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CHAPTER 2
BEYOND THE WALL OF TEXT: THINKING MAPS® AS A UNIVERSAL VISUAL LANGUAGE FOR TRANSFORMING HOW WE SEE KNOWLEDGE, THINKING AND LEARNING

> Learners construct knowledge as they build cognitive maps for organizing and interpreting new information. Effective teachers help students make such maps by drawing connections among different concepts and