjective practices and forms of life.
>
> (Bernstein, 1976, p. 230)

Bernstein is pointing to the problem in the social sciences as one of an established categorical framework for human action that is based on opposites and dichotomies. He calls for the development of integrated theories that draw on empirical description, interpretation of the empirical work, and a critical perspective using clearly exposed ideological lenses. With the ideological frames exposed, conflicts and opposites are recognized as existing and often irreconcilable. As we work through to an understanding of a human situation, Bernstein insists that

> we can discern in these "moments" a pattern that reveals how we grasp both their "truth" and their "falsity"
>
> (Bernstein, 1976, p. 235)

Within the tradition of qualitative, ethnographic research there is a focus on developing conceptual categories through a grounded theoretical approach (Glaser & Strauss, 1967). The categories and theories are developed by the researcher as he or she interactively participates in the social context being studied. This is the intersubjective relationship described by Bernstein as between objective and subjective knowing. One example is Shirley Brice Heath's interactive research with parents, children, and their teachers in schools within a community in the Piedmont Carolinas.

In Ways With Words (Heath, 1983), Heath identifies three cultural groups which she named the middle-class, mainstream, multi-racial "townspeople", the workingclass "Roadville" whites and the workingclass "Trackton" blacks. Drawing from extensive experiences with these groups, Heath reveals the deeply rooted cultural language and thinking that the Trackton and Roadville children brought to school and how their language use and thinking patterns were disconnected from the mainstream school culture. She traces the histories and present culture of the two workingclass groups and shows how the different patterns of language of these cultures affect school performance and test outcomes. The Roadville children have early successes and then fall behind by junior high. The Trackton children quickly slide down into a pattern of failure. Brice describes the "shock" of the Trackton youth entering the mainstream classroom:

> . . . their entry into a classroom which depends on responses based on lifting items and events out of context is a shock. Thus their abilities to contextualize, to remember what may seem to the teacher to be an unrelated event as similar to another, to link seemingly disparate factors in their explanations, and to create

> highly imaginative stories are suppressed in the classroom. The school's approach to reading and learning establishes decontextualized skills as foundational in the hierarchy of academic skills. (Heath, 1983, p. 353)

Heath shows that the reliance on teaching by a strict hierarchy of skills and knowledge, decontextualization as academic learning, and deculturation are foundations for success in these schools and are magnified in standardized testing. The individual Trackton or Roadville students were objectively "failing", but the failure as shown by this qualitative research is much deeper than the test scores show. It is a failure of educational principles and institutional failures based on the discontinuity between cultures. These discontinuities are shown by Heath to sustain boundaries between the culture of the school, the realities of disempowered cultural groups, and the ultimate power of the mainstream "townspeople", often by way of external forces. Heath concludes that

> . . . structural and institutional changes in the schools and patterns of control from external forces, such as the federal and state governments, have forced many of the teachers described here to choose either to leave the classroom or to resort to transmitting only mainstream language and cultural patterns.
>
> . . . unless the boundaries between classrooms and communities can be broken, and the flow of cultural patterns between them encouraged, the schools will continue to legitimate and reproduce communities of townspeople who control and limit the potential progress of other communities and who themselves remain untouched by other values and ways of life.
> (Heath, 1983, p. 368-69)

The discontinuities between the individual child and his or her teachers reflect the teacher-talk and student-listen relationship that objectively defines and limits knowledge, experience, language use, thinking, and the patterns of culture. The classroom in America, just as in research in many universities across this nation, is dominated by "objective" knowing and the relative silencing of personal, interpersonal, and social context and experience that do not fit into the pre-existing box.

Within this transitional phase from behavioralism to a yet-to-be articulated paradigm based on the construction of knowledge and human experience, the struggle of ideas and for power is ever present and rising to the surface. The struggle is a complex web of intellectual, ideological, and cultural confrontations: this kind of monumental change in classrooms across the country toward the acceptance of multiple definitions of intelligence, thinking, knowledge and toward the use of interactive teaching methods requires openness to different cultures and backgrounds, perspectives and ways of communicating. As Heath shows, this struggle is about the complicated interrelationships of cultures: language, religion, race, ethnicity, socio-economic conditions, and as Gilligan and Belenky (et al) point out, gender.

This struggle has most clearly surfaced in the conflict between those who favor an emphasis on the teaching of a common "cultural literacy" of knowledge and specific values for all students (such as E.D. Hirsch) and those who favor a significantly greater emphasis on teaching interactive processes of interpretation grounded in multicultural perspective-taking. There are many intermediate views between these opposing forces, and the complexity and even points of agreement are often lost in the extremes.

But, it is clear that those who speak strongly from the cultural literacy viewpoint also have a well established tradition and paradigm from which to communicate their ideas, whereas no clear alternative, or synthesis of a new paradigm, has been fully articulated. Just as Kuhn proposed a new way to view objectivist research in science, we await a clearly articulated alternative to the objectivist paradigm in schools. But this alternative paradigm or synthesis of ideas, if it is to be accepted and used in schools, must also come with a theoretical foundation, possibly a new language for learning, and practical tools for use in classrooms.

A Synthesis: Multiple Modes of Understanding

As presented in this chapter, three linked areas of research and practice have supported a transition toward more interactive teaching and to a range of ways of defining intelligence and knowledge. The thinking skills movement, along with process writing, cooperative learning, and conflict resolution, have provided the foundation for interactive, practical classroom approaches for teaching. Cognitive science research has identified alternative ways of representing fundamental cognitive processes, such as categorization, within different frames of reference, and thus supports alternative definitions of cognitive skills within the learning process. Research from across academic fields has challenged the traditional Western philosophical view of objective knowledge while offering additional ways of knowing and refuting the direct transmission of knowledge in classrooms.

Despite these alternatives, the objectivist view of knowledge remains the silent underpinning of the relationships which exist between teachers and students. Paulo Freire describes the outcome of the transmission of closed compartments, or categories of facts:

> the teacher talks about reality as if it were motionless, static, compartmentalized, and predictable. Or else he expounds on a topic completely alien to the existential experience of the students. His talk is to "fill" the students with the contents of his narration-contents which are detached from reality, disconnected from the totality that engendered them and could give them significance. Words are emptied of their concreteness and become a hollow, alienated, and alienating verbosity. The outstanding characteristic of this narrative education, then, is the sonority of words, not their transforming power. (Freire, 1970, p. 57)

This "narration" approach to education-- not to be confused with Bruner's use of narrative discourse --is based on explanation. The research above suggests that the methods used for developing explanations have been helpful, but ultimately this is just one way of perceiving knowledge and is not only or always the best way of coming-to-know. What stands out in this research is that beyond objective and radical subjective explanations there is an additional way of perceiving of cognition and knowledge, and thinking: constructivist. This is a useful metaphor for learning and knowing because it reflects an image-schema of one person or many people putting together pieces of information (ideas, notions, feelings, hunches, etc.) in order to create a final product, much like carpenters constructing a building.

But this term has a metaphorical foundation that also presupposes something formal being constructed and finally built, static, timeless, and unchangeable. This same metaphor may also reflect a final, hierarchical structure of knowledge. In this way, constructivism may be defined by some as students actively *re*constructing knowledge using the blueprint provided by the teacher. This blueprint is of what the final product should look like rather than providing open-ended tools (thinking process strategies) and providing the materials (content) for generating new products (multiple interpretations).

While not discarding the metaphor of constructive thinking and knowing, an additional metaphor and theoretical view may be helpful: connective thinking for seeking the overlapping webs of personal, interpersonal, and social understandings. The use of this term is inspired by Dewey's view of thinking as presented in Chapter 1 as being the discovery of connections that are linked backward and forward through experiences. How are these experiences expressed? These experiences may be represented in context as the overlapping of personal, interpersonal and social understandings.

In Women's Ways of Knowing, Belenky (et al) present one outline of connected knowing, drawn from extensive interviews with women. This view of connected knowing provides an entry point for considering the metaphor of connected knowing for personal, interpersonal and social modes of understanding.

From a point of *personal* understandings the authors state that

> Connected knowing builds on the subjectivists' conviction that the most trustworthy knowledge comes from personal experience rather than the pronouncements of authorities. (Belenky, et al, 1986, p. 112)

This is not a definition of connected knowing as radical subjectivity, but a view that one's personal experiences and knowledge can be only be approximated by other people. Within this mode of personal understanding everyone may have their own quasi-independent internal dialogue and vision, but not a "private language" (Wittgenstein, 1953): there remains shared languages through common, human experiences.

Within the thinking skills movement there has been an emphasis on students developing their own understandings of mental processes, learning styles, and ways of thinking that may be uniquely applied in different learning situations. Ideally, as students develop a metacognitive stance they begin to realize how their own experiences, and intellectual processes and dispositions are important: they cannot depend on the teacher for these lifelong understandings. Without facing their own personal strengths, weaknesses, and unique combinations of strategies and thinking processes, students may not become independent thinkers. They also will not be able to consciously transfer these ways of thinking to unique situations. This understanding is developmental and adaptive: students will gain new insights into themselves as their bodies and minds unfold over time. This view is reflected in the field of cognitive science. As Lakoff shows, idealized cognitive models are structured and learned by individuals through experiential and imaginative processes of the mind-body in the world.

Personal understandings also overlap with interpersonal understandings as objective and subjective constraints are pushed out to the edges as radical extremes. Interpersonal understandings are essential to connected knowing:

> Connected knowers see personality as adding to the perception, and so the personality of each member of the group enriches the group's understanding. Each individual must stretch her own vision in order to share another's vision. Through mutual stretching and sharing the group achieves a vision richer than any individual could achieve alone. (Belenky, et al, 1986, p. 119)

The mode of interpersonal understandings is reflected in connecting of ideas and experiences with other people. Empathy and reciprocity are dispositions that are at once based in feelings and care while also in what Nel Noddings calls "receptive rationality" (Noddings, 1984, p. 1).

The cooperative learning movement in public schools has provided a range of different structures for group interaction for the purposes of improved content learning and social skills development. The process writing approach has linked personal narrative to shared experience through autobiography. Conflict resolution and other pro-social methods focus on students taking personal responsibility for interpersonal behaviors. The thinking skills movement has been central in promoting interactive strategies-- teaching *for* thinking -- that focus on creating a climate in the classroom and whole schools for supporting dialogue and honoring multiple perspectives.

In the previous sections on cognitive science and knowledge paradigms, the support for interactive learning is apparent. Putnam's views on the cooperative, linguistic division of labor, Gardner's theory of multiple intelligences, and Gilligan's descriptions of multiple voices in moral reasoning coincide to support the need for classsrooms wherein different ideas and ways of presenting feeling and thoughts are shared and respected. Lakoff's offering of *experientialism* based on idealized cognitive models and Fillmore's frame semantics impress upon educators the call to understand personal frames of reference as partially determined by local contexts and interpersonal influences.

Much more difficult to define, and usually believed to be beyond the local context of the classroom and the hallways of the school, are the larger frames and systems of beliefs that deeply influence dialogue as students sit side-by-side facing the teacher. No matter how well developed the intellectual processes are in the classrooms, or how cooperative the students are in expressing and receiving ideas, this larger frame provides the foundation for the classroom that is rarely a centerpoint for conversation. Ultimately, what the teacher, text, or computer states as objective truth may remain uncompromised. Belenky (et al) suggest that those who may be described as connected knowers-- those who value their own personal knowledge and reach out to receive other perspectives through interpersonal exchange --may fall short of questioning and challenging the systems of beliefs which frame a classroom, community, a culture, and a country. The authors use the metaphor of constructive thinking to describe this mode of understanding:

> Once knowers assume the general relativity of knowledge, that their frame of reference matters and that they construct and reconstruct frames of reference, they feel responsible for examining, questioning, and developing the systems that they will use for constructing knowledge . . . strategies that some researchers have identified as a fifth stage of thought beyond formal-operational or logical thought.
>
> (Belenky, et al, 1986, p. 139)

In education, these are often unquestioned assumptions. There are few safe openings or havens for students who question social structures, unless a unique teacher consistently asks for and/or inspires such reflectiveness. Like normal science, "normal education" is based on built-in, hardened, mental boundaries for dialogue and questioning. Categories remain the same. This is clear in the movement toward developing students' thinking abilities. The thinking skills movement has been focused more on practical classroom strategies to the near exclusion of this "fifth stage," which Costa has identified as epistemic cognition within the teaching *about* thinking area. There are some practical strategies for developing students' abilities to constructively question and challenge existing belief structures and cultural and political perspectives. Yet, typically, at the junior high and high school levels, formal debate is the only safe placeholder for developing strategies for thinking about and discussing complex and constroversial social and global issues, and developing students' social responsibility (Berman, 1991).

In their last chapter, "Connected Teaching", Belenky (et al) suggest that educators can support the development of more authentic voices in classrooms, if they

> . . . emphasize connection over separation, understanding and acceptance over assessment, and collaboration over debate . . . if they encourgage students to evolve their own patterns of work based on the problems they are pursuing.
>
> (Belenky, et al, 1986, p. 229)

The ideal of connective knowing is a starting point for articulating a new paradigm for thinking in schools. It is broader than the ideals of constructivism which remain bound by a tradition of research in cognitive development and that carry remnants of a stark objectivist-subjectist dichotomy. A synthesis of the work in schools based on thinking of, for, and about thinking, along with research in cognitive science and work in philosophy, moral development, and socio-political theory support an alternative way of communicating ideas in classrooms beyond teacher-talk and student-listen.

As presented in the remainder of this investigation, thinking maps are one set of tools-- a new language --and a starting point for breaking through hardened categories of thought and developing patterns of thinking for multiple modes of understanding. These tools will be introduced through references to key ideas and unresolved issues of the thinking skills movement and within the framework of new cognitive science research and an uncertain new paradigm for knowing.

CHAPTER 3: INTRODUCTION TO THINKING MAPS

> One of the formal criteria of humanistic scholarship is that it be concerned with the scrutiny of texts. A text is information stored through time. The stratigraphy of rocks, layers of pollen in a swamp, the outward expanding circles in the trunk of a tree, can be seen as texts. The calligraphy of rivers winding back and forth over the land leaving layer upon layer of traces of previous riverbeds is text.
>
> In very early China diviners heated tortoise shell over flame till it cracked and then read meanings from the designs of the cracks. It's a Chinese idea that writing started from copying these cracks.
>
> Gary Snyder, 1991, p. 66

Introduction

In the previous two chapters there has been a theoretical focus on thinking skills, cognitive science, and knowledge paradigms. These next two chapters draw from these theoretical positions and research to introduce a visual-verbal language for learning: a practical set of interrelated tools for connecting ideas called thinking maps. This chapter shows how these eight flexible graphic primitives (much like stratification, layers, and expanding circles in nature) offer students and teachers a visual lexicon and syntax for constructing and revealing explicit patterns of information as meaningful text. Chapter 4 presents applications of the maps to curriculum design, classroom instruction, interpretation, dialogue, and assessment of students' thinking and learning.

This chapter begins with a brief discussion of the metaphorical relationship between the mapping of the physical world (cartography) and the mapping of mental worlds (semantic mapping). This leads into a section introducing the wide array of different types of graphic organizers that are being used in schools today. While many of these designs are effective, there are certain practical and/or theoretical drawbacks found in several approaches that have limited use and may constrain students' thinking and learning. (These approaches, as compared to the thinking maps, will be discussed in Chapter 5 after the full introduction of thinking maps later in this chapter and Chapter 4.)

These two sections provide the background for introducing the thinking maps as a common visual language of eight graphic organizers. Each map is defined and linked to a model first outlined by Albert Upton (Upton, 1941) and influenced by selected research presented in Chapter 2. Isolated examples of student applications accompany the introduction to each map. This introduction to each map in isolation provides the grounding for showing, in Chapter 4, how the the thinking maps are used interactively in various classroom applications as an integrated language for learning.

Cartography and Cognition

Artistic expression and the depiction of feelings and ideas through graphic forms and semantic markers has been an essential part of human culture from cave drawings to the recent invention of computer generated graphics. The types of graphic forms has expanded in recent years, especially in mathematics and business: Decision trees for problem-solving, hierarchy charts for showing corporate structure and line of command, bar graphs for growth, pie diagrams for showing percentages, axis diagrams for correlations, matrices for linking common qualities, flow charts for computer programming, brackets in sports tournaments for showing the elimination rounds to the final playoff . . .

Each of these examples is a graphic form that is used to represent a synthesis of information and patterns of relationships. Unlike geographic maps which show the explicit physical relationships between areas such as land and/or sea, and space, these other graphics represent relationships within mental spaces. Yet the similarity of purpose of mental maps and geographic maps is clear: Each is based on the visual representation of a region, one untouchable and mental, the other apparent and physical (with the understanding that this mental/physical dichotomy is a troublesome philosophical question). The history of cartography reveals that map making was a significant invention of and for human thought:

> The act of mapping was as profound as the invention of a number system . . . The combination of the reduction of reality and the construction of an analogical space is an

> attainment in abstract thinking of a very high order indeed, for it enables one to discover structures that would remain unknown if not mapped.
>
> (Robinson, 1982, p. 1)

James H. Wandersee, in an analysis of the connection between cartography and cognition, suggests that cartography links interpretation, cognitive transformations, and creativity. He states that map making may serve ". . . (a) to challenge one's assumptions, (b) to recognize new patterns, (c) to make new connections, and (d) to visualize the unknown." (Wandersee, 1990, p. 924) Wandersee's own research using concept maps (Novak & Gowin, 1984) for teaching science at the college level also reveals how limitations of map making reflect the gray areas in the field of science:

> Although maps are always somewhat inaccurate, approximate, and incomplete, so are the scientific theories which humans construct. Like a map, theories connect knowledge in many directions and are continually updated to incorporate new information . . . just as a map cannot be reduced to strings of text, scientific knowledge is fairly nonlinear, hierarchical, and weblike. Therefore, "the metaphor of the map" seems quite appropriate for holistic representation of scientific knowledge.
>
> (Wandersee, 1990, p. 926)

This constructive dimension of the graphic representations of physical regions is most easily understood as the purely analytic process of mathematical correspondence between a point or line on a map and a certain place where one could stand. This correspondence, while more exacting in the field of cartography, is much more problematic as one begins to make maps, or graphic organizers, as representations of concepts. The use of thinking maps or any semantic mapping must not be construed as an exact representation or mirroring (Rorty, 1979) of the world by the mind, or the map being some point-by-point configuration of ideas as linked in memory.

During the process of constructing *any* map- or drawing - the designer is bringing an interpretive frame to the drawing board. Betty Edwards suggests that a drawing is an imperfect mirror, not only of reality, but also of the self of the representer:

> the object of drawing is not only to show what you are trying to portray, but also to show you. Paradoxically, the more clearly you can perceive and draw what you see in the external world, the more clearly the viewer can see you, and the more you can know about yourself . . . drawing becomes a metaphor for the artist.
> (Edwards, 1979, p. 23)

The metaphor of map making is offered as one way of representing and communicating mental models of the world. Far from providing objective, direct correspondences between points in reality and a point on a page and an exact point in the human brain, each of these depictions comes with a frame of reference. A landscape painter may be limited by the boundary of canvas and finally the picture frame, but the painter's perspective is the implicit location of the painter-as-viewer. Ultimately, the processes of map making in the fields of cartography and in education are related by a unique nexus of the artistic creation and analytical mental organization, and the modeling of ideas, through the rich inter-subjective play of reality and the human mind-body.

Different Types of Graphic Organizers

Graphic Organizers Defined

At present in the field of education there is a confusion of terms for the visual representations of ideas. Terms such as webbing, mind mapping, clustering, semantic maps, cognitive maps, graphic organizers, and now thinking maps, are often used interchangeably. The most succinct definition of the array of these visual tools is found in a comprehensive analysis of research supporting the use of graphic organizers by John Clarke (Clarke, 1990). He defines graphic organizers, and then compares graphic forms to the form of typical sentences:

> . . . [graphic organizers are] words on paper, arranged to represent an individual's understanding of the relationship between words. Whereas conventions of sentence structure make most writing linear in form, graphic organizers take their form from the presumed structure of relationships among ideas.
>
> (Clarke, 1990, p. 30)

There are numerous ways of categorizing types of graphic organizers, such as by stated purpose, visual form, the rules for constructing the graphic, flexibility in use, theoretical foundation, and more practically, how each approach is integrated into classroom use. This review of different graphic organizers is based on three relatively distinct yet often overlapping purposes for graphic organizers: for brainstorming, for task-specific learning, and for the development of thinking processes. Yet, developers of each of the examples of these types might argue that their ultimate purpose is for the graphic to be used for supporting two or all three of these student outcomes, so these categories are not meant to be mutually exclusive. A more systematic review of types of graphic organizers is beyond the scope of this investigation and an important area for future research.

Brainstorming Organizers

Techniques called webbing, clustering, and semantic mapping became popular in many schools in the 1970's and 1980's primarily for the purpose of facilitating students' brainstorming and creative abilities. One of the outcomes of this kind of mapping is for students to generate a large quantity of associated information without strict guidelines for use. Gabriele Lusser Rico brings a similar, artistic sensitivity to the process of writing using mapping, as Betty Edwards brings to the field of drawing, by directly linking the development of clustering and webbing techniques to seeing patterns, seeking personal understanding, and envisioning metaphors. In Writing the Natural Way (Rico, 1983), Rico leads writers through a transformative process based on visual brainstorming:

> In the beginning you will relearn the fresh, childlike attitute of wonder through clustering; later you will develop your inborn receptivity to pattern making

> through the trail web . . . reclaim the ability to think metaphorically, reconcile opposites to build creative tension, and balance original vision with revision.
> (Rico, 1983, p. 20)

The clustering technique begins with very little graphic structure or rule governance: a word is written in the center of a page, surrounded by an oval, and then associations are extended using lines and curves to other ideas. The 'trial web' is the next step away from the unstructured brainstorming: central organizing ideas are identified and linked together (Figure 3.1). Rico thus makes only a slight distinction between the intial brainstorm called a cluster and the conscious structuring of ideas into a revised graphic called a web. The use of these open-end techniques for prewriting and revision are focused on developing students' fluency with the generation of ideas

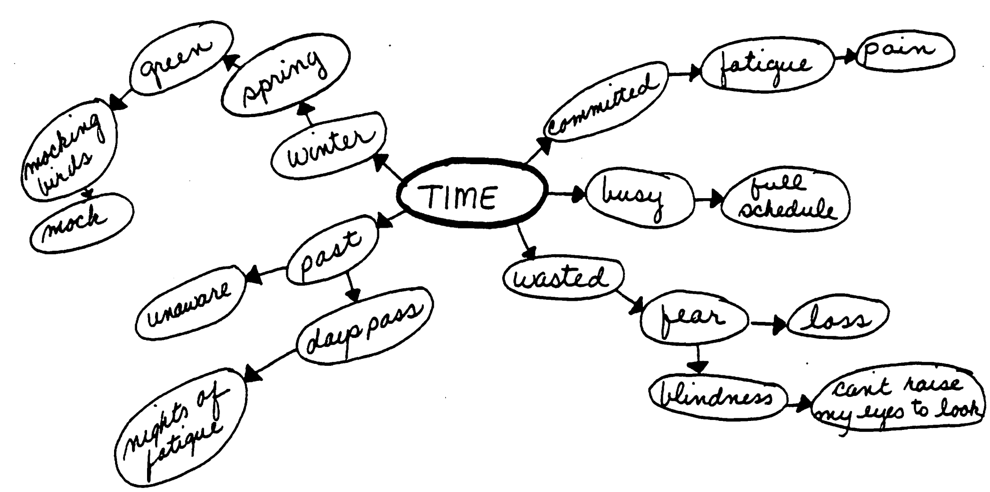


Figure 3.1. A Trial Cluster using the topic "Time"; Gabriele Lussor Rico

and not for highly developed organization. After this prewriting stage, students are instructed in the writing of a rough draft using the linked information.

Whereas Rico and other proponents of the process writing approach have developed and clarified the use of clustering for writing, Tony Buzan developed more specific mind mapping techniques for adults and younger students for the outcomes of generating ideas, taking notes, developing concepts, and improving memory (Buzan, 1979). Buzan's approach, similar to Rico's, starts with a key word or image in the center of the page, followed by extensions radiating outwards (Figure 3.2). Buzan is much more specific than Rico about the actual drawing and lettering of mind maps: Linkages in these maps are shown extended from the key idea in the center, secondary ideas may be connected to each other by arrows and lines in other areas of the map, and more important ideas

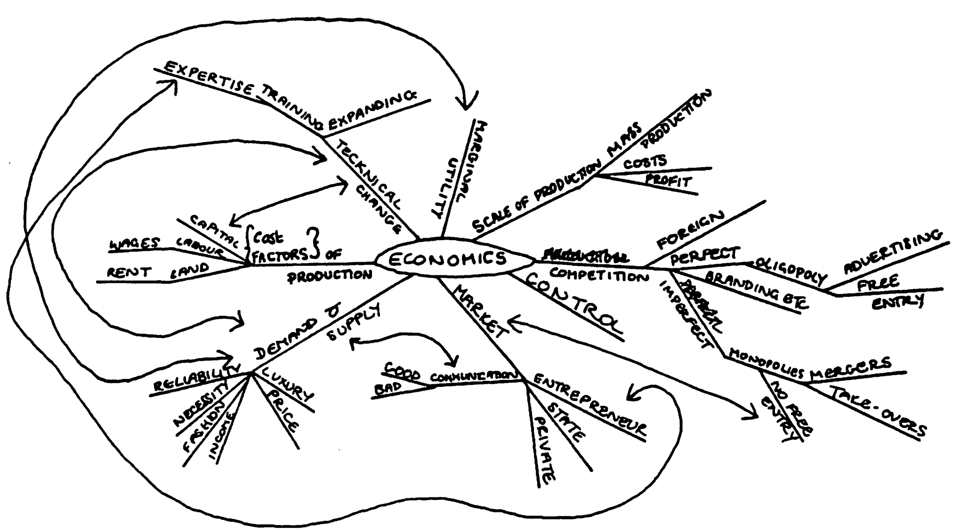


Figure 3.2. Mind Mapping using the topic "Economics"; Tony Buzan

are drawn nearer the center. Additionally, all words are printed in capitals and single words are suggested for each line. Buzan also makes suggestions for creating advanced mind maps that are more 'holographic' in appearance. The graphic is enriched by adding highlights such as arrows, codes (asterisks, question marks, etc.), geometric shapes, three dimensional drawings, unique images, and multiple colors. These additions are intended to make recall easier and for making the map more accessible to others.

Many of Buzan's and Rico's techniques are based on the translation of brain research that shows that the mind does not process information in solely list-like, linear representations. The core of research that Buzon draws from is the early brain specialization work conducted by Roger Sperry, Robert Ornstein, and others. Buzan, summarizing this research, states that

> In most people the left side of the brain deals with logic, language, reasoning, number, linearity, and analysis . . . the right side of the brain deals with rhythm, music, images and imagination, colour, parallel processing, day-dreaming, face recognition, and pattern or map recognition. (Buzan, 1979, p. 14)

The common message and the techniques that support the brainstorming approaches for visual representations are that the linear development and communication of ideas has been the predominant method to which a more holistic approach should be added. Buzan states:

> For the last few hundred years it has been popularly thought that man's mind worked in a linear or list-like

> manner. This belief was helped primarily because of the increasing reliance on our two main methods of communication, speech and print. In speech we are restricted, by the nature of time and space, to speaking and hearing one word at a time. Speech was thus seen as a linear or line-like process between people. Print was seen as even more linear.
>
> The acceptance of this way of thinking is so long-standing that little has been done to contradict it.
>
> (Buzan, 1979, p. 88)

The linear approach to communication and generation of ideas is such a fundamental practice in classroom learning that holistic or nonlinear representations are rarely apparent. A cursory look at most teachers' guides reveals that students are often asked to *list* three responses to questions, rather than actively organizing the information in any other form. The linear "list" is thus the central organizing principle in classrooms. Graphic organizers that are used to focus on brainstorming promote linkages between ideas in linear *and* non-linear patterns and tend to emphasize personal experiences and creativity as foundations for learning. Though Rico suggests a second level 'trial web' and Buzan provides a few 'advanced mapping' techniques, both approaches promote sustaining students' abilities to create idiosyncratic, integrated, holistic views of connected information across disciplines that are not systematically shared with other students or teachers.

Task-Specific Organizers

Whereas brainstorming graphics focus on the generation of knowledge through linking associations in a relatively informal and individualized process, task-specific graphic organizers are usually more formal, relatively static structures that are assigned to students. These graphics are often designed for the teacher to present content information and/or used by students to understand certain content information or processes within a subject area. The outcome is not necessarily for students to flexibly or independently apply the graphic organizer outside of the specific task. Task-specific organizers range from decision trees in mathematics, to concept circles in science, to story maps for reading comprehension, to highly structured maps for organizing writing.

One of the fundamental differences between brainstorming and task-specific organizers is that with brainstorming there are few parameters for creating the maps and the design and outcomes are open-ended; with task-specific maps the organizers are usually taught within a certain discipline and with much more constrained parameters related to and reflected by the specific the task. A second difference is that many of these graphics may be used more as teacher strategies for facilitating learning and thinking rather than as student-centered tools.

In the area of reading comprehension there have been numerous task-specific graphic organizers developed to guide students in analyzing basic text structures found in prose. These organizers are then taught to students as tools for constructing, comprehending, summarizing, and synthesizing ideas found in the text. Beau Fly Jones (et al), describe this application:

> Reading with an appropriate graphic structure in mind can help students select important ideas and details as well as detect missing information and unexplained relations. Moreover, constructing and analyzing a graphic helps students become actively involved in processing a text. Graphics foster nonlinear thinking, unlike prose summaries and linear outlines.
>
> (Beau Fly Jones, et al, 1989, p. 21)

The graphic organizers identified by these authors (Figure 3.3) include a compare-contrast matrix, a flow chart for series of events, and a problem-solution flow chart outline, a cause-effect "fishbone map", and a hierarchical "network tree" for several different processses such as grouping and showing causal relationships. The authors provide a five-step instructional sequence for training

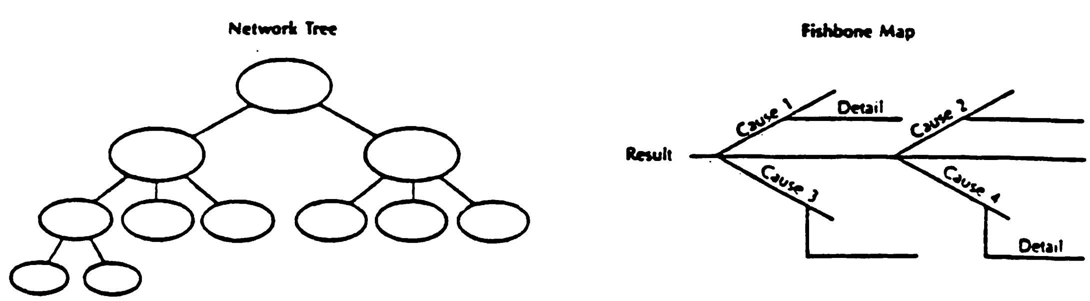


Figure 3.3. Semantic Maps for Reading Comprehension; Beau Fly Jones, et al

students how to use these organizers for reading comprehension: Showing examples, modeling use, providing procedures, coaching, and practice with feedback.

Text structure as a basis for improving reading comprehension has also been linked directly to formal writing processes by showing that graphic organizers enhance students' abilties to read and then to summarize, in writing, what they had have read (Armbruster, et al, 1989). Using control groups, Bonnie Armbruster's early research had shown that students who learned the common text structure of "problem-solution" in the social studies area at the fifth grade level made summaries that were rated significantly higher on quality of writing, which included organization, focus, and integration (Armbruster, 1987). The pre-set structures (Figure 3.4) include problem-solution, compare/constrast, sequence, and cause/effect.

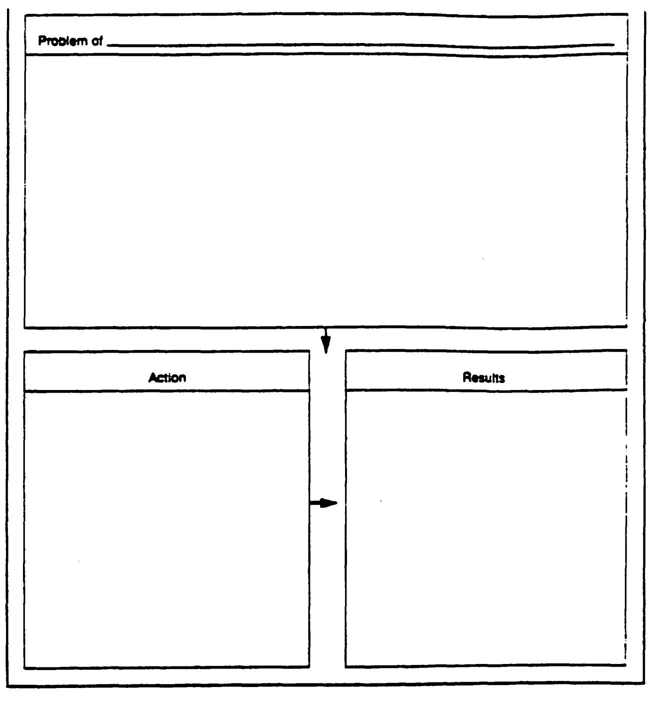


Figure 3.4. Problem-Solution Text Structure; Bonnie Armbruster

Additional research support for the use of graphic organizers for reading comprehension and writing is found in the work of Richard Sinatra who links these areas using teacher and computer-generated graphics (Sinatra, 1989). Sinatra developed three generic semantic maps (Figure 3.5) using rectangles of different sizes with arrows in

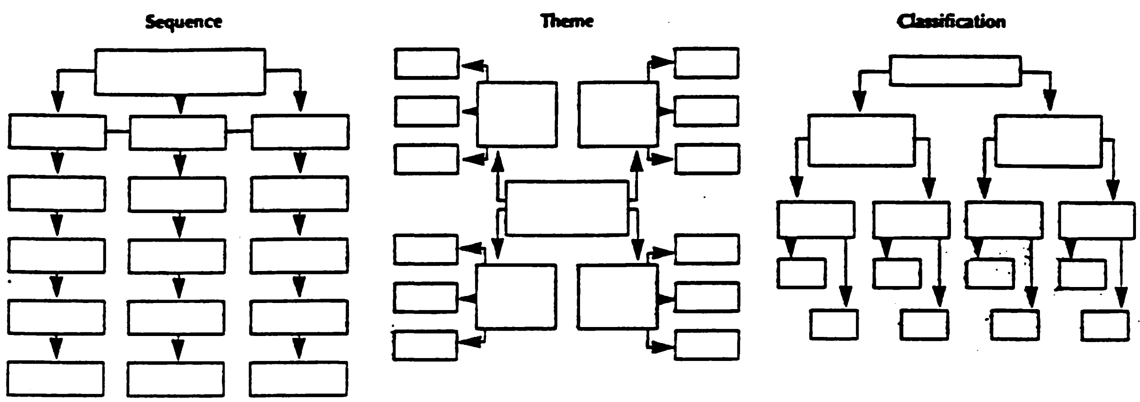


Figure 3.5. Computer-generated Generic Semantic Maps for Reading and Writing; Richard Sinatra

three different configurations for sequencing, classifying, and identifying themes. Sinatra reports that

> Using these highly structured computer programs, students learned to construct visual maps representing the relationships of major ideas, subordinate ideas, and explicit information. (Sinatra, 1989, p. 58)

Teachers involved in this approach received training and modeled how to use the three semantic maps in the reading and writing process. In the writing area, students developed maps for writing reports. The results showed significant changes in student performance on the state reading exam and writing test. These kinds of results from multiple research findings using reading comprehension organizers led the International Reading Association to state that semantic mapping is an approach "between reader and text by which meaning is found and created" (I.R.A., 1988).

In the area of mathematics instruction, pictorial and other types of illustrations are being used by students to representations of problem. The National Council for the Teaching of Mathematics strongly endorses the use of mathematical modeling using different graphics for solving problems and for making connections to other disciplines (N.C.T.M., 1990). The example (Figure 3.6) shows how a

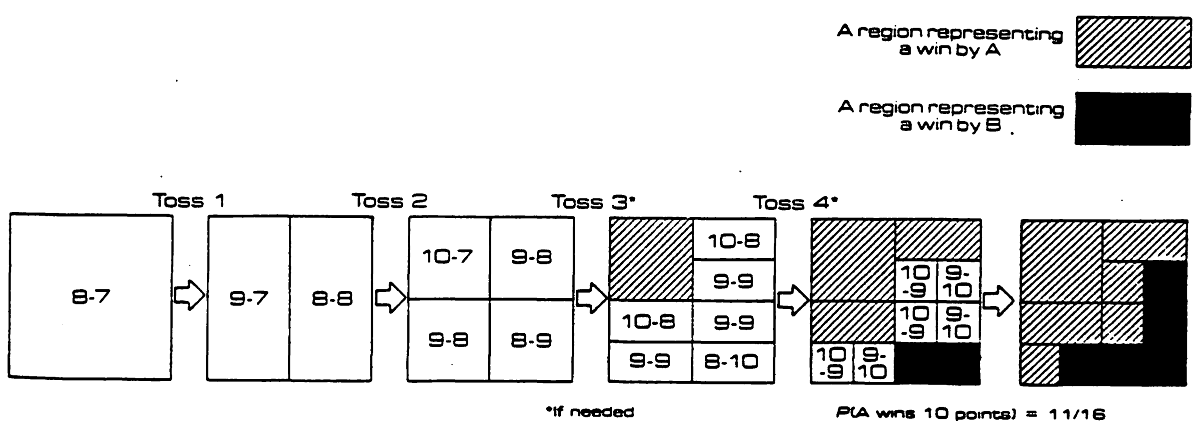


Figure 3.6. Problem-solving example using Mental Modeling; N.C.T.M. Standards

problem involving predicting the winner of a coin toss experiment could be solved using a modified flow chart as a mental model. The standards presented by this council state that

> Students who are able to apply and translate among different representations of the same problem situation or of the same mathematical concept will have at once a powerful, flexible set of tools for solving problems and a deeper appreciation of the consistency and beauty of mathematics. (NCTM, 1990, p. 146)

In mathematics the Venn diagram may be the most widely recognized visual tool for learning and has been used for representing class membership and general-specific relationships. The Venn diagram using circles is now used across many disciplines for categorization. James H. Wandersee relates the history of the Venn diagram:

> Venn (1894) pointed out that logicians borrowed the use of diagrams from mathematics during a time when there was no clear boundary line between the two fields. Line segments, triangles, circles, ellipses, and rectangles were all used to diagram categorical propositions during the early development of logic as a discipline.
>
> . . . Euler's circles were eventually replaced by Venn's diagrams because Venn's system fit Boolean class algebra so well. Many of the diagrams in books that are called Venn diagrams are actually Euler circle diagrams or modifications of them.
>
> (Wandersee, 1987, p. 927)

With this background information, Wandersee has developed concept circle diagrams based on the Venn diagram for science education. The concept circles look similar to Venn diagrams, but are not used in the same way. The concept circles are modified to highlight additional information about concepts and not strict category relationships. In the center of each circle (Figure 3.7) the

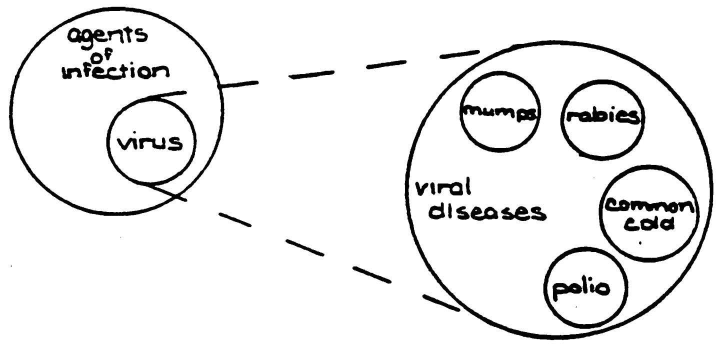


Figure 3.7. Concept Circles using the topic "Viruses"; James Wandersee

concept or category is named. The overlapping circles of different sizes and colors (up to five circles in any one cluster of circles) may represent the concept both quantitatively or qualitatively. The use of "telescoping" circles as represented by dotted lines links circles and shows relatedness of concepts, progressive differentiation, and subordination.

The wide range of applications of graphic organizers for task-specific outcomes in clearly defined content areas reveals that visual representations are not confined to any one discipline. The effectiveness of these tools for supporting students' comprehension of information and conceptual understandings also reveals that these are not merely mechanical structures for rote learning. Another dimension also is apparent: Very few simple graphics such as lines, boxes, and arrows provide the conceptual linkage between bits of content information to form complex, meaningful, holistic images that students can grasp and manipulate.

Thinking Process Organizers

The distinctions between task-specific and thinking process organizers are hardly distinguishable by visually comparing maps, because the maps may look identical. The essential difference between the two types is that the thinking process organizer is introduced and defined by teachers as a generic map based on one or several specific thinking processes or a strategy. Additionally, the outcome for using the thinking process organizers is two-fold: Students should be able to use the map for task-specific activities within a content area and for transferring thinking processes across disciplines. Obviously, there is sometimes an overlap in expected outcomes for using these two types of organizers, because task-specific and thinking process organizers usually focus on students' conceptual understandings of content information.

Thinking process organizers are not introduced as specific reading, writing, or mathematics strategies, but as tools that students will independently use for general content learning and problem-solving. The intended outcome is that not only will students improve their conceptual understandings of specific content knowledge and skills, but that these thinking process organizers will support the improvement of students' thinking abilities over time. This difference is significant because those teachers using thinking process organizers are guided by the beliefs that general thinking abilities may be improved and that thinking skills are transferrable across disciplines. Each of the task-specific organizers presented above could be defined as, and used as, thinking process organizers. For example, Figure 3.3 (Fishbone Map) and Figure 3.4 (problem-solution) are based on seeking causal relationships; Figure 3.3 (Network Tree), Figure 3.5 (Classification), and Figure 3.7 (Concept Circles) are based on establishing hierarchical classifications; and Figure 3.5 (Sequence) and Figure 3.6 (Problem-solving) are based on identifying sequences in information. Thus, the essential difference between task-specific organizers and thinking process organizers is not based on what the map looks like, but rather on how a teacher introduces and models the use of each map for students.

An early approach to using graphic organizers for general problem-solving and for improving thinking abilities was Albert Upton's work at Whittier College in California. In Creative Analysis (Upton, et al, 1960), a text for his introductory semantics English course, students used a few basic diagrams (Figure 3.8) to learn how

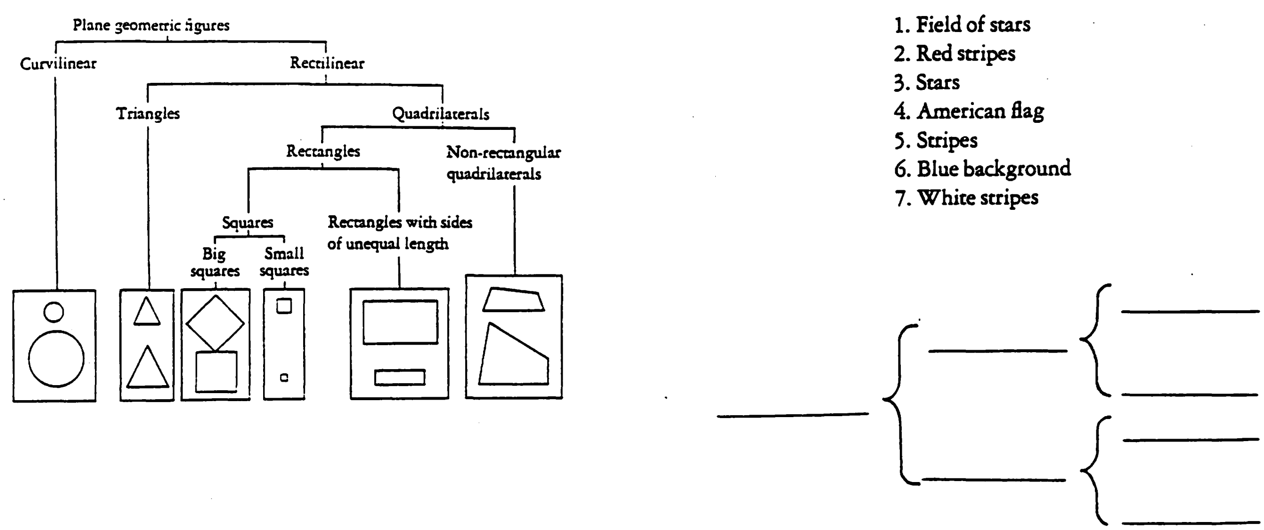


Figure 3.8. Classification using the topic "Geometric Figures" and Structural Diagram using the topic "Parts of the American Flag"; Albert Upton

to apply the thinking processes of classification, part-whole relationships, and sequencing. These diagrams showed in explicit detail how to apply thinking processes to the simultaneous organization and interpretation of information from across disciplines. Upton's early work is the theoretical and practical foundation for the thinking maps approach and will be presented in depth in the following section.

Much like Upton and Samson's early work, there is presently a range of graphic organizers used for introducing and improving students' thinking processes. Howard Black and Sandra Parks (Black & Parks, 1990; 1992) offer a number of different graphic organizers that relate to specific thinking processes. One example is the compare and contrast diagram (Figure 3.9). Students are given a

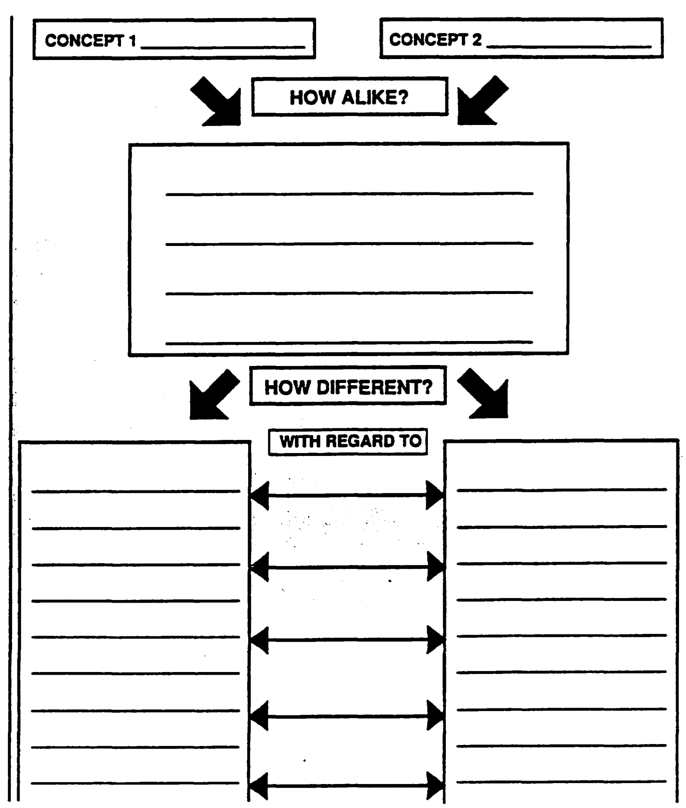


Figure 3.9. Compare and Constrast Diagram; Black & Parks

copy of this page and provided with practice examples for using the document for comparing concepts within different disciplines. This organizer is constructed so that students are working through the thinking process of comparison by identifying likenesses, differences, while clearly specifying what the differences "are in regard to." After the introduction of the graphic, the authors suggest that copies of the pages should be readily available in the classroom for students to pull out and use for other applications.

Several other similar teacher resource books have been developed showing the use of graphic organizers for the purpose of facilitating teacher curriculum design and to support students' thinking (Clarke, 1991; Fogarty and Bellanca, 1991; Marzano, 1991). Most of these applications present isolated processes and applications. The terminology and uses of these thinking process organizers generally reflect many of the goals of the thinking skills movement such as supporting interactive teaching, cooperative learning, transfer of thinking processes to content learning, metacognition, and the construction of knowledge by students.

In contrast to introducing an array of isolated thinking process organizers that may be used together (but not visually linked), there are also several approaches that focus on a single graphic form for representing an integrated view of thinking, similar to the brainstorming organizers. Two of these approaches, concept mapping and systems thinking, are based on different philosophical perspectives about how humans develop concepts.

Novak and Gowin (Novak & Gowin, 1984) have developed a process called concept mapping that represents learning as the integrated, hierarchical development of interconnected ideas. Based on David Ausubel's theory of learning and his early work using advanced organizers (Ausubel, 1968), Novak and Gowin focus on the assimilation of new ideas into the conceptual pattern of students' prior knowledge as expressed in a visual, hierarchical form. There is also a focus on the construction of knowledge, the meaningfulness of the learning that is taking place, and the reworking of maps to incorporate new understandings. The authors explain their guiding assumption:

> Because meaningful learning proceeds most easily when new concepts or concept meanings are subsumed under broader, more inclusive concepts, concept maps should be hierarchical.
>
> Concept mapping is a technique for externalizing concepts and propositions. How accurately concept maps represent either the concepts we possess or the range of relationships beween concepts we know (and can express as propositions) can only be conjecture at this time.
> (Novak & Gowin, 1984, p. 15-17)

The authors use some of the same graphic forms used by Rico (ovals and lines) along with the linking words found in Buzan's approach, within an adaptable yet strictly hierarchical structure (Figure 3.10). Concept mapping is intended to be used flexibly so that the same content and/or concept may be represented in multiple configurations. The authors use the term 'rubber map' to highlight how subordinate concepts may be reconfigured and understood at a higher level on the map. Though the basic graphic is hierarchical and thus reflects an overarching classification structure, other thinking

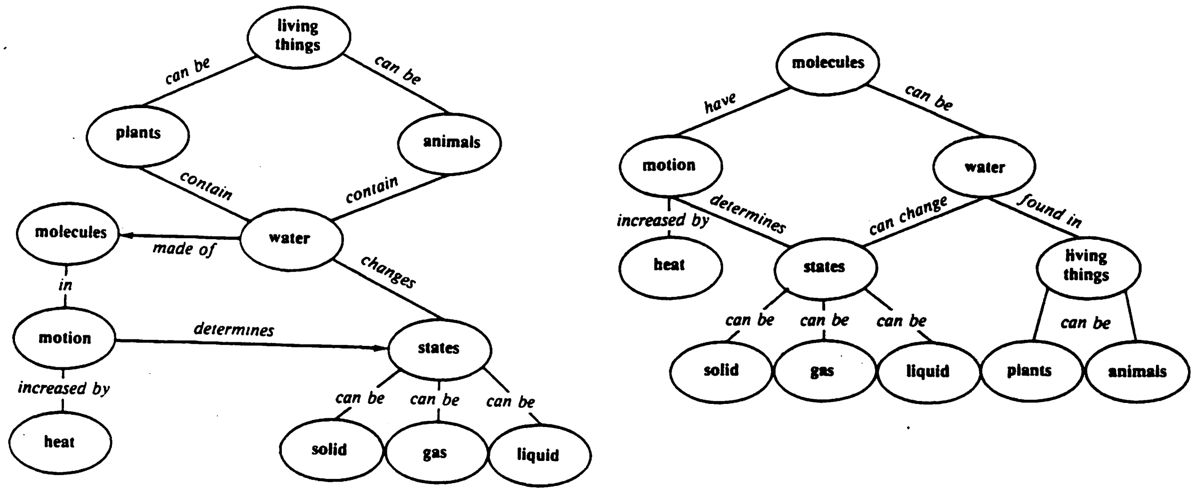


Figure 3.10. Two Concept Maps representing the topic "Water Molecules"; Novak & Gowin

processes such as sequencing, cause-effect and part-whole reasoning, and identification of attributes are implicitly integrated into the representation using linking lines and key words.

Whereas the concept-mapping techniques are based on hierarchical representation, the systems dynamics approach represents information as nonhierarchical, interconnected "flows" and feedback loops that model change over time in dynamic systems. One approach to systems thinking that has been translated for use in business and education is based on a set of graphic tools activated by software called STELLA (Richmond, et al, 1991).

Systems thinking using STELLA shifts the organizational structure often found in schools from "listing" information to showing and modeling dynamic phenomena. The authors state that there are three basic assumptions within the systems dynamics approach: (1) there are positive and negative feedback cycles that influence a system over time rather than causality that runs one way (from cause to effect); (2) that the internal patterns of dynamics latent within a system are often precipitated by outside forces rather than that there are only external causes that "shock" a system; and (3), that causal factors are interdependent rather than relatively independent (Richmond, 1991, p. 49-51).

A STELLA diagram shown below (Figure 3.11) represents the dynamics of human population growth. Each of the symbols, called 'tools', is a static represention of a changing system. The rectangles are "stocks" which are conditions that accumulate over time, such as population; the circle with the "spigot" on top are the "flows", such as the births and deaths which are activities which change the stocks. The "cloud" shapes represent non-material quantities. The other circles with curved arrows attached are "converters" that represent the translation of units of measure within a stock. Importantly, each

A STELLA Diagram of Relationships Governing Human Population Dynamics

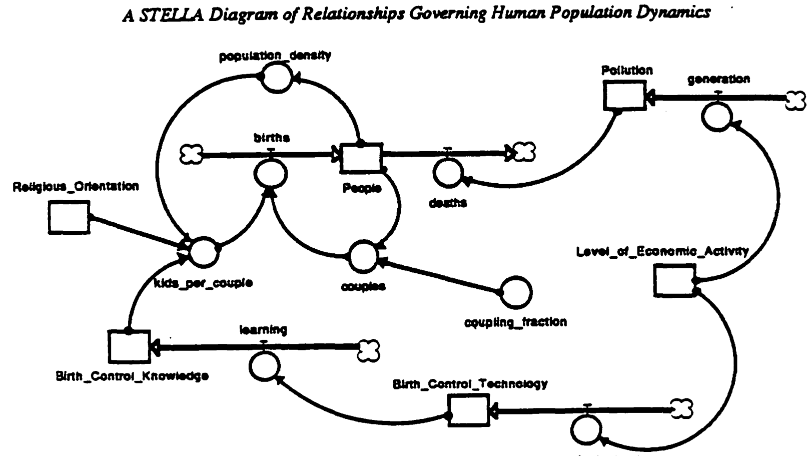


Figure 3.11. STELLA Diagram using the topic "Relationships Governing Human Population Dynamics; Richmond, et al

of the stocks and flows is given relative, numerical weights and the stocks and flows are connected through algebraic equations. This model is thus linked up by a mathematical underbelly so that variables may be changed and the program "run" and tested. This is essential in systems dynamics: To attempt to graphically show, mathematically model, and then test predictions of what will happen over time in a system. The systems thinking approach, as shown using STELLA, is supporting a new way to understand and define the thinking processes based on "feedback" cause and effect reasoning.

The three types of graphic organizers presented in this review, though distinct, show much overlap in form, use, and purpose. Interestingly, the systems dynamics approach incorporates the holism of the brainstorming approach, the rigidly defined framework of many task-specific organizers, and the focus on a single thinking process (flow of information) to form a process of analysis and visual representation that is significantly different from any of the "static" uses of graphic organizers presented in this review, or of the thinking maps. Obviously, the use of graphic organizers is still in a preliminary state of development, and the three categories constructed for this review will soon be outdated as new forms enter the field.

Importantly, the *forms* of several of these graphics-- such as hierarchical concept-mapping and systems flow diagrams --represent in an entirely new modality explicit depictions of differing definitions, theories and structures of knowledge.

Thinking Maps Lineage

Thinking maps are based on a model of interrelated thinking processes as initially defined by Albert Upton. Upton's theoretical perspectives were first presented in "Design for Thinking" (Upton, 1941), a text on semantics and the thinking processes, and extending from the work of I.A. Richards (Richards, 1923). Upton was most interested in issues of representation using signs and symbols, context in problem-solving situations, metaphorical understandings, and, most importantly, meaning as generated within the connections of different types of relationships.

Upton believed that meaning ". . . is always a matter of relation. Nothing ever means itself alone; it can only be meaningful to somebody about something else . . ." (Upton, 1941, p. 23). With colleagues Richard Samson and Ann Dahlstrom Farmer, Upton translated his theoretical work into a college level text, "Creative Analysis" (Upton, et al, 1960). It was through the development of this text that the authors established a non-hierarchical, non-linear thinking process model. This model was based on a simple triad: the processes of naming entities in context (later called "thing-making"), identifying the sensory, logical, emotional/aesthetic qualities of things, and finding relationships between things. Upton focused on only three basic relationships between entities, reasoning that the biologist studies the natural world by creating categories (taxonomy), identifying physical structures (anatomy), and seeking to understand dynamic operations (physiology). These relationships became, for

Upton and his colleagues, the essential patterns for problem-solving within any discipline.

Upton also believed in the central importance of linking similar relationships through analogical and metaphorical reasoning within the process of making meaning and problem-solving. Though Upton did not have George Lakoff's theoretical perspective or research base on conceptual metaphor, he did express a similar idea that metaphors are not merely figurative devices:

> Metaphors are not just pleasing additions to speech or writing. They are instruments of creative thinking. When a known relationship between things in a familiar universe is transferred to a new world of thought, insight (or the discovery of a new relationship) is the result.
> (Upton, 1941, p. 162)

Results from the use of the Creative Analysis text by Upton's students revealed significant changes in intelligence tests as reported in the New York Times (New York Times, 1960). A group of 280 freshman students at Whittier College were given pre- and post- versions of the Bellevue-Wechstler test. The results showed that *all* students gained in their scores over an eight month period of time and that the average score increase was significant. This notoriety--at a time when there were few alternative definitions of intelligence other than the Intelligence Quotient and when intelligence was viewed as static --later led to the development in the early 1970's of a thinking skills publishing company, Innovative Sciences, Inc., which based its materials and staff development on the Upton model. Two comprehensive programs, called THINK ! for language arts and

Intuitive Math for mathematics, were created based on the six thinking skills model that had been further clarified by Upton's associate, Richard Samson (Samson, 1965), as shown below:

Upton-Samson Terms	Common Terms
Thing-Making	symbolizing, labeling
Qualification	attributes; comparison
Classification	categorization
Structure Analysis	part-whole relationships
Operation Analysis	sequencing; cause-effect
Seeing Analogies	analogies; metaphor

By late 1975, more than 900 school districts had piloted or implemented these programs. There were numerous reports of different types of success with these materials, including improved aptitude scores, improved student attitudes toward the English and mathematics subject areas, and improvement in students' self-concept of their own mental ability (Tacoma, WA, 1975; Worsham, 1982). In the early 1980's, a thinking skills program for junior high and high school levels called Strategic Reasoning (Glade, 1985) was distilled from these comprehensive language and mathematics programs. Teachers were trained to use Strategic Reasoning as a set of materials for the direct teaching of thinking to students. The program had four stages: introduction to the six thinking skills, application to multiple-choice problems that had several possible "right" answers, applications to reading selections from across disciplines, and finally, a discovery/simulation activity through which students analyzed issues such as prejudice, peer pressure, and the information age in a future world. During the 1970's and into the late 1980's Innovative Sciences, Inc. consultants also conducted in-depth seminars for teachers called "Applying Thinking Skills." Teachers learned to use the Upton-Samson model to focus their teaching on the outcome of facilitating students' thinking.

One of the many elements of these materials and staff development programs was the use of what were then called "formats" for designing thinking skills activities, which included graphic organizers from Upton's earlier work: the tree diagram for classification, the brace diagram for structure analysis, and flow charts for sequencing. Later, a bubble diagram was created by Gene Marr and Judith Kovacs (Marr, et al, 1986) for facilitating the process called qualification. These formats were introduced as tools for applying thinking processes to learning. In the late 1980's Innovative Sciences, Inc. published a student resource booklet and teacher's guide for grades 5-8 called Expand Your Thinking (Hyerle, 1989). This program was developed as a way to train teachers and students how to use specific graphic "formats" called thinking maps as tools for transferring eight thinking processes across disciplines.

The Eight Thinking Maps

Overview

The thinking processes definitions and related graphics that provide the foundation for the thinking maps are based on the broad framework of the Upton-Samson model. Several important changes have been made in the definitions and terms of the thinking processes that underlie each map, and additional maps have been created. The six "thinking skills" model has been expanded to a set of eight "thinking maps" by defining the processes of comparison/constrast and cause/effect reasoning as separate extensions from the processes of qualification and operation analysis, respectively. As related below, recent cognitive science research, philosophical work, and a view of thinking as connective that were presented in Chapters 1 and 2 have been central to the further development of the theory and practice of thinking maps. Obviously, the most significant change in this approach is that thinking skills are now defined for students in both verbal *and* visual terms.

The Upton-Samson model was offered as a comprehensive set of fundamental mental processes, as highly interrelated, nonhierarchical in theory, and used without a step-by-step procedure. The core presupposition of this model is that humans use these processes in an integrated way according to the purpose of a task or in response to a problem. Several key elements of Upton's early work remain essential to the thinking maps approach. First, this language represents a complete set of fundamental cognitive processes as tools which are used from simple to complex applications. Second, the maps, though introduced below as graphically isolated, are interrelated and are most effectively used in unison. (Several applications showing how the maps are used in a coordinated way in classrooms are provided in the following chapter.) Third, there is no procedure, starting point, or hierarchical ordering of the maps:

Thinking maps are used in response to immediate need and/or intended learning outcome.

The basic design for each thinking map is essential to this language of graphic organizers. There is a unique, graphic syntax, or basic visual starter pattern for each map. There is a "legend" with explicit rules for generating and expanding each map-- as in cartography --that teachers and students learn. Thus, these graphic primitives (not to be confused with mental primitives) form a graphic language from which different configurations emerge. This consistency leads to effective communication, efficient expansion of ideas, and flexible use of multiple patterns of thinking.

A more complete discussion of the idea of the thinking maps as "a language" is presented in the last chapter of this investigation. Below is an introduction to each of the eight thinking maps in isolation, and the metacognitive frame, along with student examples.

The Circle Map

The circle is a universal image, often representing wholeness, centeredness, and inclusiveness. The center of the mandala image, showing permeable concentric circles, inspired the creation of this interpretive tool. The circle map (Hyerle, 1989) is based on the process of representing text (an idea) in context. Upton and Samson initially called this process "thing making", or the process of *making* sense of, representing, and thus giving definition to some *thing* through the awareness of contextual information.

This map (Figure 3.12) provides learners with a tool for graphically 'putting things in context.' In the center of the circle the learner draws the symbol (text) that represents or names the idea being investigated, such as words, phrases, numbers, drawings, or any other kind of representation. The inside circle represents the process of creating a symbol for an idea. Within the outside circle the learner writes in contextual information that gives meaning to the text. This may include immediate observations, inferences, and the learner's own prior knowledge about the idea being studied. A learner may also start an investigation by identifying contextual information in the outside circle for a yet to be established central idea.

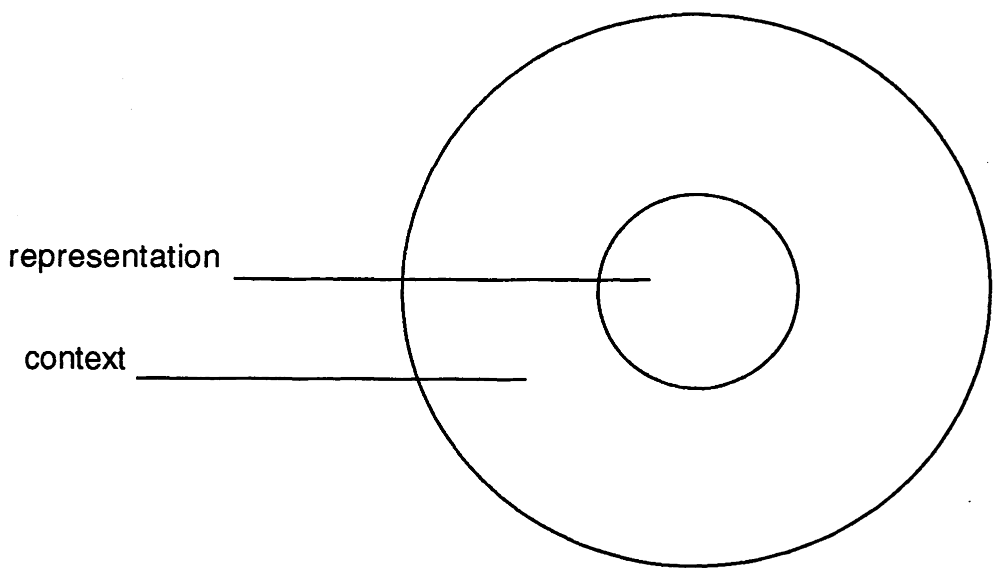


Figure 3.12. The Circle Map

The process of symbolizing is not consistently highlighted in schools as a key to learning. The process is usually called "naming" or "labeling", because from with the paradigm of knowledge-as-objective the essential requirement is that students learn to identify the correct symbol that directly and unambiguously corresponds to an object or idea. Words and other symbols may be understood by students as static to the degree that context is rarely investigated, beyond learning synonyms. Within a constructivist account of knowledge, and drawing upon Hilary Putnam's view of how the linguistic division of labor and the environment influences definitions, how one symbolizes (or names) an idea is connected to the context in which it is used and possible metaphorical extensions. From a Piagetian framework, the naming and categorization of things is central to the assimilation of new concepts into the prior knowledge of the learner. One of the challenges that students face in schools today is to develop a flexible and dynamic view of words--not as ideas --but as imperfect placeholders for meaning through which they must actively re-make and interprete ideas in context.

By using this map, students establish context by generating an array of words about a topic (or text) within context *without* explicitly showing specific connections. Simply stated, the circle map is for brainstorming in context. Other thinking maps are used for generating and showing different types of relationships. This map thus becomes a theoretical tool for showing a word or other representation in context for the purpose of constructing knowledge, rather than blindly accepting a dictionary or textbook definition that may be bound by a highly objective context.

One of the central features of the thinking skills movement has been for students to be able to identify and use context information. As the review of research above on cognitive science and knowledge paradigms shows, the importance of being aware of and using context for defining and constructing knowledge shifts students away from the inferred educational aim of the regurgitation of objective knowledge. This is one way for learners to begin to assimilate prior experiences and knowledge with new information.

The Metacognitive Frame

The circle map is used by learners for understanding symbols as changing meanings within different contexts and for identifying one's prior knowledge about an idea. Yet as students begin to use the thinking maps as tools for constructing knowledge they will also understand how their personal and interpersonal experiences, and social-cultural knowledge influences their construction of knowledge. As presented in the previous chapter, Charles Fillmore's research in frame semantics-- and Lakoff's use of frame semantics as a foundation for Idealized Cognitive Models -- shows that understandings of daily experiences as well as the interpretation of texts are based on these often unconscious and unquestioned frames of reference.

The "frame" is a square that is drawn around any of the eight thinking maps, though it is often introduced with the circle map. The frame with the circle map completes the mandala image of concentric circles framed by a square. It is a metacognitive graphic that represents several questions: What is my frame of reference for the information shown in the map(s)? From whom did I get this information? What is influencing my interpretation and opinion? What are the frames that my classmates and my teacher have for their opinions? The frame was developed for shifting frames: students interactively share and investigate the frames of reference of their peers, a character in a story, a figure from history, or the frames (belief system) of a certain group of people. This changeable frame concretizes the importance of consistently seeking out and valuing context and alternative point of views in a classroom (Hyerle, 1990).

The example of a circle and frame map (Figure 3-13) was generated by a New York City middle school student. The student named the idea she was asked to think about (the United Nations), the context information that showed her prior knowledge, and the multiple background frames that influence how she understands the idea 'United Nations.' Her beliefs (freedom, believer), status (child, American, citizen, member, student), and connections to the past and future (future of this country, taxpayer, voting) were the basic frames.

The frame, when used around any of the thinking maps, provides a tool for students and teachers to more safely negotiate different points of view and perspectives on a central issue. This is because an idea that is present in a holistic way shows respect for deeply thinking about multiple frames of reference beyond conventions and the institutional culture and power over knowledge of the teacher, text, or school. When used by an individual, the

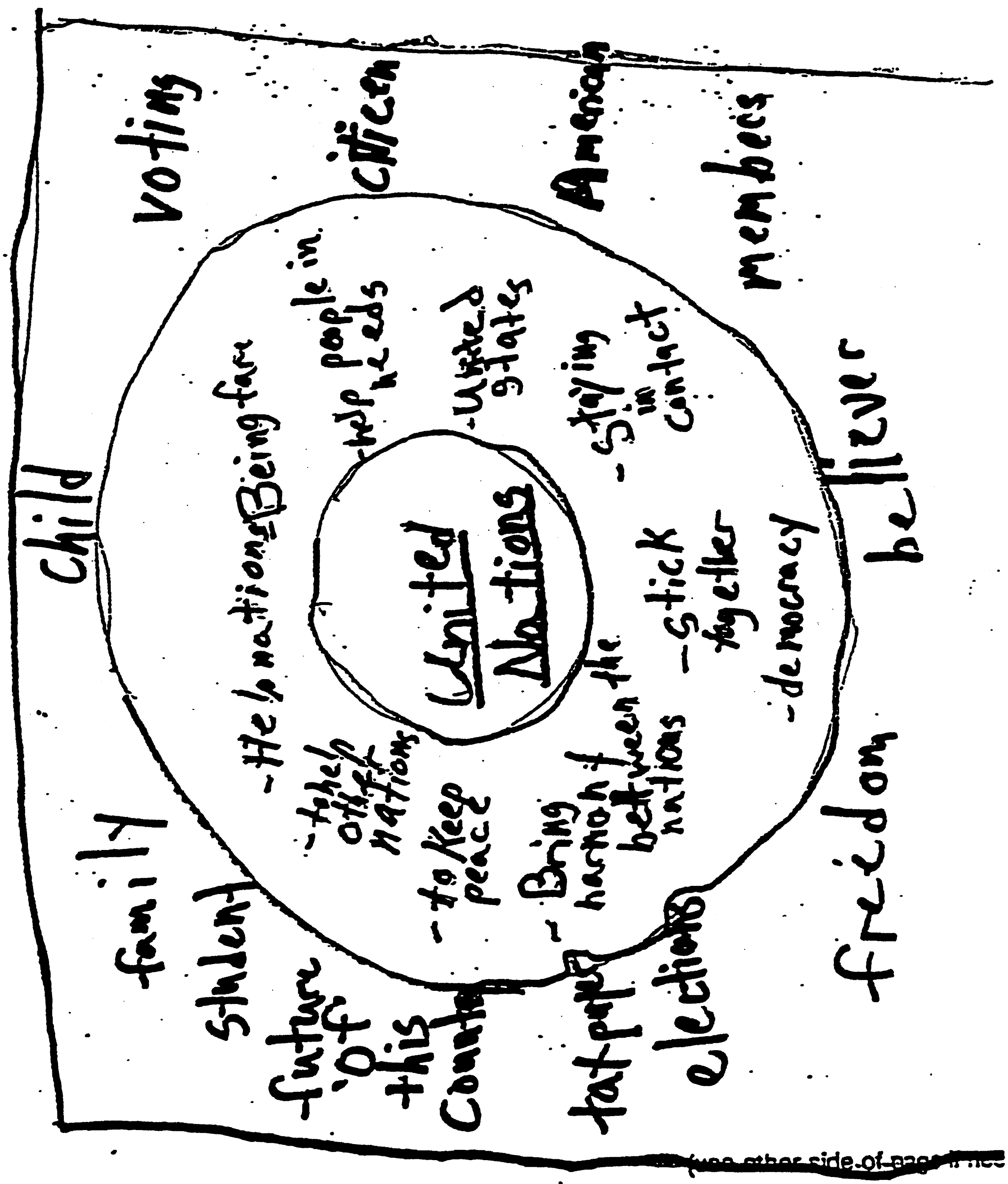


Figure 3.13. **Student example of Circle and Frame Map using the topic "United Nations": New York City**

frame is a metacognitive tool for reflecting on how one is thinking and what private, experiential frames are influencing the generation of ideas. When used by learners in pairs and cooperative groups, the frame becomes an avenue for dialogue: Students can see each other's whole ideas, the idea in context within a frame of reference, and thus more easily understand other perspectives in dialogue. Thus the frame is used by students to explicitly identify perspectives for personal, interpersonal, and social understandings.

As students become fluent in the use of the eight thinking maps, the frame is also used by students to reflect on their own learning process using these questions: Why did I use one map rather than others? What has influenced how I generated this pattern of information? How effective and what were the limitations of the thinking maps for my understanding these ideas? These questions are embedded in the thinking maps assessment matrix introduced in the next chapter.

The Bubble Map

Whereas the circle map is a tool for seeking how an idea is being represented in context, the bubble map is used exclusively for the process of identifying and describing the qualities of some thing. Upton called this process *qualification* using adjectives and adjective phrases. The bubble map is used to generate qualities or descriptors of things such as traits of characters in literature, properties of numbers in mathematics, and attributes of object in science.

As we have noticed above (pp. 69-72), Hilary Putnam has pointed out the example of the analysis of 'gold' (Putnam, 1988), the attributes of some 'thing' are elusive and difficult to define and/or quantify in purely objective terms. The process of describing something in the world is interactive with our bodies/minds, and within social frames and thus, constructive. As Upton related, by attempting to describe a person, a character in a story, a naturally occurring element, or an idea we draw upon our five senses to perceive qualities of things. During this process-- and framed by personal, interpersonal, and social frames --we *project* qualities onto things and *abstract* qualities from things.

The bubble map (Figure 3.14), though similar in form to other types of graphic organizers such as the web or cluster, is used only for the process of describing things using adjectives. This map was named and defined by Gene Marr (Marr, et al, 1986). In the center

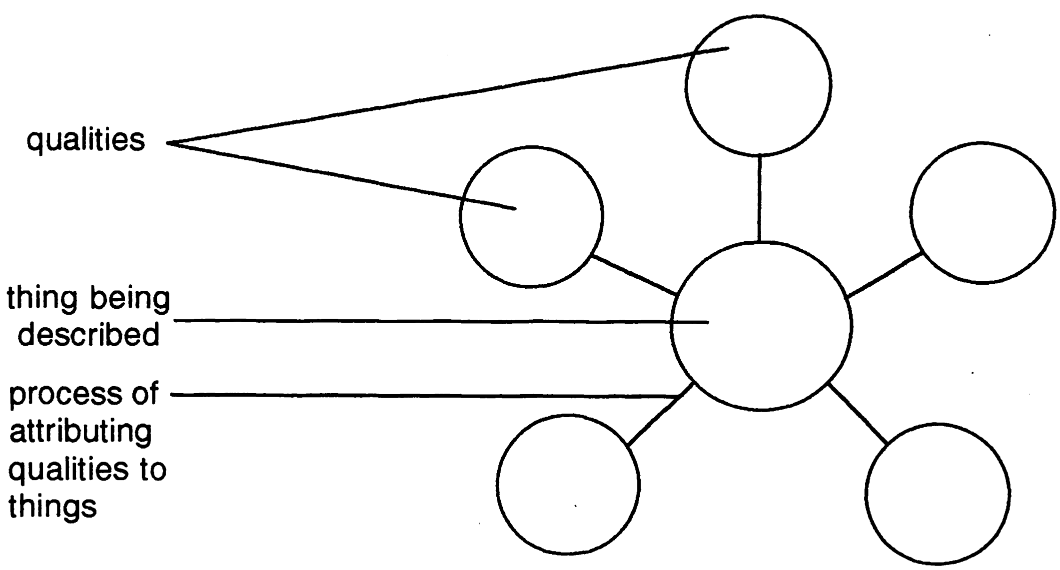


Figure 3.14. The Bubble Map

circle (taken from the circle map) the learner represents the concept being investigated. The lines extending from the center represent the process of qualifying things through projection and abstraction. The outside 'bubbles' are placeholders for qualities of the idea.

In Design for Thinking (Upton, 1941), Upton suggests three basic types of qualities: sensory, logical, and emotional/aesthetic. By becoming aware of different types of qualities, and the uncertain areas between these categories, students begin to make distinctions between observations that have social acceptance as true (facts) and those that depend more on personal judgment (opinion). An example of a student's map will help clarify these distinctions (Figure 3.15). This fifth grade student from North Carolina was assigned the task of writing a descriptive paragraph about a favorite animal. She was asked to use the bubble map as a prewriting tool to generate qualities about the animal. The adjective 'soft' may be identified as a sensory quality because we can 'sense' this attribute. If the student had identified the colors of a specific cat these would also be sensory qualities. When the student used the adjective 'fat' she was identifying a logical quality because there is an implicit mental scale for weight (thin, medium, fat). Logical qualities are often based on a quantifiable scale. The third type of quality, emotional/aesthetic, is represented in this example through the adjectives "friendly", "smart", and "loveable." These adjectives were identified by this "cat lover" who probably has an affection for cats and has identified these qualities as reflective of most cats. This student also uses the nouns father and mother to "describe" a cat. Strictly speaking, these are not qualities. These responses may involve a categorical or operational relationship. This student's responses in the bubble map that are not based on the thinking process of qualification are not wrong, but provide the teacher with an opportunity to have the student describe *how* she was thinking about the relationship of a cat to a mother or father and to develop this idea more clearly using other maps. For example, if the student says that there are mother cats, father cats, and baby cats, then a tree or (radial) map may be useful for categorizing types or groupings of cats. Additionally, if the student stated that she was thinking about how a mother cat gives birth to a baby cat, and how the kitten grows up to be a mother of her own kittens, then the flow map may be the most effective one for investigating these operational processes.

Awareness of the process of qualifying things is fundamental to the development of personal, interpersonal, and social knowing. What one chooses to identify, the words and numbers used to describe some thing, and the complex array of descriptors used, deeply influences how categories are created (Lakoff, 1987) and how knowledge is constructed. Marr shows how the process of qualification is central to the evaluation of information during problem-solving: identifying, prioritizing, and establishing critieria making decisions (Marr, et al, 1986). Again, the metacognitive frame may be added to a completed bubble map in order to investigate what has influenced the identification of certain qualities.

The Double-Bubble Map

An extension of the single bubble map for description is the double-bubble map (Figure 3.16) for the process of comparing similar and different qualities of two things. This map is based on the same theoretical foundation as the bubble map. Though there is no required sequence for use of the thinking maps, an effective way to develop this map is to begin with two or more separate bubble maps showing the qualities of things being compared. After completion of the bubble maps, double-bubble maps are constructed showing the comparison of two items. In the large center circles the two items are shown, the common qualities of the items are written in the inside bubbles, and the respective unique qualities of the two items are shown in the outside bubbles.

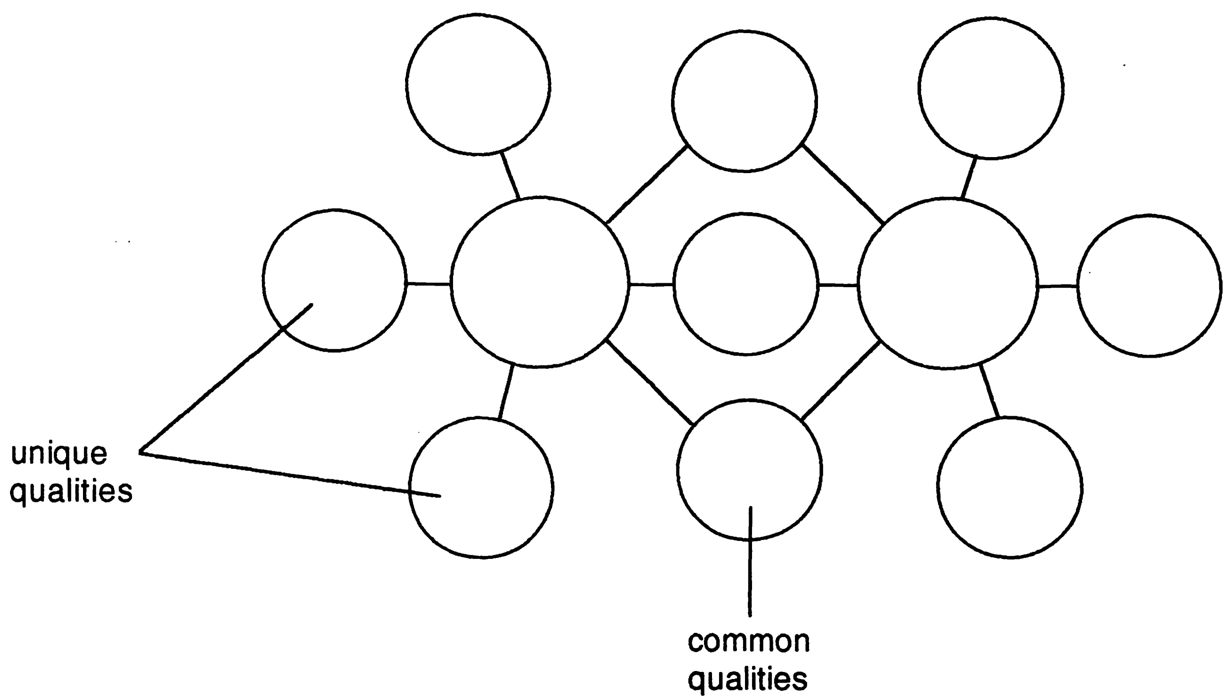


Figure 3.16. The Double-Bubble Map

The double-bubble map was created as a tool for students related to a fundamental thinking process of identifying similarities and differences (Hyerle, 1989). This process is found at various levels across taxonomies of thinking skills. A simple use of this process is for the identification of similar and different "objective" qualities of two characters in a story, two cultures, two number systems, two rock specimens, et al. An example from New York of one use for the double-bubble map is found in the interpretation of literature (Figure 3.17). As a culminating activity after a class had read two books, a middle school teacher assigned groups of students the task of comparing Holden Caulfield from Catcher in the Rye and Huck Finn from The Adventures of Huckleberry Finn. This first draft map shows an interesting range of ideas with complex themes.

Though sometimes identified as a lower-level skill in taxonomies of thinking skills, the process of comparing requires complex linkages of different kinds of attributes across different disciplines, especially when seen within the constructivist paradigm for knowing. Often the process of comparing is used for evaluating or valuing one thing over another, and is influenced by what the reader brings as background experiences to the text.

When comparing two things, in this case two fictional characters, students are actively answering these kinds of questions: What is my purpose for comparing these items? Which qualities have I decided are important as related to this purpose? What are my background frames of reference that are influencing the sensory, logical, and emotional/aesthetic qualities I am attributing to these two people? Did I begin this process by favoring one character over the other? After completion of this map, which of the qualities are most important for evaluating these characters?

Each of these questions may become more explicit when students draw the metacognitive frame around their own map and then share their frames of reference with their peers. The frame may also be used to identify the two authors' backgrounds and points of view, the historical time-frame in which the characters were developed, and the accepted conventions of the genre in which the authors were writing which may have influenced the development of each character. The frame thus provides an explicit, metacognitive filter for individuals working in cooperative groups for interpreting texts and for more easily bringing multiple students' personal, interpersonal, and social frames into a discussion about the development of character, and of the cast of characters in the context of their respective cultures.

The Tree Map

Albert Upton based his model on the representation of things in context (thing-making), identification of the attributes (qualification) and three primary relationships between and among things. The three fundamental types of relationships that he identified were drawn from the field of biology: Biologists create taxonomies or *classifications* of things, analyze the anatomy or physical *structures* of things, while also analyzing the physiology or *operations* of things. Upton called these three processes "analytical skills" and used visual formats as tools for students to learn how to apply these processes. As discussed extensively in Chapter 2, one of these analytical skills, the process of categorization, is central to human cognition and to concept development.

Upton focused on how words represent the abstract organization of ideas into general and specific classes. The tree map (Figure 3.18)-- a traditional format for establishing hierarchical relationships --was introduced by Upton as a diagram for conducting a "working classification" of ideas. He believed that categories are often constructed within the context of a problem, and thus stressed the need for students to make several drafts of a working diagram before formalizing an idea or solution. Though similar to a decision tree or a family tree, which are not based on the process of classification, this map is used exclusively for deductive (top-down) or inductive (bottom-up) classification. This hierarchical structure

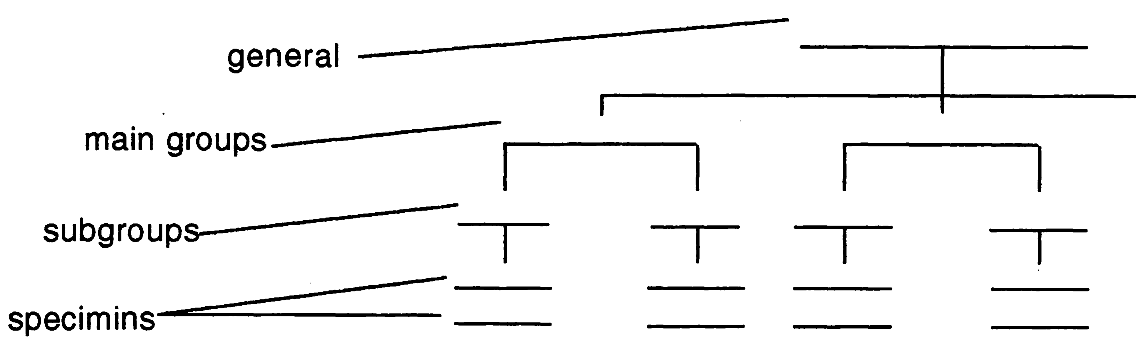


Figure 3.18. The Tree Map

has been used as a tool for constructing graphic general-specific relationships as shown above in Novak and Gowin's concept maps and by John Clarke who developed a graphic organizer-- called an inductive tower --for developing categories and theoretical statements from specific details (Clarke, 1991). Classification using a hierarchical framework is essential for learning, such as the example of a tree map of geometry concepts produced by a middle school student (Figure 3.19), though most categories are merely given to students without question. The classification of geometric forms into "dimensions" is partially represented in this example with only a few details about further subcategories under each heading. The tree map is also used for analyzing less clearly defined general to specific relationships such as the main idea or theme, supporting ideas, and details of a reading passage and for organizing writing into major themes, and supporting details.

The tree map is most useful when students are in control of developing the map, and when teachers and students use the map as a working tool for questioning the boundaries between categories. For example, there are at least three ways the map of the geometry concepts may be generated: (1) the student copies the map developed by the teacher or text for memorization; (2) the map is generated by the student from information presented in the text, but not organized graphically; or (3), the students create multiple tree maps inductively from experiential activities and/or in cooperative groups. The first two possibilities merely continue the rote re-construction of knowledge, because the students are not asked to question the categories, whereas the third possibility invites students to create their own tree map and to challenge and discover conceptual linkages. Ultimately, in all three situations the tree map may help students see, organize, and remember the relationships between groups of things, but only the third learning structure supports students in the construction of knowledge.

Just a few years ago this discussion of categorization and the tree map would have stopped here, for this was acceptable within the then-present paradigm for knowledge which defined and structured categorization as exclusively hierarchical in form. Few researchers or teachers conceived of the process of categorization as anything other than hierarchical.

Given George Lakoff's work and the other research across disciplines as presented in Chapter 2, the tree map must also be flexible enough to suggest radial represent-ations of category structure. The work by Rico and Buzan using brainstorming techniques for grouping ideas from the center outward suggest a radiating form. Black and Parks offer graphic organizers that begin with a central idea and spread to the periphery, though there are no clearly stated theoretical or practical foundations for these graphic forms. The radial tree map (Figure 3.20) is a variation in design for categor-ization based on Lakoff's additional definition of categorization. This is an attempt at providing a map for explicitly representing radial categories (Hyerle, 1990), but this map has not been piloted and systematically linked to Lakoff's views. This is an important area for future research. The radial map design suggests to students that the grouping of information does not always fit the top-down design. Teachers and students, once aware of these two kinds of maps, may begin to reflect on different ways of constructing and representing categories. They may begin to question the form of a given concept: Is this a tightly defined concept with clearly articulated categories that are bound by attributes, such as the lawfully established attributes for a senator? Or, is information

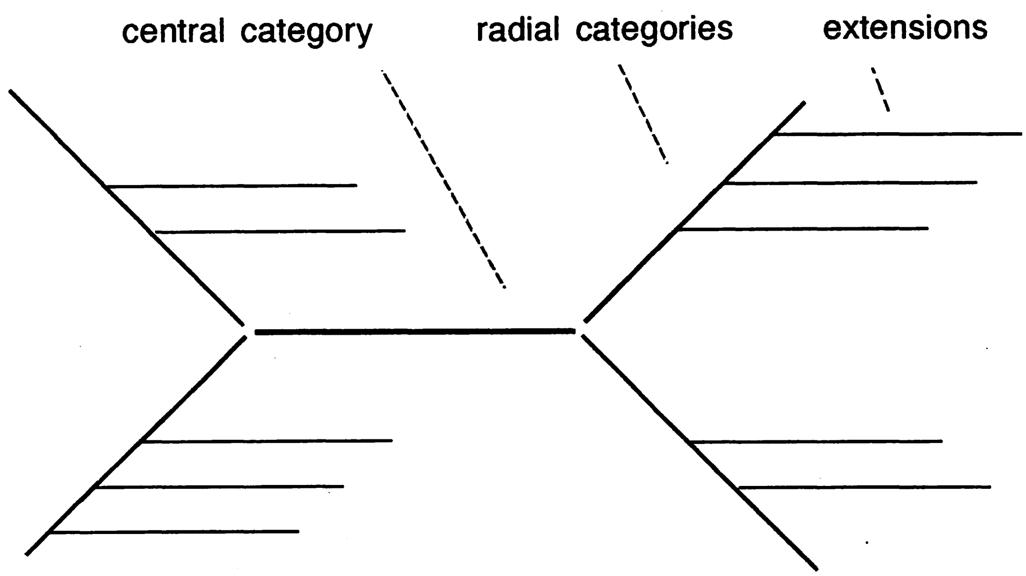


Figure 3.20. The Radial Tree Map

about a concept extended from an ideal category that is not defined by explicit attributes, but instead reflects social conventions that do not have a hierarchical representation, such as the definition of "mother" (Lakoff, 1987)?

By working with these two maps and facing these questions teachers and students may become aware of different types of categories and the implications for learning through these categories. Using the frame around the tree maps, classroom participants will also begin to focus on the influence of social frames on the development of categories.

The Brace Map

Upton identified the articulation of physical boundaries between things, or part-whole relationships, as another basic way of seeing and patterning relationships. He called this process "structure analysis" and focused on *the mental boundaries* that are constructed between objects in an otherwise dynamic world:

> What do we mean when we say that boundaries and relations are things? Are not the water's edge and the land's end one and the same? Is the shoreline a part of the land or of the sea, or is it a line in its own right? A person must draw that line somewhere . . . the world is really a dynamic operation; only by means of symbols can the mind deal with it "as if" it were a static structure. (Upton, 1941, pg. 35)

The process of structure analysis is used to understand any kind of spatial relations, from the stage setting of a play, to the dimensions of geometric figures, to the parts of the human body, to the geo-political landscape. Upton used the diagram (Figure 3.21), now called the brace map, to support students in identifying a whole

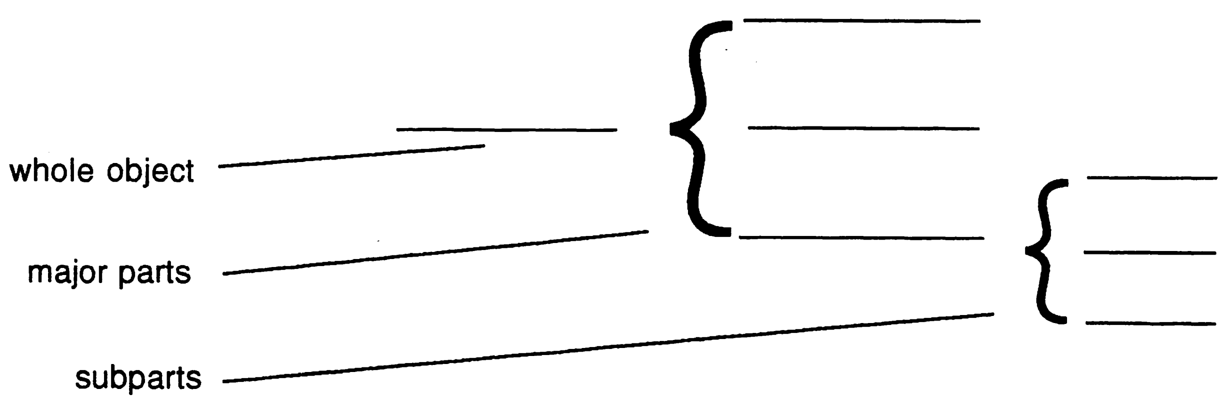


Figure 3.21. The Brace Map

object, its major parts, and subparts. Though a pictorial representation of an object with labels attached (like a picture of a skeleton with names of bones shown) provides a clear identification of parts, the brace map helps students make decisions about which of the parts are major and minor subparts of the whole. By going through this process, students must make decisions about which factors are most important for understanding an object. For example, an initial analysis of the skeletal system by a student from Mission, Texas (Figure 3.22), shows that he not only identified the parts of the skeletal system, but also began to make decisions about which are the major parts and subparts.

In much the same way that categories do not exist absolutely in the world, Upton also stated that mental representations are created by humans when they freeze an otherwise dynamic world in order to establish boundaries that are often guided both by the actual physical object and by human context.

As several educators have noticed, the tree map and the brace map look similar in form. This is because both thinking processes focus on inclusiveness: the tree map is used to identify a generalization with supporting ideas and specific details, whereas the brace map is used to show whole parts are made of major parts and subparts. The brace map is simply created horizontally (with the whole object identified on the left) rather than vertically as with the tree map (with the category name at the top). The mental boundaries that are drawn in both maps explicitly represent conceptual understandings: each line in the map represents the mental isolation, connections, and abstraction of relationships within an otherwise fluid world. But because these are different thinking processes, each of these maps has its own visual-verbal lexicon and syntax.

The process of identifying spatial relationships is typically applied in such fields as anatomy and geometry. The brace map supports students in both of these areas. George Lakoff's research on conceptual metaphor importantly reveals that our physical relationships in the world also act as a guide for language and reasoning. The conventional term for this language game is anthropomorphism, but Lakoff has provided a much more sophisticated understanding of this body-world connection. As discussed in Chapter 2, a key image-schema such as a building can provide a metaphorical basis for an abstract idea such as an argument. One of the applications in the next chapter is based on this metaphor.

The Flow Map

Upton believed that the world is a dynamic operation and that the processes of categorization and structure analysis were abstractions of a *flow* of information. The third of Upton's relational processses is based on the sequence of and/or change in operations. Upton drew all of these "changes" under the umbrella term called operation analysis which includes seriation, sequencing, and cause and effect. In the Upton-Samson model, operations consisted of major phases which could be broken down into events, stages and substages as represented using what was called a flow diagram, now called a flow map (Figure 3.23).

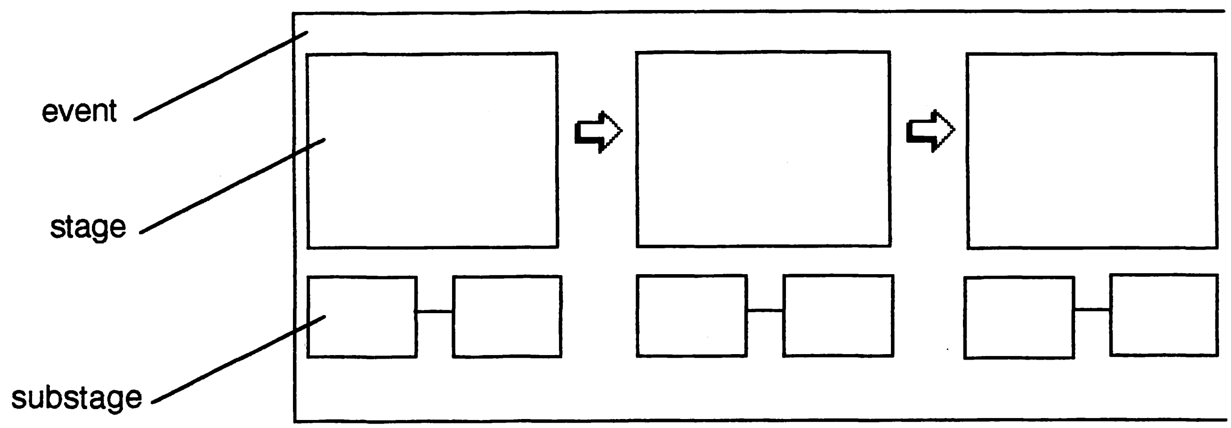


Figure 3.23. The Flow Map

Again, as with classification and structure analysis, Upton introduced operation analysis using the flow chart so that students would make explicit the logical distinctions between an event and possible stages, and between a stage and possible substages. The identification of the factor of change in a basic number line is relatively easy: the stage is distinguished by a factor of a unit of one being added to form the next stage. When a student is in the process of reading a story or interpreting historical documents, decisions are constantly being made about whether an occurrence is significant and broad (thus an event) or secondary (a stage) or incidental (a substage). The events may also be seen within a larger phase in a novel or historical period.

The example of student work from North Carolina (Figure 3.24) shows the process of writing a newspaper. This is a first draft, and each step of the process has been identified by the student so he can see the whole process. But the student has made no distinction between the events: each step is weighted equally in both time needed and importance in the process. Further work with this map might consolidate and synthesize information into several major stages with a series of substages within each stage.

Through this reworking of the map, the student may see that the process of writing a newspaper, as with many processes, may involve a cyclical pattern, such as in the revision stage (and graphically depict a cycle of recurring events). Thus the flow map is used in different configurations to show more complex cyclical processes, such as the four seasons, the condensation-evaporation cycle, life cycles, and computer 'if-then' flow charts. As with any of the thinking maps, the flow map may be used in very simple form by kindergarteners who are reading a fairy tale and move toward complex interrelationships of a sytem designed by a computer programmer.

Multi-Flow Map

Students may use the flow map to follow directions, identify number order in mathematics, sequences in history or a story, life cycles in science, but often embedded in these sequences are causes of events and effects. Multiple, interrelated events may be occurring simultaneously and there are different types of causal factors that interact and influence each other, depending on the discipline. The multi-flow map (Figure 3.25) was developed as an extension of the flow map for investigating and showing cause-effect relationships (Hyerle, 1989). Students identify a major event and then work backward to identify causes and forward to identify effects. As the

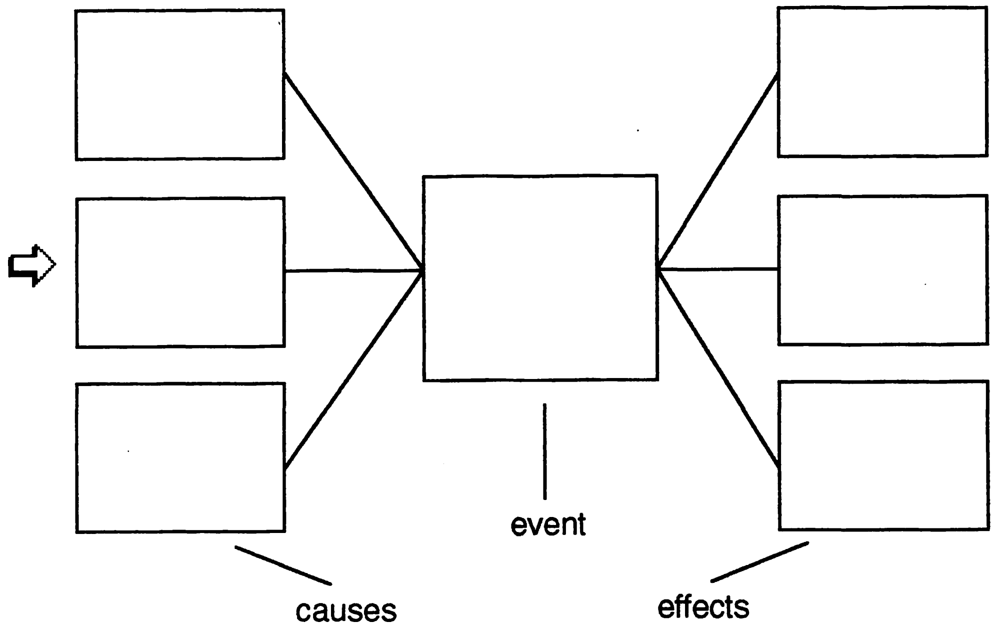


Figure 3.25. The Multi-flow Map

map expands backwards, students are guided to seek long term, multiple, linked causes, as well as immediate causes of the event. Additional major events are also shown as large boxes when necessary. As the map expands forward, students investigate short and long term effects and use the array developed in the map to predict long terms effects.

The multi-flow map by a fifth grade student (Figure 3-26) was a starting point for identifying the causes for recent growth in the border town of Mission, Texas. This is a first draft of the map and shows a basic pattern of the causes and effects of growth. With further analysis and a reworking of this map, the student may begin to seek out both causes and effects from a historical perspective. These questions might arise: As causes of growth, did tourism lead to companies moving to Mission which then led to greater immigration of Mexicans to work in these factories? More technology and building contributed to greater population growth and to more cultural activities, but did these conditions also create more homelessness and gang activity? This questioning may support students in developing a non-linear systems dynamics map that will show feedback loops and a more sophisticated view of the interrelationship between events. For example, one feedback loop is evident: population growth creates more construction, fostering the need for more workers, and then forcing up population growth. The development of students' abilities to understand the interrelationships in a system and begin to think about the long-term significance of decisions within a system-- whether it be a human body, a social structure, or an ecosystem --is made explicit in this map. The flow and multi-flow maps are first steps toward seeing complex dynamics inherent in systems.

The Bridge Map

The Upton model is based on the connections between how some thing is represented in context, the description and comparison of the qualities of things, and the three basic patterns of relationships (classification, structure analysis, and operation analysis). Underlying each of these ways of perceiving and patterning information is the importance of the evolution of word meanings. Upton called this evolution the "progressive ambiguity" of words. Words change, develop multiple meanings, and also evolve into (or are used for) completely new meanings. Upton suggested that this process occurs primarily through analogical and metaphorical thinking. He called the process of seeing similarities between relationships, and different worlds of thought, *seeing analogies*.

The bridge map (Figure 3.27) was developed as a tool for applying the process of analyzing and seeing analogies in learning settings (Hyerle, 1989). It is through our ability to construct analogies that we are able to transfer information from one "body" of "knowledge" to another, and in our language to communicate complex ideas by using concrete examples.

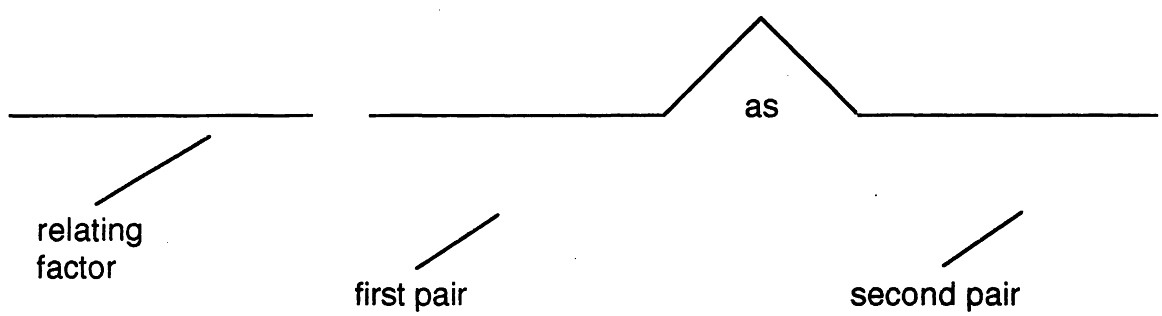


Figure 3.27. The Bridge Map

The example (Figure 3-28) shows how a middle school student from Mission, Texas used the bridge map to link information within one discipline. Students are taught how to identify the common relationship which is "bridged over" within the map. The "relating factor" is the similar relationship that links two items and that then provides the transfer from one side of the analogy to the other side. Using the relating factor "is a main source of energy in", the student began generating pairs of relationships. Though not all of the pairs of relationships correctly fit the definitions for sources of energy, the student and his teacher would be able to use this display of conceptual linkages to assess the students' understandings.

Unfortunately, other than in the study of figurative language in literature classes, the use of analogies in schools has been relegated to testing for evaluating students' vocabulary development rather than for systematic use in problem-solving processes and developing conceptual understandings. This situation is unfortunate because teachers often use analogies on a daily basis to explain ideas to students. Textbooks in the sciences and social studies use analogies extensively for linking new ideas to students' prior knowledge.

George Lakoff's research in conceptual metaphor unveils powerful opportunities for developing students' conceptual understandings by investigating the metaphorical underpinnings of ideas. Whereas an analogy in the form of a bridge map is often presented using a single relating factor, metaphorical relationships are multi-layered and complex. An extension of the bridge map, called the "world map" (Hyerle, 1990), has been developed as a basic tool for investigating conceptual metaphors and is presented in the following chapter.

In this chapter, an overview of three types of graphic organizers was presented along with introductions to each of the eight thinking maps (and the metacognitive frame). The different graphic organizers presented in the first section have proven to be effective in isolated areas, such as writing, reading comprehension, mathematics problem-solving, and for concept development. Many of these organizers are visually similar and reflect similar thinking processes as represented in several of the thinking maps.

While several of the developers of graphic organizers show an array of different uses of one or several graphics, none of these authors explicitly presents a coherent, *comprehensive* model of visual tools. Importantly, graphic organizers are often presented as secondary, isolated strategies for expanding a teachers' repetoire or for facilitating students' learning of specific tasks or thinking processes, rather than as central organizing and communication tools for whole classroom, school, or school district learning communities. (The exceptions to this may include Novak and Gowin's concept mapping and Richmond's systems thinking, which are highly sophisticated and singular graphic displays for daily use.)

In the following chapter applications of thinking maps-- as an interrelated *language* of thinking process graphic organizers --are presented. These applications reveal certain advantages to having a formal language of visual tools in a learning community: all students learn a foundational thinking process language, organization and communication of complex ideas is improved, interdisciplinary approaches are enhanced, and holistic assessment of students' thinking is possible.

In the fifth and final chapter, after integrated applications of the thinking maps have been shown, further discussion and comparison of different graphic organizers are detailed along with a synthesis of the benefits of having a *language* of theory-embedded graphic tools for multiple modes of understanding.

CHAPTER 4: THINKING MAPS APPLICATIONS

Introduction

The applications presented in this chapter are excerpts from documents showing how thinking maps are used together to support teaching and learning in classrooms. The five applications are: 1) an introductory series of activities for high school students investigating culture and multiculturalism; 2) a middle school social studies unit on writing a research paper; 3) a correlation of maps to an inter-disciplinary theme for elementary students; 4) a metacognitive activity based on conceptual metaphor; and, 5) a holistic assessment rubric using thinking maps. Each of these selections presents a different way for integrating thinking maps into classrooms and as tools for personal, interpersonal, and social understandings. The holistic assessment rubric establishes baseline criteria for using thinking maps as alternative structures for formal assessment and for valuing these modes of understanding.

The five applications are most effective after teachers *and* students have had formal instruction in how to use thinking maps. If the teacher is the only classroom participant who knows how to use thinking maps, then the maps may be understood by students as teachers' strategies and not as their own tools for learning. A brief description of a process through which teachers and students become fluent with thinking maps is presented below as a prerequisite to independent and interdependent use of these tools by students.

Learning How to Use Thinking Maps

At present, the focus of implementing thinking maps in the United States is on working with whole school faculties and students at either the elementary or secondary levels. The form described below is one of several ways of introducing thinking maps into schools. The recommondations are based on extensive experience in staff development over the past three years.

The intended outcomes of the implementation design is for teachers to be able to use thinking maps as an interactive instructional approach and to teach their students how to use thinking maps during the first year of implementation. The independent use of thinking maps may be reinforced over multiple years as students move between teachers and content areas, and from grade level to grade level. The implementation design consists of three related strands: staff development, grade level appropriate resource materials for teachers and students, and follow-up classroom visitations by trained consultants.

Staff development consists of a minimum commitment by the whole staff to a full day workshop. During this workshop, teachers are introduced to the thinking maps model, learn how to introduce the maps to students using resource materials, and begin redesigning their lesson plans and assessment techniques.

There are three types of materials: a comprehensive training manual (Hyerle, 1990) for use during the workshop and as a continuing resource, lesson plan guides and student materials for introducing the maps at each grade level (Hyerle, 1992), and a set of eight posters for classroom display. The training manual shows how the thinking maps may be introduced, transferred across disciplines, used in conjunction with teaching *for* thinking strategies, and for curriculum development and assessment. The resource materials are presented as an extension of the workshop day: by working through the introductory activities with students, teachers deepen their understandings of the specific and flexible uses for each map.

The minimum three days of follow-up visitations at each school consist of conferencing with individual teachers, model teaching and co-teaching in classrooms with students, and grade level and whole faculty meetings. Applications using thinking maps by students and teachers are reviewed and feedback is provided. The purpose of these three separate return visits is to support consistent and flexible use of the thinking maps across grade levels and disciplines so that the thinking maps become a common language for learning and assessment within a school. Student portfolios of thinking maps and related work are established within the first year for assessment purposes. By the end of the first year of implementation, schools are encouraged to support several teachers in receiving additional training so that they can become facilitators for improving the use of thinking maps at the school.

The long-term outcome of this implementation design is to enable all students, teachers, and administrators to develop fluency with these tools for faciliating thinking within the whole school. This introductory phase also provides the foundation for teachers and students to use thinking maps in complex learning contexts and for assessment, as shown in the five applications presented below.

Applications of Integrated Uses of Thinking Maps

1. What is Culture?

The term 'culture', taken here as an anthropological construct, is a broad, multifaceted, often illusory concept. It is a concept that many students spend their academic years investigating. Recent efforts have been made in many schools to approach learning through a multicultural perspective across disciplines. In some classrooms study may remain confined to a surface level awareness of culture rather than a deeper questioning of personal, interpersonal and social understanding of culture, different forms of culture, and cultural conflicts. Recent events such as the South Central riots of Los Angeles and the Crown Heights confrontations in New York City, along with discussion of issues of economic equity and political power, heighten the need to have students investigate this topic.

Though these cultural conflicts may be discussed in classrooms as "current events", what may be lost is a deeper dialogue about a simply stated, complex question: What is culture? From this question arises a large problem: How do teachers support students in seeking out, constructing, and sharing complex, value-laden personal, interpersonal, and social understandings of culture?

The series of activity ideas presented below is excerpted from a more extensive unit of study using thinking maps to investigate these questions. These activities are starting points for students to develop their ideas. There is no answer key for the teacher, and only the open maps are provided below. The maps provide a guide and support for discovery. As suggested in the instructions, the maps merely present an example of the form that each map could take rather than being maps that students "fill in." The intended outcome of this set of activities is for students to work together in order to face the complexity of defining culture from personal, interpersonal, and social points of view. Some of these activities have been used as early as the upper elementary grade levels, but this discovery unit is best suited for high school students and should be embedded in a much more extensive analysis of culture.

Activity 1: Personal Understanding using the Circle and Frame Maps

The first activity is a personal study of how one's daily life is influenced by outside forces. This map initiates the unit and is embellished by each student as the investigation deepens. The activity begins with each student creating their own circle map (Figure 4.1). In the center of the map, students write down all of the different names they are called: birth name, nicknames, what parents and grandparents call them, what teachers call them, etc. This highlights for students the different ways they are represented, by name, in relationship to different people in their lives. Within the outside circle each student generates as many things about their lives as possible, including relationships, places they regularly visit, what they enjoy doing with their time, where they work, learn, vacation, worship, etc. This area of the map represents the context of their lives.

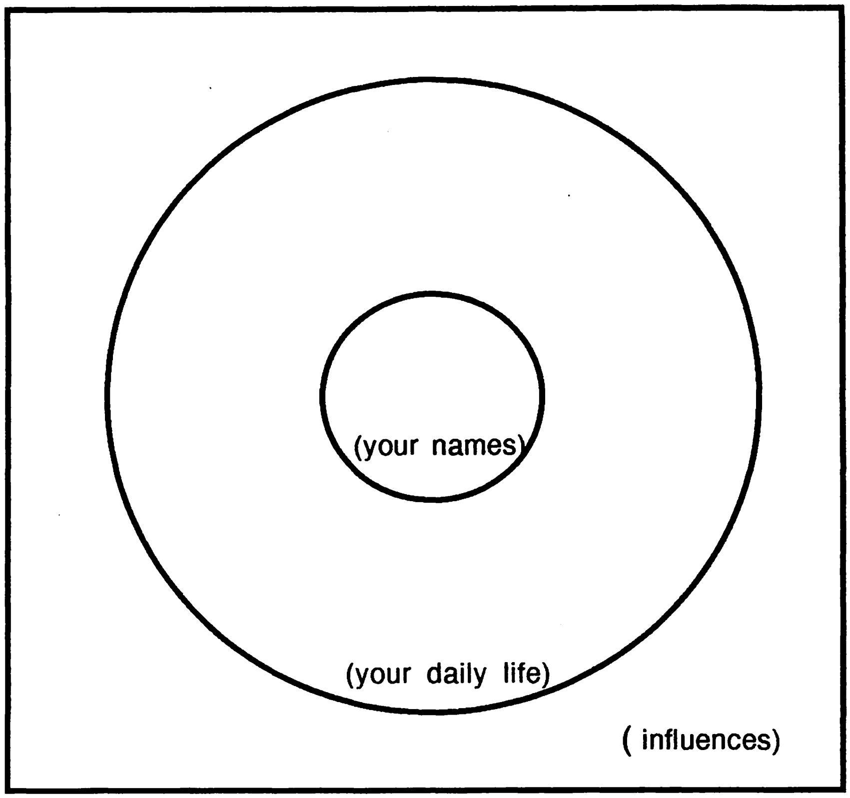


Figure 4.1. Personal Circle and Frame Map

After the circle map has been developed, students are asked by the teacher to draw the frame map around the circle map, as shown. Though the circle map is helpful for generating ideas about the context for one's life, the frame map is used to consider the influences on this context, past and present. Students use the frame as a guide to the identification of the people and experiences that have influenced the various aspects of their daily lives. For example, a student may write down that he goes to a place of worship every week because his parents have decided that this is important, or that he goes to baseball games because his grandfather always enjoyed the game. The influences may be internally motivated: another student watches television because she likes this activity. The frame acts as a reflective prompt: Does television watching occur *only* because she likes watching? Are there other pre-existing social frames that are influencing the student, such as that she lives in the late twentieth century in an industrialized country, her family can afford a television, her parents permit and even encourage this activity, and that television watching has always been a central activity for her family. The student also could have been a "latch-key" child who was told to come home after school and watch television rather than do anything worse.

After students independently complete a first draft of their map, they are asked to share their ideas with a partner and identify some similar and different context information and frames of reference. This information is used in the next activity. Two options at this point of the investigation are available: students could analyze the causes and effects of these influences on their lives by constructing a multi-flow map and/or use the double-bubble map to compare and contrast their maps.

Activity 2: Interpersonal Construction of Types of Cultures

After students have discussed the circle and frame maps in pairs, there is enough shared personal information, grounded in context and frames of reference, to begin to develop a basic idea of different kinds, or types of culture. Pairs of students from the previous activity are organized into groups of four for creating a radial tree map for constructing categories of culture. (In this cooperative group, the roles might include: one student as the map maker, one as the process watcher, one as the time keeper, and one as the eventual presenter of the map to the class.) The groups are asked to create a radial map (Figure 4.2) using the information

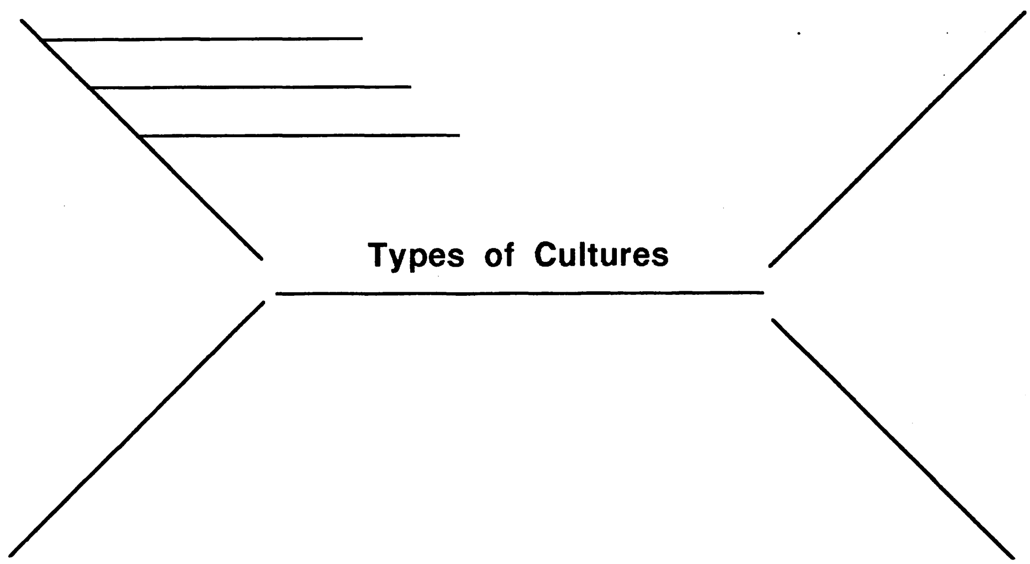


Figure 4.2. Interpersonal Radial Map

provided in the maps created in the previous activity. The teacher may provide the key concept in the center of the map, such as "types of cultures" or "groups of people," or have students identify how they are naming this organizational structure of individuals. On the lines extending from the center, students may identify a wide array of categories, depending on their interests and understanding. The categories constructed may be based on more traditional ways of defining culture such as membership by religion, race, socio-economic status and/or citizenship. Other radial maps may focus on less traditional dimensions such as age, gender, and sexual orientation. Still other maps may be developed based on students' experiences in school, such as in peer groups, sports teams, and computer clubs. The lines linked to the extension lines are used for identifying members of each category that is constructed. There will be confusion and complexity in the array of different groupings of people in cultural categories in each radial map. This lack of clarity about what comprises culture, or a culture, is a key point for dialogue within this investigation.

Central to this activity is that the development of these maps represents the personal knowledge of each member of the group of four students in a classroom combined into an interpersonal construction of cultural groups. After an initial radial map is created by each group, students are encouraged to add information to their maps about other cultures that they might identify and that do not exist in their map. Each group of four then presents its radial map to classmates by transposing their maps onto an overhead transparency and/or having their maps duplicated for each student.

As each map is presented, the teacher facilitates a discussion among students about the similarities and differences among the maps. As an option, each group may be asked to identify the common frames of reference within the class-- by drawing the frame map around the radial maps --to show what personal background frames are influencing their generation of kinds of, or categories of culture as represented in the maps. Questions about how the categories were created are useful at this point of the discussion to investigate how this knowledge was constructed. There could also be a discussion about the nonhierarchical relationships as presented in this map as compared to a representation in a top-down tree map. From these initial experiences and information, students are asked to write an essay defining culture within their contexts, while describing what may be influencing their definition.

Up until this point in this investigation the emphasis is on students' background knowledge and their shared construction of types of culture. There is no definition of culture given to students, though students may be asked to investigate the term "culture" in reference books in order to discover how their ideas match textbook definitions. After the essays are completed and shared, a radial map synthesizing these multiple representations may be created by the students.

Activity 3: Metaphors for Social Understandings

After a preliminary understanding of the complexity of defining culture is established, a discussion may be directed by the teacher to the question: How do different cultures interact within a wider culture and how could one represent this relationship? For example, how does a minority culture interrelate with a so-called mainstream American culture?

A common understanding of this interrelationship is often represented by the 'melting pot' metaphor based on an idealized view of the assimilation of different cultural groups into the mainstream culture. A melting pot is a container in which different ingredients are thoroughly mixed and thus become a singular, undifferentiated, uniform substance. The concept of assimilation has become for many people the idealized model for understanding that subcultures *should* become fully assimiliated within a 'mainstream' culture. This metaphor, and alternative metaphors, may be investigated by students using the bridge map (Figure 4-3).

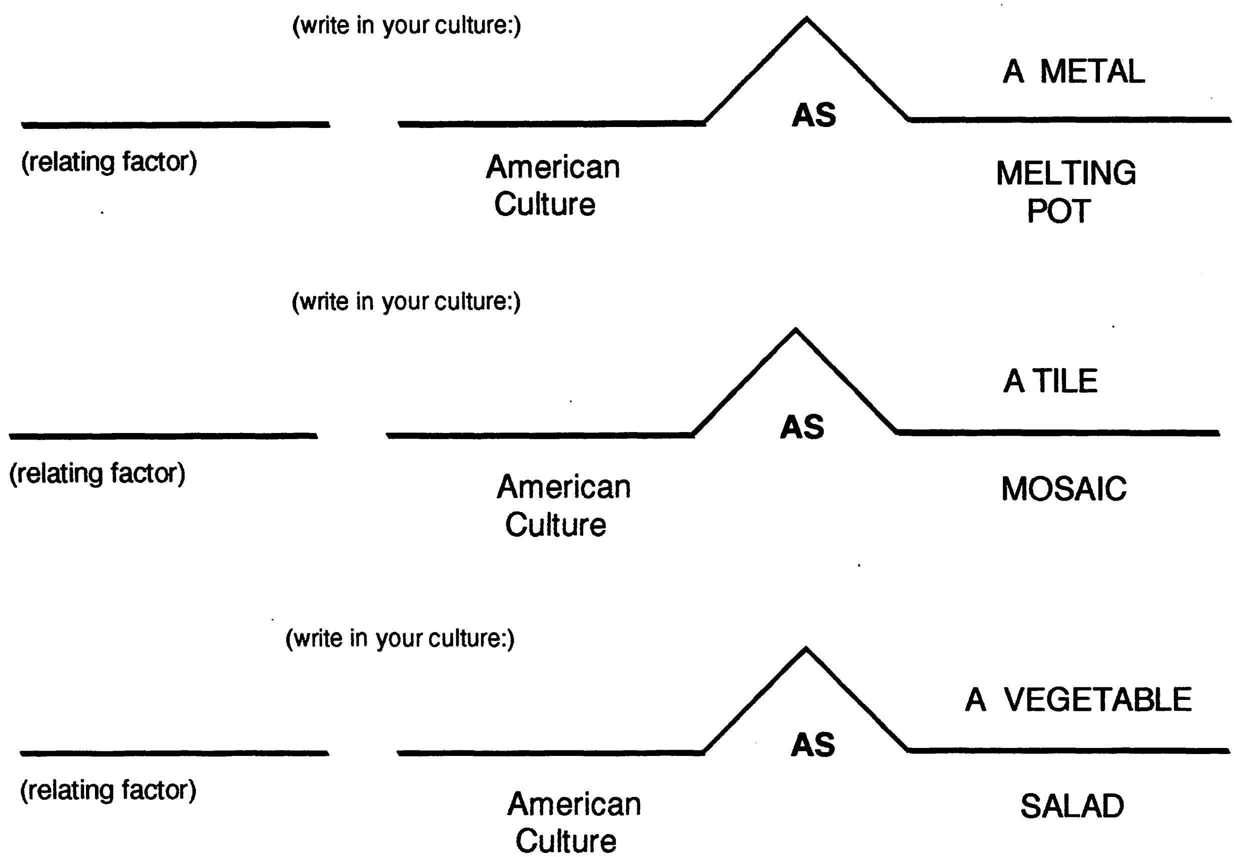


Figure 4.3. Bridge Maps showing Social Understandings of Culture

The teacher first introduces the basic melting pot analogy using the first bridge map by identifying the relating factor (in this case, 'blend in" is the relating factor) with students: minority cultures *blend in* mainstream American culture just as metals blend in a melting pot. Students may also be asked to investigate why this metaphor has become the guiding form for understanding how cultures are assimilated into mainstream culture. This investigation might include using a multi-flow map for gathering and analyzing the historical causes and effects of immigration during the late 19th and early 20th century in America.

The political and social significance of the melting pot metaphor has been revealed by conscious efforts to create and use alternative metaphors for redefining the pattern of relationships between cultures within this country. Two alternative metaphors are the "tile-mosaic" and "vegetable-salad" models. The "we are all tiles in a beautiful mosaic" metaphor was used extensively by the present New York City Mayor, David Dinkins, during the mayoral campaign to express the ideas of diversity, equity, and unity. This was as an explicit alternative to the emphasis on uniformity of cultures central to the melting pot metaphor.

The next step of this activity is for teachers to guide students in their analysis of the metaphorical entailments of the tile-mosaic and ingredient-salad concepts. Students need to identify the relating factor for each analogy and to discuss the implications for citizens in a society as they understand relationships between cultures through these various mental constructions. Essential questions arise from this discussion: How do these metaphors overlap in meaning? What do the different physical relationships (metals, pots, tiles, mosaics, salad ingredients, salads) embedded in these metaphors influence one's understanding of culture? How are actions influenced by each of these metaphors? How might the transition from the exclusive use of the melting pot analogy to multiple metaphors influence our social understanding? In addition to the response to these questions, students are encouraged to develop additional metaphors to the melting pot, mosaic, and salad forms.

Activity 4: Seeing Self in Culture

After these activities are completed, students are asked to return to their personal circle-frame map and radial maps and remake them, investigating how different metaphors may have influenced their construction of categories and other ideas.

Students are then asked as individuals to create a bubble map with the frame (Figure 4.4) for investigating cultural influences on character traits. Some examples of traits that a student might identify in the bubbles include intelligent, caring, musical, quiet, religious, even-tempered, funloving, etc. After students have completed the bubble map they are asked to draw the frame around the map and identify the values, attitudes, and/or behaviors in their culture(s) which have influenced each trait. For example, a student may identify "being intelligent" as a highly valued goal reinforced by her parents (and possibly within the culture her family inhabits). Another student might also be taking music lessons because of the direct influence by a teacher at the elementary school he attended. This ending activity leads to a new set of complex and controversial questions, possibly raised by the teacher: What are the relative influences of heredity and environment on development of certain traits? To what degree are cultural groups honored or dishonored

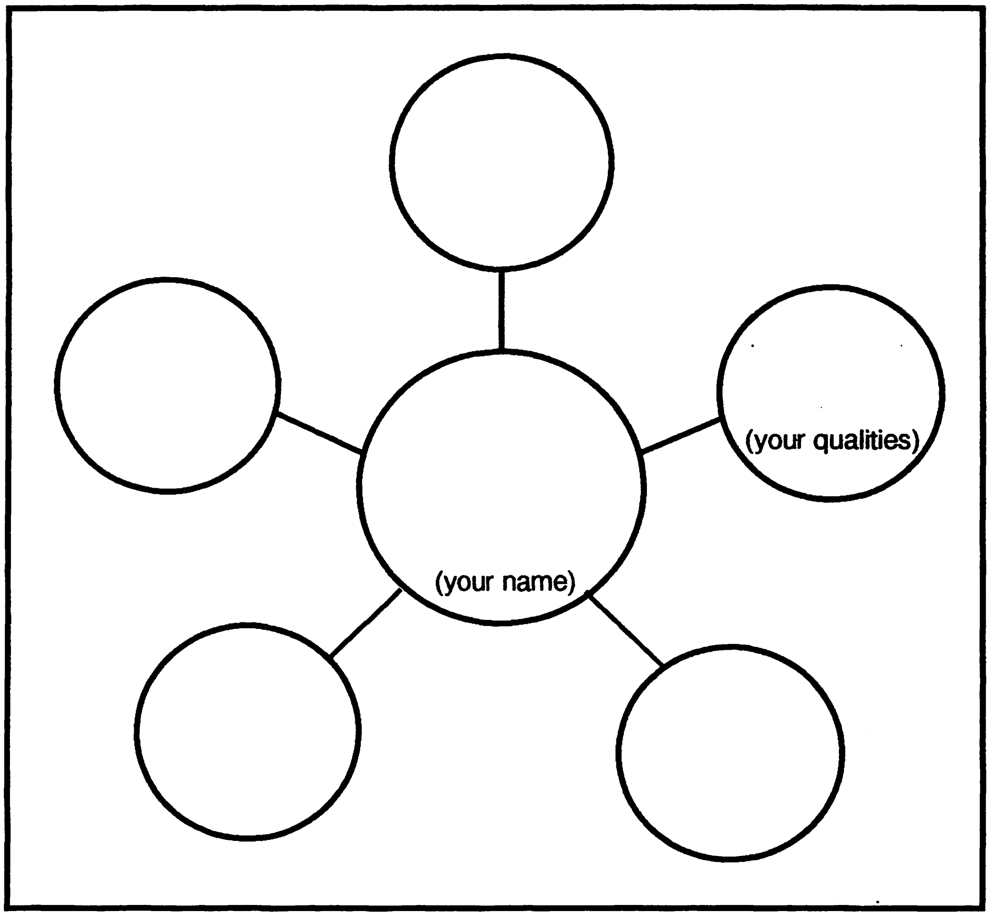


Figure 4.4. Bubble Map showing Cultural Influences on Self

according to certain characteristics that become stereotypical of that culture? And, to what degree do these stereotypes become prejudices in a country and directly influence personal, interpersonal, and social understandings and actions?

As a closure to this series of activities students are asked to return to their work and consider what new information they wish to add or delete and write an essay using their maps as the foundation. The development of the circle/frame maps, radial maps, the multiple bridge maps, and the bubble/frame maps provides structures for linking information together, defining ideas in context and within frames of reference, and investigating the influences of idealized and stereotypical views of cultures.

2. The Cotton Gin: Linking Reading, Writing and Thinking Processes

During the course of a school year a middle school staff in the San Fransisco area received training in the application of thinking maps to curriculum development. A social studies teacher from this faculty developed a unit of study based on two outcomes:
1) students' understanding of the historical implications of the Cotton Gin invention; and, 2) developing students' abilities to write a research paper. The students were required to read about the Cotton Gin invention, gather background information from various sources about the effects of the invention, and then write a research paper using the information they had found.

Teaching students how to write a research paper at this age is difficult because students often have difficulty knowing what information is important as they read, how to organize the information, how to generate a meaningful thesis that is more than a reproduction of what is found in resource books, and then how to write an interesting paper using their own (premature) style and voice as writers. The work presented below consists of excerpts from a few lessons initiated by the teacher to show students how to use thinking maps for these requirements of research.

Activity 1: Discovering and Organizing Ideas about the Cotton Gin

The tree map is used as a tool for collecting and organizing information while simultaneously identifying key ideas and concepts. in a hierarchical pattern of information (Figure 4.5). The teacher first introduced the tree map to students and then worked with them

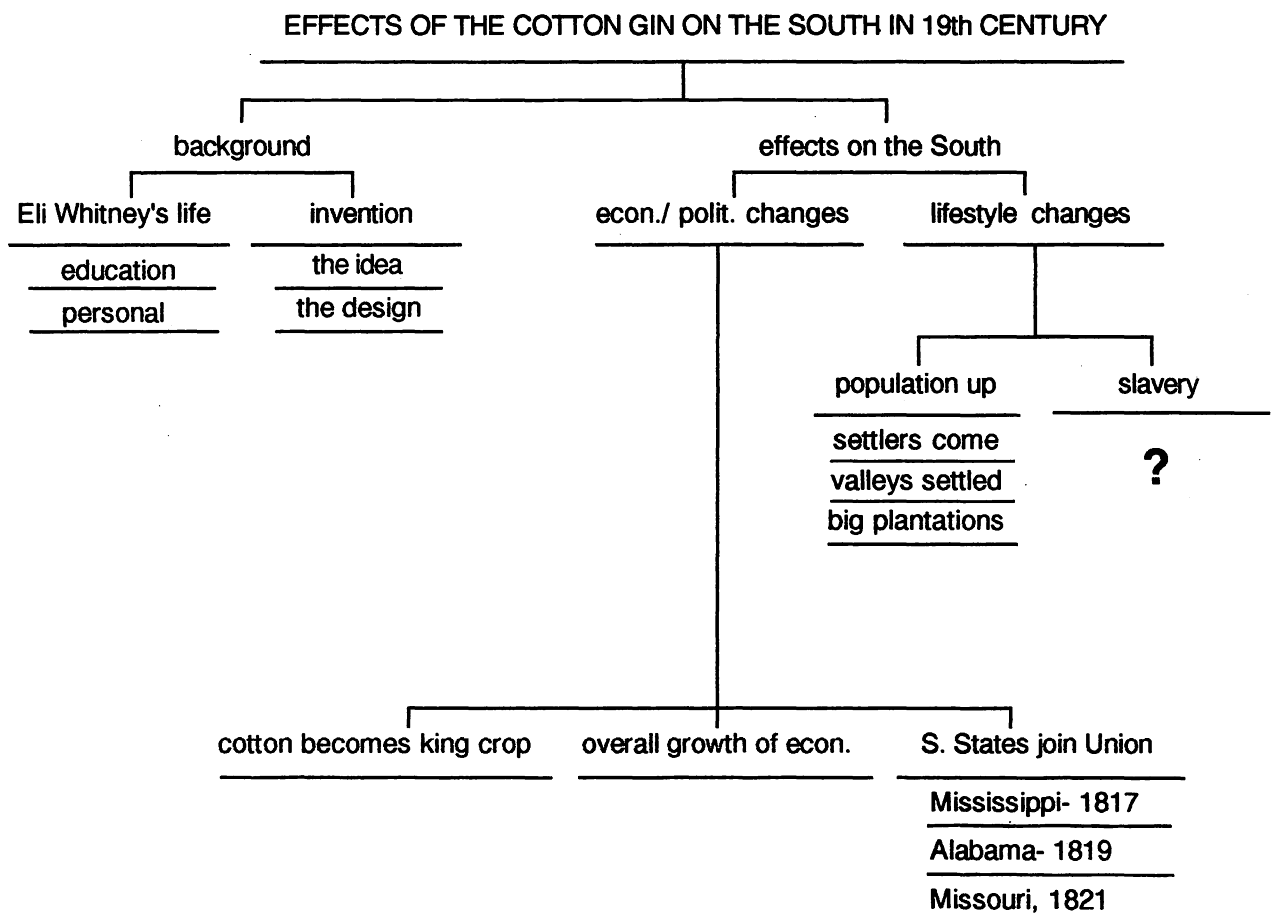


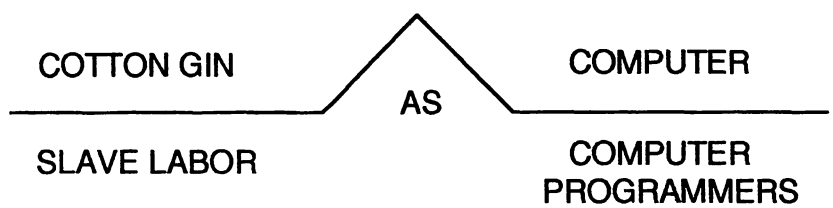
Figure 4.5. Tree Map of Main and Supporting Ideas, and Details

to sort through information about the Cotton Gin and create a map. This map shows a guiding idea for a research paper, the supporting ideas and details. The example presented shows that the general topic was identified as the effects of the Cotton Gin, with two major areas of investigation: background information about the inventor and invention and the different areas of effects on the south. Two other thinking maps were also used in this stage of the investigation to further support the structure of the tree map: The flow map for identifying a timeline of events, followed by the multi-flow map for analyzing the historical causes and effects of this invention.

By using the tree map with a given topic, students are organizing information in a deductive process as they read and link information in the pattern of general to specific ideas. The tree map also may be used for inductive development of ideas, beginning with details and building upwards to a general concept. The process of organizing information in this map (and other thinking maps) often leads to the discovery of significant issues and/or blind spots in an investigation. In this case, the teacher and students found that they had nearly completed the map, but that one of the issues that had not been fully addressed was a central problem: slavery. The teacher highlighted this overlooked area with a question mark in the tree map.

Activity 2: History as Analogy

A key analytical tool for historians is the use of analogies. In this series of activities, the bridge map was used by the teacher and students to investigate the economic relationship of the cotton gin to slavery (Figure 4.6). The teacher and students first attempted to show the basic rise in the need for labor with the increased productivity of the invention, and then linked this idea to the modern invention of the computer, and expansion of the computer industry. As shown, the four parts of the analogy were identified, the relating factor was developed, and the whole analogy was written as a complete sentence.



Relating Factor: . . . produced a rapid expansion in the use of . . .

Analogy as a Sentence: The cotton gin produced a rapid expansion in the use of slave labor just as the computer produced a rapid expansion in the use of computer programmers.

Figure 4.6. Guiding Metaphor for a Research Topic

With closer analysis, of course, the interpretation of this analogy in terms of increased labor requirements needs to be understood within the frame of reference of slave labor versus free market labor. A frame map could be put around each side of this analogy to support students in questioning the historical frames within is study: this analogy may be interesting in the simple sense of an increased need for labor, but the economic, political, and moral differences between slave laborers and free market laborers are fundamental dimensions that need addressing in the investigation of the cotton gin. The differing historical frames of the labor market--the social and moral circumstances between present and past structures --were then presented to students as a possible theme of this paper. The use of the analogy (and the bridge map for investigating and clarifying analogies) is an example of how to work with complex and often limited analogies for generating a meaningful theme for writing a research paper.

Activity 3: Translating Ideas into a Final Written Document

The flow map is an essential tool for students after they have organized the topic, themes, and details of a research project. The students must repattern the conceptual organization of information in the tree and bridge maps to a coherent sequence for writing. The flow map (Figure 4.7) provided these students with a tool for going from the hierarchical form of the tree map showing ideas subsumed under headings to the linear representation of ideas necessary for writing. Notice that the analogy is used as the vehicle for introducing the topic, guiding the ideas, and concluding the paper.

The traditional outline form consisting of roman numerals (headings), letters, and numbers has been useful for students as a structure for organizing information for a research document. The cognitive organization found in the outline form is the integration of the hierarchical classification and sequencing of ideas. The simultaneous integration of these processes may confuse student when they are first learning how to structure a research paper. The side-

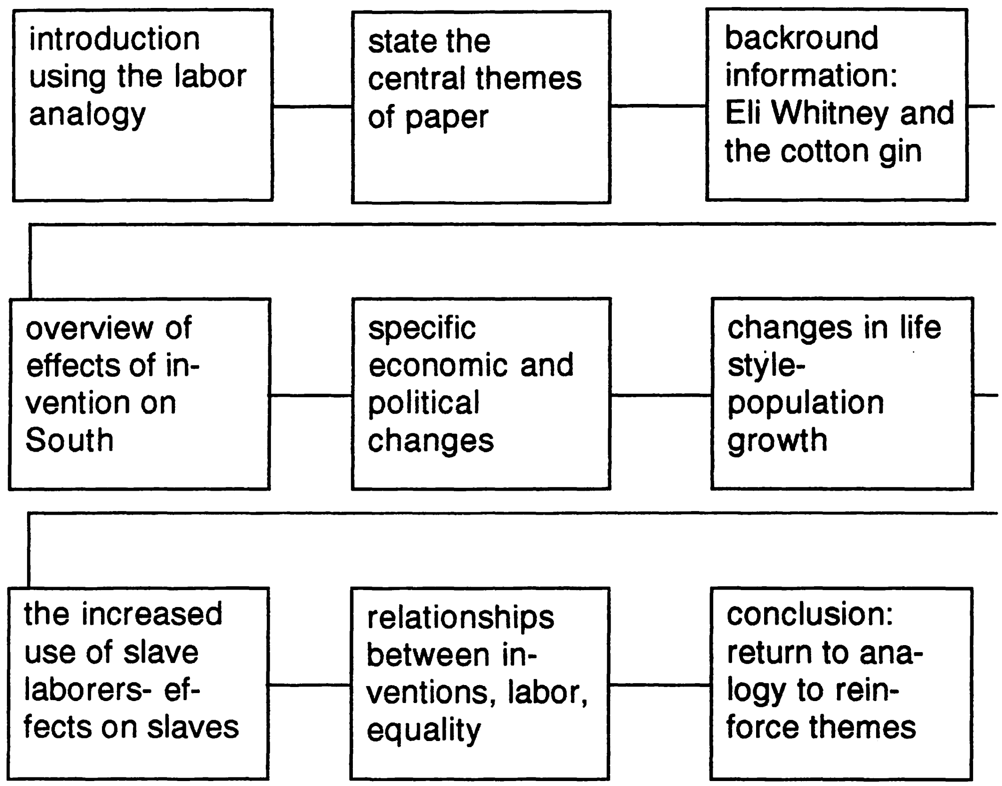


Figure 4.7. Flow Map for Sequencing Ideas for Writing

by-side use of the tree map for generating and grouping ideas with the flow map for sequencing the ideas enables students to work through the two processes separately while making connections for a final product.

3. Conceptual Metaphor and Metacognition

As discussed in Chapter 2, George Lakoff provides a view of the structure of concepts and actions as partially grounded in metaphors. Central to Lakoff's theory is that human beings understand a concept through more concrete, physical relationships in the world.

Metaphors thus are our mental tool for bridging abstract and concrete ideas. Teachers in the language arts area will attest to the difficulty of guiding students to understand traditional forms related to metaphor: similes, analogies, metonymies, and allegories. This may be because these forms are introduced to student as strictly literary devices representing highly symbolic ideas rather than as practical structures for reasoning and understanding, or as central to the study of daily language, communication, and actions. Metaphors, for many students and teachers, remain mysterious rather than practical in everyday life.

Lakoff's work has yet to be applied in a systematic way to the practice of primary or secondary education. This application is a writing activity that was piloted at the high school level. It is based on the outcome of students learning to use a multi-level bridge map, called a "world map", for identifying, structuring and analyzing metaphors for writing. A second intended outcome of this work is metacognitive: Students think about how they are thinking using multiple, overlapping metaphors and consider how these structures, in turn, may affect their actions. The writing prompt and metaphorical analysis used below were derived from a deeper analysis of "arguments" (Lakoff & Johnson, 1980).

<u>Activity 1: Free Writing about Arguments</u>

The first step is for students to write in a stream of consciousness approach in response to this writing prompt:

> Arguments are a part of our lives. We have spoken arguments with people and we write down arguments on paper. We even argue within ourselves at times. What are arguments? How do they begin? What happens? What do you think about? What do you feel? What do you do in an argument? Why do we have arguments?

Most students spent at least twenty minutes on this activity and wrote at least two full pages in response to this prompt. The papers were collected and brought back to the class on the following day.

Activity 2: Defining and Identifying Metaphors

The second and third activities occurred on the following day. Activity 2 consisted of first providing students with a basic definition of metaphor as "understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980). The class was then organized into working groups of three or four students each, and three paragraphs were distributed to the groups. The three paragraphs were a synthesis of, respectively, three central metaphors identified by Lakoff: arguments as wars, buildings, and journeys. Students were asked to identify the guiding metaphor in each of the following paragraphs:

Paragraph 1: What is an ARGUMENT about ?

In an argument people are battling to win. Each person creates a strategy to put the other person on the defensive. Every time one person takes a position --even if it is right on target --the other person tries to attack it, and shoot it down. Somebody always weakens, gives up ground, and finally concedes defeat. Often people get mad and explode with anger.

How does this writer explain an argument?
AN ARGUMENT IS A ___________ or maybe ______________

Paragraph 2: What is an ARGUMENT about ?

In an argument people are putting together their ideas to make a strong foundation. Each person tries to buttress their arguments with solid facts and opinions so that it won't fall apart. Most of the time people will construct their ideas with different levels so their argument will be strengthened. If the argument is at all shaky then the main ideas may collapse. This will usually happen if one person does not frame the argument so it stays together.

How does this writer explain an argument?
AN ARGUMENT IS A ____________ or maybe ______________

Paragraph 3: What is an ARGUMENT about ?

In an argument people begin by setting out to prove their points of view. Usually each person proceeds from step to step to get to their goal, covering a lot of ground. Both people in the argument try to follow the direction of each other's ideas, but often the discussion strays off course. Sometimes people just to go around in circles and get lost in an argument instead of arriving at a clear ending.

How does this writer explain an argument?
AN ARGUMENT IS A ______________ or maybe ______________

The teacher first worked with the whole class to identify the 'argument as war' structure in the first paragraph and then students worked in groups to identify the metaphor in the other two paragraphs. Most of the groups of students were able to identify the guilding metaphor in each of the paragraphs.

Activity 3: The World Map

After discussion of the three metaphors, the world map was introduced for the second paragraph 'arguments as buildings' (Figure 4.8). On the left side of the map are the *sources* of the metaphor. In this case, the terms in the paragraph associated with buildings are the source. On the right side of the map is the *target* domain, in this case 'argument'. The entailments that are linked are thesis (as the foundation), evidence (as the buttress), outline (as the frame), and synthesis (as putting together).

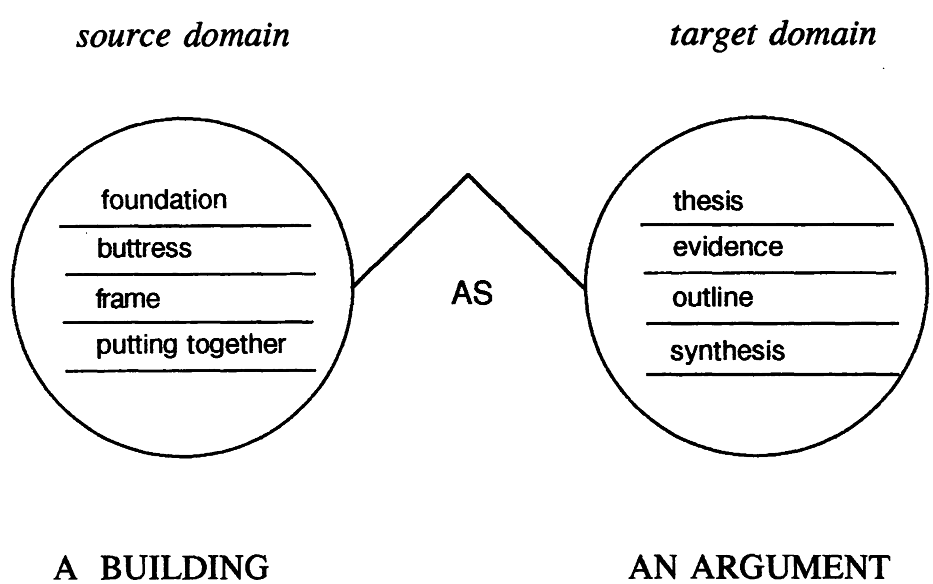


Figure 4.8. The World Map for Analyzing Metaphors

Activity 4: Identifying Conceptual Metaphors in Writing

The final activity in this series is based on students applying what they had learned about the three paragraphs and the world map to their original writing completed on the previous day. Students were asked to reread their papers and underline any of the three metaphorical entailments for arguments, or any other metaphors that they might be able to identify. Many students were able to identify a central metaphor at work in their own writing, as well as secondary metaphors. The dominant theme in most pieces of writing was the more violent "arguments as war" metaphor. Most of the pieces of writing drew from several metaphorical entailments. As Lakoff suggests, most if not all concepts are understood using multiple, overlapping metaphors and that the use of only one metaphor usually hides certain dimensions of understanding.

During the follow-up discussion concerning this activity one student stated that he had never been aware-- through all of his years of schooling --that language worked in this way. This series of activities reveals to students that the foundations of language and thinking are based on complex structures: our understandings are constructed within our direct experiences in and relationship to the world, and we are often using more concrete objects as conceptual bridges to more abstract ideas.

This activity also provided students with an exercise in metacognition: they were looking into their own writing which expressed understandings of "arguments" and used a tool (the world map) to reflect on how they were structuring their understandings. The follow-up discussion also addressed how the conceptual metaphors that guide their thinking also may guide their actions: a person who understands that arguments are wars being fought may act in violent ways whereas one who understands arguments as journeys may act for peaceful resolution of a conflict.

4. Interdisciplinary Learning

There has been some movement in schools in recent years toward more interdisciplinary learning focusing on enabling students to approach broad problems and ideas using skills and knowledge from different subject areas. There are numerous ways of integrating disciplines at the elementary and secondary levels including the identification of a rich, or "fertile" interdisciplinary concept or theme for study. Students create products and conduct experiments that require the use of skills and knowledge from across disciplines. This approach reinforces the need for the transfer of thinking processes across disciplines.

The outline of the interdisciplinary unit on the following page is guided by the theme of "Time, Change, and Growth" (Figure 4.9). A key outcome for this unit is for students to be able to consciously transfer the thinking processes of sequencing, ordering, cause-effect, cycles, and systems dynamics using thinking maps across subject areas. The flow maps are used in differing configurations as the primary tools for showing the connections across this theme.

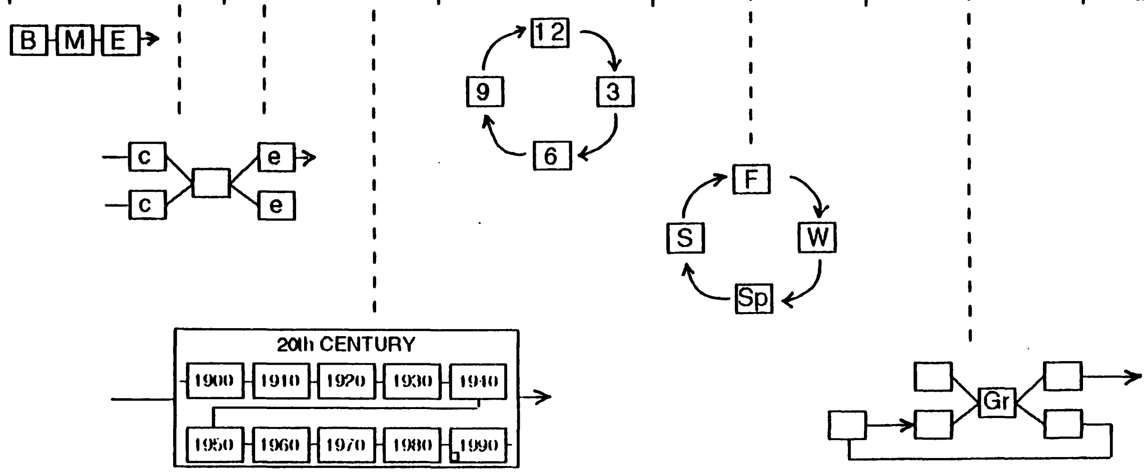
The five disciplines area design was taken from the North Carolina State Standard Course of Study, grade 3 (NCSCS, 1991). Below, the five disciplines are selected content focus areas suggested by the state for study, followed by the respective content focus areas, and more discreet skills and content concepts. The thinking processes are shown immediately below the discrete skills and connected to various patterns of operations using the flow and multiflow map.

GRADE 3 **North Carolina: Standard Course of Study**

Theme: **Time, Change, and Growth** *using thinking maps for connecting content, concepts, skills, and thinking processes*

	COMMUNICATION SKILLS	SOCIAL STUDIES	MATHEMATICS	SCIENCE	HEALTH
CONTENT FOCUS	reading comprehension (p.123)	history (p.313)	measurement (p.226)	earth sciences (p.268)	human body (p. 177)
CONTENT CONCEPTS AND SKILLS	story plot analysis; time	time; chronology of events; change	ordering time; a.m. and p.m; elapsed time	time; seasons; forces changing earth;	growth; factors influencing growth; differential development
COMMON THINKING PROCESSES	sequencing cause-effect	sequencing cause-effect	sequencing cyclical process	sequencing cause-effect cyclical process	sequencing cause-effect cyclical process systems dynamic

THINKING MAPS



CONNECTIONS

Concepts: chronology, time, factors influencing change and growth

Processes: sequencing, cause-effect, cyclical flows, systems dynamics

Figure 4.9. Interdisciplinary Unit Matrix

Each of the map configurations shown below is used by students in this unit. The most simple sequence that students are taught is the beginning, middle, and end of a story plot (shown in the flow map as B - M - E) and the causes and effects of events in the analysis of a plot (shown in the multiflow map as "c - e"). The chronology of time periods is represented as an expanded flow map (century, decades, years) followed by the multiflow map for causes and effects of historical events. At the third grade level, the 24 hour day cycle is studied in mathematics and the cyclical phases of the seasons are studied in science. These patterns are represented by the flow map drawn to reflect these cyclical relationships.

An overview of the unit design "Watching the Time Go By" is displayed in outline form showing the flow of a possible lesson plan (Figure 4.10). The outcome of having students understand the flow of time and the dynamics of change as related to growth in their own life create the thematic center of this unit of study. Crucial to this unit is the focus on personal, interpersonal, and social under-standings. One of the products of this unit is for students to use the flow and multi-flow map to write an autobiography; a second product is for students to work together to read stories about how people become friends and how this changes relationships; a third product is for the class to observe and collect data on how time is structured in our social calendar from daily and weekly activities, to clock time, to calendar time, to seasonal changes in the surrounding environment. A link may be made here to cultural definitions of time and the creation of alternative calendars in other parts of the

INTERDISCIPLINARY UNIT TITLE:

"Watching the Time Go By"

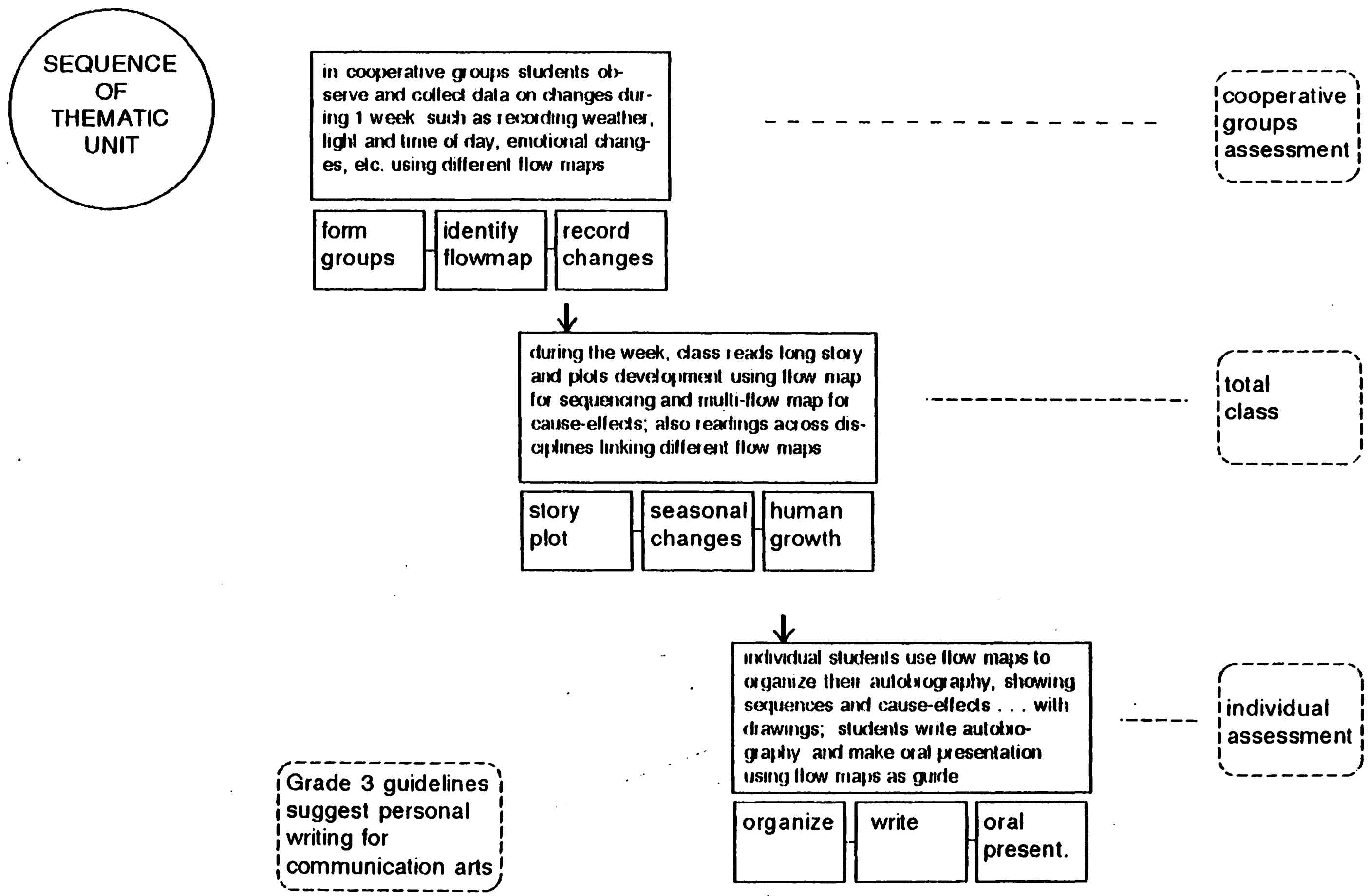


Figure 4.10. Lesson Design for Interdisciplinary Unit

world, as Geertz has shown by the example of the Balinese calender (Geertz, 1973).

These three outcomes are shown, respectively, in the three major stages of this interdisciplinary unit. Embedded in the unit is the strategy of using cooperative learning groups for collecting data using the flow map, whole class analysis of reading selections about time and change, and individual work for the writing of the autobiography. Assessment is also conducted in each area of discovery. The cooperative groups present their findings using the different configurations of the flow maps and comparing the findings of each group. The whole class work is focused on identifying different flows of information and collecting them in a booklet (story plot showing rising and falling action; seasonal changes using cyclical flows; feedback loops in the human body system). The autobiographies are assessed through the numerous flow and multi-flow maps, the final written product, and oral presentations.

The previous applications concerning multicultural education and writing a research paper used several maps for deepening students' understandings. This interdisciplinary unit purposefully focuses on students deepening their ability to use just the flow and multi-flow maps in various configurations, thus enabling students to become aware of how to transfer cognitive processes across disciplines.

5. Assessment using Thinking Maps

There are five basic ways that thinking maps may be used as tools for assessment: as informal "in the moment" assessment by teachers during classroom interaction, for private conferencing between a teacher and individual students, self-assessment by students, for analyzing portfolios of students' work, and for pre- and post- formal assessment of student work. The focus of this section is on the assessment of students' thinking maps work using a holistic scoring rubric called "MAPPER" (Figure 4.11).

The MAPPER rubric was developed to be used by teachers and older students who have been formally trained in the use of thinking maps. Without a clear introduction to the thinking maps language and at least partial fluency with the use of multiple thinking maps the use of this assessment tool is invalid. This is because there is an expectation embedded in the rubric that students know how independently and flexibly to apply all eight thinking maps and the frame in a variety of learning situations. There is also an expectation that students are using thinking maps-- not as isolated activities -- but as mid-range tools for creating final products such as writing, dialogue, oral presentations, scientific experiments, etc. The MAPPER rubric is thus a holistic tool for use by teachers and students to assess the development of students' thinking, the growth in content knowledge, and for the communication of personal, interpersonal, and social understandings.

Figure 4.11. MAPPER Rubric for Asssessment

MAPPER: A Holistic Scale for Assessing Students' Thinking about Content using Thinking Maps

	MINIMUM	ATTENDING	PARTICIPATING	EFFECTIVE	REFLECTIVE
EXPAND [ ]	• very few connections • use of only one map 1	• multiple connections • few supporting details are shown 2	• multiple concepts are shown with details • multiple maps are used 3	• thematic and interdisciplinary connections are shown 4	• personal, interpersonal, and social implications are recorded 5
CLARIFY [ ]	• bits of information are isolated,disorganized • irrelevant information is included 1	• different kinds of information are provided • details are shown in relation to general concepts 2	• patterns in maps are developed • details are sorted • general concepts are fully supported with relevant details 3	• connections are shown between multiple maps • central ideas are highlighted for application 4	• frame is used to establish point of view and value of map • hypotheses are generated 5
ASSIMILATE [ ]	• one perspective or solution is shown • rote repetition of information is presented 1	• alternative way of presenting information is initiated • points of confusion are highlighted 2	• integration of prior knowledge and new information is shown • fundamental misconceptions are resolved 3	• several maps are coordinated for use in final product • novel applications are created 4	• multiple perspectives are shown • limitations of map(s) are suggested • self-assessment is initiated 5
DESCRIPTIONS: Holistic Scoring: • Give a score of 1-5 in each of the three area boxes above. • Add the three area scores together to show total score in this box: [ ]	The student is demonstrating a simplistic level of understanding of content and/or limited effort.	The student is attending to the task and demonstrates a basic grasp of content and information.	The student is actively engaged with thinking about content and is beginning to integrate and initiate new ideas.	The student is strategically synthesizing information,focusing on organizing ideas and details for meaningful applications.	The student is seeking a deeper understanding of knowledge by recognizing interpretations, implications, and limitations of work
	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15

The MAPPER rubric has two axes as discussed below: three dimensions of conceptual development on the vertical axis and five "signs" of understanding on the horizontal axis.

Dimensions of Concept Development

The three dimensions of conceptual development-- expand, clarify, assimilate --are roughly synonymous with the description provided by Novak and Gowin (Novak & Gowin, 1984) who outlined three areas for scoring their concept maps model.

The expand dimension is used to identify not only the expanding wealth of information being organized, but also the range of different thinking maps being used to show relationships, different patterns of information, concepts and interdisciplinary connections. This dimension is more extensive than what Novak and Gowin have described as "hierarchical structure" wherein more information is added and subsumed under different and broader levels of generality within a top-down category structure.

Within the thinking maps model, the expand dimension values the addition of new information to *multiple maps* while also expanding the maps to *multiple modes* of personal, interpersonal, and social understandings. For example, in the Cotton Gin example, the use of the tree map showed how students could have initially expanded information hierarchically. While this map may have shown expansion in the area of factual information, it did not expand to fully develop the ideas of slavery and/or labor markets until the discussion was expanded to the use of bridge map for analyzing the problem in more depth.

A second dimension, clarify, corresponds to what Novak and Gowin have described as "progressive differentiation" and values the specificity of information and precision of meanings as concepts are being developed. An example of the clarification of concepts is addressed in the multicultural unit, "What is Culture?" Students needed to work and rework their radial maps to further clarify their ideas about different types of cultures. Endless expansion of the concept "culture" without synthesizing ideas into more central ideas would lead to confusion rather than clarity about the subject. Also, this rubric gives value to students when they identify their frame(s) of reference. Students and teachers are thus challenged to investigate how their personal background experiences and social frames influence the information that they perceived to be important. They must also reflect on why and how they used certain thinking maps to structure the information.

Assimilation, a third dimension of the rubric, is based on what Novak and Gowin call "integrative reconciliation." This is the identification by the student of new relationships between concepts and the generation of new principles. The ability of students to assimilate new information into previous knowledge structures has two important sides. First, students must be able to integrate new concepts into their own personal understandings. Secondly, they must be able to question the given, objective knowledge structures provided by teachers and from different of texts. Assimilation also means that students are generating novel knowledge structures that are the foundation for products such as written documents. Ultimately, the assimilation dimension means that students are consciously acquiring new ideas and assessing the value of these concepts through self-assessment. This self-assessment includes seeking multiple perspectives and evaluating the effectiveness and possible constraints of the tools that they are using, such as thinking maps.

Signs of Understanding

The five signs of understanding across the horizontal line of the matrix represent the degree of active engagement in the activities as specified by simple to more complex representations (signs) of understandings. Often these two aspects of performance-- *effort* or motivation by the student and *ability* to complete the activity --are nearly impossible to separate. During many tasks a teacher might ask about an underperforming student: Does the student lack motivation and/or ability? In the MAPPER rubric these two aspects are shown as linked: a student may or may not perform or show "understanding" depending upon the level of motivation to understand the ideas being presented. Also embedded in this view is the value of personal, interpersonal and social modes of understanding.

The five signs of understanding, from minimum to reflective, are described at the bottom of each column of the rubric. The extent to which a student becomes more attentive to the activity of learning using thinking maps shows up in the map(s) that are created by the student. At a *minimum* level, the student is not *showing* much involvement and/or understanding of the task. This may be due to lack of motivation, lack of conceptual understanding, or both. As a thinking map is expanded, clarified, and new information is assimilated, the student is showing an *attention* to the learning situation. As multiple maps are used together to show ideas and misconceptions are resolved, then the student is fully *participating*. When connections are made to broad themes, transfer to other disciplines, and to the generation of a product, the student is *effectively* using the maps. Signs of *reflectiveness* are evident when the personal, interpersonal, and social implications are shown, possible limitations of the work completed is sought, multiple perspectives on the ideas are considered, and limitations of the available resources and thinking maps used are suggested. All of these signs reveal a reflective learner who is becoming self-assessing.

The MAPPER rubric may be used with or without the scoring framework. Though some preliminary piloting of this matrix has been attempted, there has been no systematic attempt to test the validity of the rubric. A few important points have been made by those reviewing and using this tool. First, it is essential that students and teachers are fluent in the use of the thinking maps. Second, in the analysis of student work, all of the working drafts of the maps and products that students create must be available for review. Third, it is possible to be at different levels within each dimension. For example, a student could show an attending level on the expand dimension (because of the use of only one map) while scoring at an effective level on the assimilation dimension because the one map used is richly developed. Finally, it is clear that this rubric should be just one of several ways of assessing student thinking and learning.

The formal assessment of student work using the MAPPER rubric may be conducted by collecting all of the documents of a unit of study (such as in "The Cotton Gin" application shown above). It may also be used as a tool for conducting a pre-post analysis of students' understanding. For example, a teacher introducing the unit "What is Culture?" could have individual students generate and show their understandings about "culture" before beginning the unit. These maps could be set aside and compared to the maps students create after the unit of study is completed to identify changes in quality of ideas over the course of study.

This rubric also supports informal assessment in the classroom. Teachers may use this document as a rough guide as they move around the classroom and scan the thinking maps that students are creating. A teacher may then take a student aside and conduct an informal assessment conference using the student's map as a guide to see the ideas the student is expressing. In the conference the student may bring other documents and use the maps to support how and what she is thinking. This kind of one-to-one conference will also facilitate student self-assessment. The teacher may ask the student to identify the development of ideas as shown on the maps.

One of the most effective uses of this rubric may be for the analysis of student portfolios of thinking maps and other documents collected over one or several school years. This developmental portrait may show not only increased sophistication in the use of these tools for thinking, but also the development of students' thinking and content knowledge. Teachers and students together may be able to meet for a final conference at the end of each school year and review a thinking maps portfolio, with the MAPPER rubric as a guide, to see the progress of student work.

The five applications in this chapter show how the thinking maps, which were introduced in Chapter 3 as isolated tools, are linked together as an integrated language for learning and for facing several of the key curricular issues in schools today: multicultural education, interdisciplinary learning, and alternative assessment. The final chapter reveals the foundations for this visual-verbal language, the implications for what has been presented in each of these five applications, and the relationships to issues and research presented in the first two chapters of this investigation.

CHAPTER 5: THINKING MAPS AS A LANGUAGE FOR LEARNING

> It is pictures rather than propositions, metaphors rather than statements, which determine most of our philosophical convictions. The picture which holds traditional philosophy captive is that of the mind as a great mirror, containing various representations- some accurate, some not -and capable of being studied by pure, nonemperical methods. Without the notion of the mind as mirror, the notion of knowledge as accuracy of representation would not have suggested itself. (Rorty, 1979, p. 12)

Introduction

Several key ideas have emerged from the previous four chapters: the false dichotomy of knowing into objective and subjective spheres, the investigation of the term "connective" as an additional metaphor for knowing, the description of an alternative definition and structure of categorization, the centrality of metaphor for conceptual understandings, and the importance of personal, interpersonal and social frames in the daily life of classrooms. This final chapter is devoted to synthesizing these and other overlapping ideas as related to the three purposes of this work: identifying the theoretical background support for the need for tools such as thinking maps, defining and showing the practical applications and implications for thinking maps in daily classroom activities, and to offer thinking maps as a coherent language for learning.

This chapter begins with a rephrasing of the need to articulate an alternative to the current definition of knowledge as based on objectivism. This directly relates to the need for practical tools for teachers and students, such as thinking maps, that reflect this alternative. Following this section is a clear definition of thinking maps as not merely a set of strategies, or a model, or a thinking skills program, but as a coherent *language* for learning. This language has four important characteristics: theoretical breadth, graphic consistency, flexibility, and reflectiveness. The fourth section identifies the implications for using thinking maps as a language for multiple modes of understanding in education using the five applications in the previous chapter as examples. This is followed by a brief section addressing the limitations and research possibilities related to thinking maps. Concluding comments offer thinking maps and other graphic organizers as a third dimension in classroom practice and educational theory-- "form" --that connects "contents" with "processes."

Shattering the Knowledge Mirror

Many of the ideas that surfaced in this study provide the context for a central problem established in Chapter 1 of this work: the one-direction teacher-talk and student-listen relationship in most classrooms. This lack of intellectual connectiveness, as described by Dewey over seventy years ago, continues today as an outcome of a seemingly unbreakable philosophical tradition. This tradition, as described in Chapter 2, and summarized by Richard Rorty above, is based on knowledge as defined by the development of exact correspondences- or mirroring -of things in nature by the human mind through unambiguous representations. Truth is thus found in the mind as the exact *mirror* of nature. This picture is often described by way of overlapping metaphorical concepts: knowledge is *transmitted* (Freire, 1970) by teachers and sent by words and numbers as *counters* for ideals (Dewey, 1919) through a *conduit* (Reddy, 1979) to students who *consume* the parcels and then feed-back or *mirror* (Rorty, 1979) these representations on tests.

On the most basic level, until this institutional ideal of mind as knowledge mirror is broken, indeed *shattered*, reform of schooling in America may continue to be a resurfacing project rather than a reconstruction of how we teach and learn. Unless this issue is faced, effective new learning approaches described in Chapter 2 such as process writing, cooperative learning, conflict resolution, and thinking skills-based learning may remain dependent upon how knowledge and intelligence are defined, communicated, and evaluated *as objective*.

A brief review of sections in Chapter 2 on the thinking skills movement, new cognitive science research, and the analysis of the wide spread critique of positivism reveals the need for a clearly articulated alternative paradigm for defining knowledge in schools.

The thinking skills movement has focused on, for the most part, teacher questioning, higher-order skills development, interactive learning, and problem-solving by students. This work has had a significant impact on the direction of education, yet there are several problems in this field: there is little evidence of thinking skills transfer and many of the cognitive skills approaches remain entrenched in a view of thinking as a hierarchy of lower and higher-order skills. In addition, beyond the Philosophy for Children program (Lipman,1991), most cognitive skills instruction does not attempt to integrate the teaching of thinking (processes) with teaching about thinking (epistemic cognition). Finally, thinking skills instruction rarely focuses on dealing with complex social issues and facilitating extended dialogue as students are faced with controversial issues. New tools, such as thinking maps, may facilitate the transfer of thinking processes across disciplines, into controversial issues, and beyond the low-high dichotomy found in most models.

Research presented in the second chapter also suggests that "constructivism", upon which much of the thinking skills movement is based, is only one dimension of an alternative view. Though there is a new interest in the social "construction" of knowledge, constructivism is primarily based on researching and teaching for the cognitive development of individual students and not centered on the whole child in a social context: on personal, interpersonal, and social understandings. Furthermore, new cognitive science research is revealing idealized cognitive models which include frames, radial categorization, and conceptual metaphor. These dimensions of cognition and research are based on our experiential relationships in the world and not on isolated cognitive tasks.

A third section of Chapter 2 showed that leading researchers from across disciplines have rejected the present paradigm for knowing that is based on the hardened dichotomy of objective and subjective knowing. Belenky (1986, et al) offer the term "connective learning" as a guiding metaphor for working in a new paradigm in schools. Connective learning/knowing offers a synthesis of personal experience and individuals as constructors of knowledge within the interpersonal and social connections and multiple cultural frames. Within an idealized view of connective knowing, a student is seeking to find personal meaning as an outgrowth of interpersonal relationships and the influence of social contexts.

The idea of connective ways of knowing as outlined by Belenky overlaps with Lakoff's view of experiential knowing and provide together, an initial outline, if not a foundation for a new paradigm for knowing. Proponents of "normal" education today, like any "normal" science, view such alternatives as outside the bounds of legitimacy. Yet, such "big picture" alternatives are needed to provide legitimate time and place for experimentation. Most importantly, practical new strategies for communicating and learning in an alternative framework for knowing are also essential for such experimentation to occur between teachers and students.

Thinking Maps as a Language

One way of shattering the static ideal of the knowledge mirror is by articulating a practical language for generating, representing and communicating ideas. That a *new language* may be necessary is due to the problem that our practical, *everyday language* in classrooms is thoroughly saturated with the "knowledge as mirror" metaphor. That a new language may be needed, based on a different representation system (visual) than is normally used (verbal), is due to the problem that our holistic patterns of ideas are most often communicated through linear representations:

> Written or spoken messages are necessarily linear sequences of concepts and propositions. In contrast, knowledge is stored in our minds in a kind of hierarchical or holographic structure.
> (Novak & Gowin, 1984, p. 53)

An additional language in a new representation system that helps students to visually connect ideas in holistic ways may provide support and definition to a connective paradigm for knowing. Thinking maps have been offered in this work as theory-embedded, practical tools for students and teachers. These maps are not intended as point-by-point mirrors reflecting some "objective" world, but used for the purpose of holistic, connective knowing: personal reflectiveness, interpersonal communication and dialogue, and social-cultural interpretation. The eight thinking maps are-- when used together --a formal and flexible visual-verbal *language* for facilitating students' connective knowing.

Typically, a language has a lexicon and syntax, or a defined vocabulary and set of rules for communicating information. As presented in Chapter 3, each thinking map has its own lexicon: a rectangle is a symbol communicating a stage in a sequence, a small circle within a large circle is a symbol for defining in context, a bubble extended from a circle using a line is a symbol for a quality, etc. Each map also has visual syntax from which, like a legend on a geographical map, rules are used to generate simple-to-complex patterns of relationships using the basic lexicon.

There are four basic characteristics that are essential to defining and using this language: Theoretical breadth, graphic consistency, flexibility, and reflectiveness. Each of these characteristics is partially supported by effective practices of isolated graphic organizers presented earlier in this chapter and synthesized in the thinking maps language.

Theoretical Breadth

As presented in Chapter 3, the revised Upton-Samson thinking process model provides the theoretical foundation and breadth for linking the eight thinking maps. The eight thinking processes, represented by eight respective thinking maps, are commonly described in the field of thinking skills and cognitive science as "lower-order" thinking processes. But, as this investigation has shown, the thinking maps are based on a non-hierarchical view of thinking: these *visually* primitive starting points may expand to show complex applications for multiple modes of understanding. In addition, the thinking maps language includes key tools based on new cognitive science research, such as the frame map for frame of reference, the radial tree map for radial categorization, the multi-flow map for showing system dynamics, and the bridge map for forming analogies and metaphors. This is an attempt to integrate so-called "lower" and "higher" order thinking in a nonhierarchical model.

While developers of isolated graphic organizers have shown that each graphic is based on a particular task or a thinking process, there have been no attempts to present a broad *and* coherent, theory-embedded array of graphic tools. There have been obvious successes using the isolated graphic organizers, as presented in Chapter 3 of this work, but there are so far few examples showing how the different, isolated graphic organizers are used together and/or embedded within each other to solve complex problems or to communicate ideas.

Additionally, thinking maps are presented as a central organizing principle-- a language --in classrooms for learning based on a theoretical view of constructivism and connective knowing. These definition of each map and foundations in research were presented in Chapter 3 and then modeled in Chapter 4. The introduction of a comprehensive, theory-based language of graphic organizers to teachers and students has significant implications in the classroom: As a range of patterns of thinking are introduced, applied and reinforced, students and teachers deepen their understandings of thinking processes over time. The maps are then used as an interrelated set of tools rather than as disconnected "strategies" for isolated learning tasks, communication in classrooms is enhanced, interdisciplinary transfer is faciliated, and informal and formal assessment is possible.

Graphic Consistency

The language of thinking maps is established by the consistent display of graphic primitives unique to each map and linked directly to fundamental patterns of thinking. This consistency is the most obvious and significant difference between thinking maps and several other approaches to using graphic organizers.

There is a wide range in the degree of visual consistency of graphic representations, as presented in Chapter 3. The uses of clustering by Gabriel Lusser Rico and mind-mapping techniques by Tony Buzan require few if any constraints on the creation of a map, though both approaches begin in the center and branch outward on the page. There are useful graphic languages that have rigorous graphic form, such as the systems thinking language used for modeling with the support of computer software. The STELLA software (Richmond, et al, 1988) has four basic tools, each graphically unique, rigidly defined, and mathematically related so that a highly disciplined "systems" thinker is generating a model that can be read by any other person who knows the language. Between these two extremes are examples of the same graphic organizer being used effectively without strict rules and for multiple thinking processes or tasks. The three generic semantic maps developed by Richard Sinatra (Sinatra, 1990) for sequencing, themes, and classification are all based on the same graphic representation: rectangles and arrows. The only visual distinction between each map is found in the configuration of the map.

Most of these approaches have been shown to help students to brainstorm ideas or structure information in isolated tasks. Thinking maps, as a language, is based on the interactive and efficient generation and communication of ideas in a classroom and over multiple years in a school. This long-term approach requires graphic consistency so that students and teachers continue to improve their abilities to apply and transfer thinking processes and do not need to explain or decode every graphic they use or create.

This language does not preclude the development of idiosyncratic graphic representations, but it does provide a common visual basis for communication. For example, students learn that when they are investigating a sequence of ideas that they start with rectangles and arrows; when they are categorizing (hierarchically or radially) they use horizontal, vertical, or diagonal lines; when they are seeking qualities they start with the ideas in the center circle and draw extension lines with bubbles. Thus every line, circle, or rectangle of each thinking map is *meaningful*.

The graphic consistency of the thinking maps language, along with the theoretical breadth described above, is thus an alternative way to *give definition to* related thinking processes. Up until recently, "thinking skills" have been defined using strings of words in sentences and practiced through linear representations in schools (by speech and written form). Teachers may have asked "higher-order" questions that require students to think in holistic patterns of information-- such as asking about the interrelationships of causes and effects in a system --yet students are only able to respond through linear representations. The effect is that thinking has been constrained *by the form* in which ideas are being communicated. By presenting a consistent graphic language to students based on theory and practice, such as thinking maps, teachers are providing tools to students for representing the complexity of relationships as patterns in context and for entering dialogue about the form of ideas.

Flexibility

A third characteristic of the thinking maps language is the flexibility of the eight basic forms. Whereas the consistency characteristic is based on the clarity of definition and graphic form, flexibility is based on how each thinking map may be expanded and developed to reflect ideas, and the degree to which the graphic organizers may be visually integrated.

Each of the thinking maps begins with a simple form and may expand in multiple directions to show more connections. The form of each map may be configured to reflect the unique and/or complex ideas being investigated by the learner, and maps may be linked together and embedded within each other to show processes within processes. For example, a multi-flow map may be expanded in any direction on a page and evolve into a systems diagram showing feedback loops. A tree map may be expanded horizontally and vertically, starting from the bottom or the top, to show general to specific relationships.

Though introduced as isolated graphics-- unlike the single, integrated forms of brainstorming maps, concept maps, and systems diagrams --thinking maps are used in unison once fluency with the basic lexicon is developed with each map. On the same page, multiple maps are often developed and visually linked together. A word representing a category in a tree or radial map could easily become the starting point for a flow map, depending upon how the learner is thinking about an idea. If a student is showing a process for writing a research paper, a flow map of stages and sub-stages may evolve. Within each box (stage) other thinking maps may be embedded to show the organization of ideas within the flow, such as a tree map showing the main ideas and details of a particular concept. Without this flexible use, the thinking maps are no longer language tools and may lead to students merely filling in a static graphic without much thought or reflection.

As presented in Chapter 3, there is a broad range in the degree of flexibility across the different examples of graphic organizers. The brainstorming maps are highly flexible with few constraints on development and use. Novak and Gowin's hierarchical concept mapping has a consistent language for how the maps should be constructed and assessed (showing top-down relationships), and the final outcomes show integrated and flexible use of graphics within the language. Systems thinking uses graphic tools based on flows: The language for developing the STELLA diagrams is rigidly defined by non-hierarchical flows and feedback loops, yet the final outcomes show that the graphic language is used flexibly to reveal configurations reflecting the unique content and interpretations of each problem. Other graphic organizers are static, fill-in forms that are effective for certain tasks, but do not engender flexible use and transfer of thinking processes.

The most significant outcome of having a simple, consistent and flexible language is that students from early elementary through adult learning are able to use the same tools. Young children may begin with a simple pattern and build in different configurations toward complexity. A first grade student may only identify a few major stages in a nursery rhyme using a flow map, a junior high student may generate a flow map showing the stages in the evaporation cycle, and a college student may develop a complex computer flow map with intricate feedback loops. Thus each thinking map, though consistent in design, may be used flexibly to explore and show simple to more complex concepts.

Reflectiveness

One of the central concerns of the thinking skills movement, as presented in Chapters 1 and 2, is the development of students' metacognitive abilities, or "epistemic cognition." This means that students are becoming aware of their own problem-solving processes, learning styles, general thinking skills, self-assessing their progress in the learning process, and reflecting on the nature of knowledge.

Most of the examples of graphic organizers shown in Chapter 3 are *implicitly* supporting metacognitive activity. Arthur Costa has called graphic organizers "displayed metacognition" (in Clarke, 1991,

p. xi) because each graphic is a representation of a pattern of thinking and may be re-viewed for self-assessment purposes. For example, the brainstorming maps by Rico and Buzan, as well as many of the task-specific graphic organizers, are holistic representations of students' thinking. Students and teachers may use these graphics as ways of assessing work and improving thinking abilities.

Of course, there is no assurance that a map maker will reflect on his or her visual thinking any more than thinking that is spoken or written in linear form. This is especially true when graphic organizers are presented to students as isolated, inconsistent, and/or inflexible strategies for completing task-specific acitivities or rote memorization of information. Some graphic organizers now appearing in textbooks are of this kind: Students fill-in a graphic organizer much like they fill-in a worksheet assignment, without reflection. Metacognitive activity may depend on teachers asking the questions which will facilitate students' reflective thinking.

There are several examples of uses of graphic organizers that simultaneously focus students on both the construction of knowledge and reflectiveness on the process. Novak and Gowin use the "Vee Heuristic" diagram in conjunction with concept maps to provide students with a graphic tool for showing the conceptual and methodological elements that interact in the construction of knowledge (Novak & Gowin, 1984, p. 3). Clarke's inductive tower is partially based on Novak and Gowin's work, and provides a graphic organizer for consciously transforming facts into theoretical propositions (Clarke, 1991). A third example is found in systems thinking. As with the two previous examples, the process of creating a STELLA diagram is explicitly understood as the active construction of dynamic, mental models of reality. During the process of constructing a STELLA diagram, learners are consistently challenging, testing, and reworking their models and presuppositions about how the system functions in reality, and how well the model represents the "real" world.

The thinking maps language includes a graphic representation -- the frame --that *explicitly* promotes reflectiveness by linking the learner's frame of reference to the construction of knowledge. The frame is a simple graphic that is used around any of the thinking maps (and could be used around any graphic representation) by the learner to question the background frames which are influencing the construction of the maps. This simple tool reflects the research by Lakoff (1987) and Fillmore (1986) revealing the fundamental importance of personal, interpersonal, and social frames on how we construct categories and other basic patterns of knowledge.

Implications: Thinking Maps for Multiple Modes of Understanding

Each of the applications presented in Chapter 4 reflects in different ways the four characteristics of the thinking maps language summarized in the previous section: theoretical breadth, graphic consistency, flexibility, and reflectiveness. The isolated introductions of each map in Chapter 3 alone could not have revealed the interactive, connective use of thinking maps in classrooms.

These five applications also were chosen because they are practical examples of key research presented in Chapter 2. Each example also represents important and controversial leverage points for shifting education beyond the replication of objective knowledge and toward a vision of constructivism *and* connective knowing. The synthesis below centers on the implications for thinking maps as a language for multiple modes of understanding in five areas: perspective taking and multicultural studies, organization as interpretation, interdisciplinary learning, concept development and conceptual metaphor, and assessment.

Educating for Perspective-taking and Multicultural Studies

Educating for perspective-taking is essential as our schools become more integrated, as formerly disempowered minority groups become more empowered to "speak their minds," and as global communications and travel link people from around the world. Yet several practical problems arise in classrooms as participants have discussions, debates and enter dialogue about complex and/or controversial ideas: there is not enough time for all students to speak; teachers and the more verbal students usually have control over discussions; complex, holistic ideas are represented only in linear form; personal experiences and different cultural contexts and frames are often undervalued; conceptual metaphors which guide thinking are deemed too abstract or complex to interpret.

The implications for using thinking maps for sharing differing perspectives may be drawn from the first application in Chapter 4. The activities are based on defining "culture" and begin with students seeking personal understandings, using the circle and frame maps through the context of their own lives, and the multiple frames of reference which influence their lives. From these maps, students work together to generate a radial tree map showing categories, or types, of culture. This collaborative development of nonhierarchical categories from personal contexts supports interpersonal understandings. The third activity, using the bridge map, reveals to students that definitions of culture and traditional social understandings about how minority cultures are to assimilate into mainstream society are grounded in metaphor. Most importantly, students learn how to work with and construct additional social understandings of cultural relationships by creating new metaphors that may guide their understandings and actions.

The theoretical work presented in Chapter 2 becomes more concrete and focused when brought into practice using thinking maps. Students are explicitly creating and seeing representations of alternative frames of reference in relationship to ways of constructing categories and metaphors. These activities also draw from the core ideals of the thinking skills and cooperative learning movements: students are independently and interdependently applying thinking processes to perspective-taking and the explicit, interactive construction of knowledge.

Organization as Interpretation

The second application in Chapter 4, a series of excerpted activities from a longer unit on "The Cotton Gin", links reading, writing and thinking skills to the field of historical analysis and the process of writing a research paper.

Research in the areas of reading and writing presented in Chapter 3 shows that students' reading comprehension improves when they are introduced to basic text structures such as sequencing, cause-effect, and main idea. Two of the thinking maps shown in "The Cotton Gin" application, the tree map and flow map, reflect the basic text structures of main idea and sequencing, respectively. Importantly, students are not filling in a static graphic organizer based on a text structure, but are learning how to generate these patterns using a visual lexicon.

This is a step toward developing students' independent abilities to organize information for research. This includes seeking connections between past events, present relationships and future possibilities (Dewey, 1919) and generating meaningful writing that focuses on interpretation as a part of the organization process. Prior experiences and background frames, and how one *begins* to organize ideas, influence future interpretations.

Graphic organizers that are used as static, fill-in forms may focus primarily on the organization of information as a step that comes *before* interpretation. As discussed in Chapter 2, some educators have incorrectly translated Bloom's Taxonomy of Educational Objectives into a hierarchical thinking process model.

This means that "knowledge" must be organized and "comprehended" before it is "analyzed" or interpreted and "evaluated." A crucial part of a view of connective thinking is that interpretation and evaluation are happening *all the time*, because we are each thinking from within personal and cultural frames of reference, and idealized cognitive models, which influence how (and what) we remember, organize, and interpret information.

The thinking maps language represents in graphic form the simultaneity of organization *as* interpretation. This simultaneity is made explicit by the use of the frame map that is drawn by students around each of the other maps. This guides students to think about why they selected certain maps to use, the influences on information by configuring the ideas using different maps, and their processes of adding and deleting ideas as a map develops complexity. These concerns and connections help students and teachers link personal frames of reference for studying history to the organization and interpretation of texts.

Concept Development, Conceptual Metaphor, and Metacognition

The field of thinking skills instruction during the 1980's has focused on the teaching of fundamental cognitive processes and the ability of students to reflect on their own processes for thinking, concept development, and learning. Each of the thinking maps provides initial scaffolding for primary thinking processes, and used together, show pathways for developing concepts. For example, the circle/frame map is a tool for generating prior knowledge about a topic, which may lead to describing the topic using the bubble map and comparing it to a similar idea using the double-bubble map. This, in turn, may lead to the development of a tree map for generating (deductively or inductively) conceptual categories.

Concept development is also dependent upon conceptual metaphors which overlap to structure understandings. The third application in Chapter 4 focuses on an extension of the bridge map--the world map --for the purpose of students learning to use a concrete tool for systematically investigating the metaphors that structure their thinking. By using the world map to interpret how they understand arguments, students are linking their personal concept to a selective few, socially constructed metaphors for arguments. These overlapping metaphors of arguments as wars, as buildings, and as journeys are understandings based on experience.

The broad term "metacognition" has been helpful for promoting reflectiveness in classroom, but this term, in turn, is defined in schools by how our culture defines (human) cognition and knowledge. By using the world map, students are seeing that the metaphors-- which are unconsciously guiding their thoughts and actions --influence their interpersonal relationships. This meta*cognitive* activity is thus based on seeking out new ways of perceiving, and facing the metaphors that guide our thinking, concept development, and actions.

Interdisciplinary Transfer of Thinking Processes

Disciplines are not arbitrary categorizations of content. Each has been developed through the ages as attempts to explain and reflect our understandings of the world. Unfortunately, classroom learning is often reduced to the isolation of disciplines to the degree that students rarely have an opportunity to apply what they know from multiple fields to interdisciplinary problems or ideas.

One of the central tenets of the thinking skills movement has been that thinking processes are transferable across subject areas. Research presented in Chapter 2 shows little evidence of students being able to transfer thinking skills (low-road transfer) or principles (high-road transfer) across disciplines (Perkins & Soloman, 1989). The authors suggest that students need "cueing" by teachers for low-road transfer to take place. After students learn how to use thinking maps, these maps become *student-centered* rather than *teacher-centered* visual cues for low-road transfer. High-road transfer may be facilitated if a concept is developed in one area using a thinking map and then linked, by visual means, to an analogous concept used in another discipline.

The interdisciplinary matrix presented in Chapter 4 based on the theme "Time, Change, and Growth" shows the transfer of the flow maps across disciplines, thus providing "cueing" for low-road transfer. The flow maps are used in several different configurations: linear, cyclical, cause/effect, and finally, feedback loops in a holistic system. This discovery unit promotes both low-road transfer by focusing on "flows" and high-road transfer through the use of the concept "time" that is understood in different ways across disciplines.

The implications for thinking maps for interdisciplinary learning are several: students are able to move from discipline to discipline with a language for transferring thinking processes; because the maps are flexible, content-specific applications will develop to show different configurations of each map; problem-solving and themes which involve multiple disciplines may be approached by transferring (high-road) concepts through a common visual language; and, students may independently seek out interdisciplinary connections because they have a language that helps them traverse different, yet connected, disciplinary terrains.

Assessment of Connective Learning

As presented in the last application in Chapter 4, thinking maps may be used in several ways for assessing students' thinking and for self-assessment. The MAPPER rubric establishes criteria for using thinking maps in classrooms and for assessment purposes. There are three basic assumptions and attending implications that are embedded in this rubric: 1) thinking maps are used for connecting and constructing knowledge; 2) thinking maps are midrange tools and should not be accepted as final outcomes of students' thinking; and, 3) thinking maps are reflective tools used for personal, interpersonal, and social understandings.

First, many forms of assessment, such as standardized multiple choice tests, focus on students' abilities to replicate or apply unquestioned knowledge in isolated problems. The standardized testing of content knowledge may establish a worthwhile minimum level of functioning, but unfortunately this form of assessment often levels teaching and learning to rote memorization. Graphic organizers are now beginning to be used in some state-wide tests as mere extensions of this standardization. As shown in this work, thinking maps are based on a view of knowledge as connective. This "sign" of understanding is specified as "reflective" in the MAPPER rubric.

Second, thinking maps are midrange tools and should not be construed as final outcomes. Products of student work such as written documents, oral presentations, dialogue, multi-media projects, and personal actions must be the primary focus of learning and assessment. This is represented in the MAPPER rubric as the "effective" sign of understanding. But time invested in reflecting on the *processes* as connected to the *products* becomes a rich resource for continued learning and assessment. The thinking maps provide a visual record through a series of connected "working maps" for looking back on the developing structures of students' thinking. The prior knowledge and early blueprints of an investigation when sketched as thinking maps, and when compared to fully developed maps and related to the final product of student work, are documents showing growth over time. There are also implications for longitudinal analysis: these records, collected from work completed within and across disciplines and over multiple years, show an additional view of the cognitive development of a student or group of students in the way they perceive and create mental models.

Third, thinking maps as envisioned in this work are a language not only for personal growth, but also interpersonal group development and for seeking deeper social understandings. So much of schooling consists of learning information while not facing controversial and important issues such as abortion, racism, war, and multi-national imperialism. Little effort is given to seeking alternative critical perspectives on America's form of capitalism and democracy, or the social systems that expand and limit possibilities for different economic classes.

Yet individual actions and lives are rarely independent actions: personal decisions and actions are most often linked directly to either interpersonal and/or interdependent effects because of the interconnections of human life. When assessment in school consists primarily of valuing students' abilities to be "effective" problem-solvers (the fourth column in the MAPPER rubric) as based solely within individual relationships and not within social systems, then we have limited the importance of interpersonal context and social frames. The MAPPER rubric is an initial attempt at establishing a theoretical framework that honors not only *effective* signs of understanding, but also *self-reflective* understandings.

Limitations and Research Possibilities

As this investigation of thinking maps progressed it became clear that together these tools could be presented as a language for learning. The decision to focus on the basics of this "language" for multiple modes of understanding also became a limiting factor to the scope of this study. Interesting areas of research that might have connected to thinking maps such as cognitive development, schema theory, cognitive styles, learning styles, cultural differences, and second language acquisition were pushed aside. Also discarded were intended topics such as the linkage of the thinking maps to different educational philosophies and teaching styles. These are fertile areas for grounded research in classrooms.

With this definition of a new visual language also comes possible limitations, constraints, and concerns that have not been fully thought through, yet need highlighting here to remain for further research.

Though much has been stated above about the importance of a *language* of graphic organizers, a fundamental concern and limitation is present: when introducing this language into schools there is the possibility that the framework may be used in rigid and formulaic ways, and that this language could then become oppressive through constraining students' thinking to use only these eight graphics in highly rule-governed ways. A fair warning once stated about teaching is offered here concerning the role of teachers using thinking maps:

> No good teacher ever wants to control the contour of another's mind. That would not be teaching, it would be a form of terrorism. But no good teacher wants the contour of another's mind to be blurred. Somehow the line between encouraging a design and imposing a specific stamp must be found and clarified . . .
> all so that the student may turn himself not into you but into himself. (Giamatti, 1980, p. 32)

The thinking maps language has been investigated here as an attempt to represent a line between encouraging a design and creating a rigid, formulaic stamp. The limitation of this language is found if, over time, other graphic representations are not used in coordination with thinking maps and in unison with strategies for teaching *for*, *of*, and *about* thinking. Mapping for brainstorming purposes is particularly important for the creation of powerful, new, highly idiosyncratic designs by students and teachers. Additional research is needed in this area: How do the different types of graphic organizers facilitate thinking in classrooms? How do these different graphics support and/or possibly confuse students? How do thinking maps overlap with these other forms? Is it effective to have students begin their education with a common visual language -- such as thinking maps --or should students have exposure to many types of graphic organizers and later be introduced to graphic languages?

Other limitations that also link up to interesting research questions are found in the fields of cognitive development, learning modalities, and cognitive styles. First, no research has been conducted on the possible influence of thinking maps (or graphic organizers) on cognitive development. There has been no work to support the interesting notion that these tools could facilitate and enhance early childhood development. Of course, a problem with this idea is that thinking maps may be more useful for older students who can easily draw the maps and understand what the maps represent. Presently, kindergarten and some pre-school children are making pictorial drawings in the place of words in pre-formed maps so that they become aware of the primitive forms and later will be able to create the maps, with words, on their own. Thus, unlike spoken language that is developed from early age, thinking maps seem to be limited to older children.

Another obvious limitation is that the maps may be weighted in usefulness toward strong visual learners and teachers. Some children who are strong auditory or kinesthetic learners may find the maps distracting and not very useful. Though this is an area of concern, blind students in Mission, Texas are now using braille thinking maps to help them structure and expand their thinking abilities, and there has been interest shown by teachers of deaf students in using the maps with this population. These areas of practical application and research may overlap with research into the interrelationships between thinking maps, cognitive styles, and learning styles.

An area of concern that has been raised in several sections in this study are the possible limitations for using thinking maps as assessment tools. Thinking maps are midrange tools representative of students' thinking to a *uncertain* degree. At this time, it is difficult to ascertain the degree to which the maps represent how and what students are thinking and understanding. The MAPPER rubric as presented in Chapter 4 is a first generation framework for studying this issue. This area of research is essential because as applications of the thinking maps become more sophisticated this language may come to provide an alternative set of diagnostic tools for *seeing* how children connect ideas and develop concepts.

Finally, the issue about assessment through thinking maps is linked to a broader concern and another area of research: the use of thinking maps as tools for connective thinking and dialogue in classrooms. Understandably and regretably, there may be a tendency by some educators who are guided by the objectivist view of knowledge to see thinking maps as effective tools for narrating information to students in pre-structured maps and requiring that students then memorize and regurgitate the maps as presented. Thinking maps could become static placeholders for teaching, learning, and assessment in some classrooms.

As expressed throughout this document, thinking maps are based on connective thinking for multiple modes of understanding. This perspective leads to another set of questions: How do thinking maps facilitate communication and cooperative learning in classrooms for interpersonal understandings? Do students more often seek out multiple perspectives when using thinking maps? Are students more reflective and self-assessing of their learning and thinking as they become fluent with these tools? Are students able to articulate how these tools have supported their learning as they begin to *see* the "form" of their ideas?

Thinking as Form

The work by the researchers presented in Chapter 2 directs us to connective ways of knowing that exist without public display, and rarely with prestige in classrooms. This partially developed alternative paradigm for knowing called 'connective' is appealing because it seems to break through the objective and subjective spheres while sharing certain qualities of both.

Another basic dichotomy-- this one at the heart of educational debate --has been the argument over the relative weight we should give to "content" and "process." This dichotomy has slowed the forty-year cognitive revolution, implementation of thinking process education, the translation of new cognitive science research into practice in schools, and the acceptance of new ways of viewing knowledge. This is because the greatest effort in schools has been place on transmitting objective "content" to students.

The introduction of visual tools into the field of education during the past fifteen years may provide educators with one way to bridge this dichotomy. We may be able to systematically talk about and *see* a third dimension to learning: form. The near exclusive use of linear representations for communicating ideas limits our attention to *linear* representations of otherwise complex, interconnected, *holistic* ideas and ideals. By offering a new language for revisioning and transferring thinking processes, the thinking maps provide an alternative representation system-- a language of form --for bridging and connecting contents and processes.

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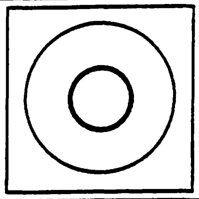
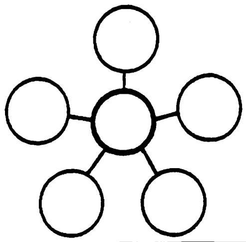
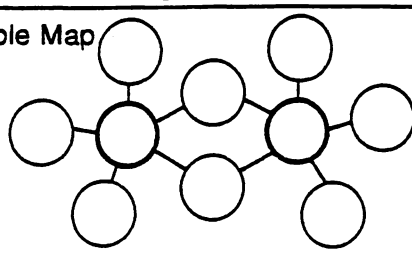
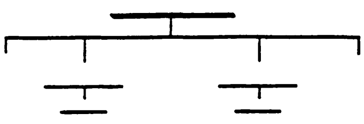
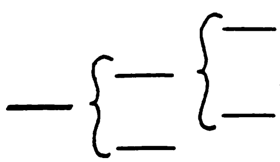
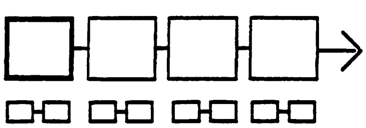
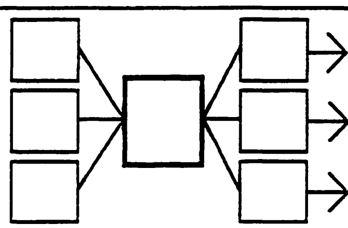
Appendix

Teachers' Questions
Students' Thinking

Thinking Maps
Mapping Metacognitive Questions

Teachers' Questions	Students' Thinking
How are you defining this thing? What is the context? How do you know this?	**DEFINING IN CONTEXT** Frames of Reference
How are you describing this thing? Which adjectives would best describe this thing?	**DESCRIBING QUALITIES** Using Adjectives
What are the similar and different qualities of these things? Which qualities do you value most? Why?	**COMPARING-CONTRASTING** Identifying and Prioritizing Important Qualities.
What are the main ideas, supporting ideas, and details in this information?	**CLASSIFYING** Main Ideas, Supporting Ideas, and Details
What are the component parts and subparts of this whole physical object?	**STRUCTURING** Part-Whole Physical Relationships
What happened? What is the sequence of events?	**SEQUENCING** Events, Stages, and Substages
What are the causes and effects of this event? What might happen next?	**CAUSE-EFFECT** Predicting Outcomes
What is the analogy being used? What is the guiding metaphor?	**SEEING ANALOGIES** Analogies, Simile, Metaphor

Thinking Map	Mapping Metacognitive Questions
Circle Map 	**Center Circle:** How am I naming this thing? How is this affecting the definition I am giving to it? **Outside Circle:** What is the context information that supports the definition for this thing? **Frame:** What is my frame of reference? What is influencing my point of view on this subject?
Bubble Map 	**Center Circle:** How am I naming this thing? **Outside Bubbles:** What *adjectives* am I using to describe this thing? Are the adjectives more factual (sensory), or based on an opinion guided by reasoning (logical), or based on personal judgment (emotional/aesthetic)?
Double Bubble Map 	**Two Center Circles:** How am I naming the two things that I am comparing? **Middle Bubbles:** What are the most important common qualities of these things? Why? **Outside Bubbles:** What are the most important unique qualities for each of these things? Why?
Tree Map 	**Top Line:** How did I identify this main idea or general category name? How is this influencing my ideas? **Middle and Lower Lines:** Where did I get these supporting ideas and details?
Brace Map 	**Far Left Line:** Is this the only name for this *physical* object? Is this part of another, larger object? **Middle Lines and Far Right Lines:** How did I decide which were the major and minor parts?
Flow Map 	**Large Boxes:** How did I decide what were the major stages of this story or event? **Small Boxes:** Could any of these substages of each major stage be understood as a major stage?
Multi-Flow Map 	**Center Box:** What do I think was *the* most significant event in this story or sequence of events? **Far Left Boxes:** What were the immediate and distant, historical causes of this major event? **Far Right Boxes:** What were the short and long term effects and my predictions about the future?
Bridge Map 	**Bridge ("as"):** What is the common relationship between the related pairs of things on the left side and the right side of the bridge?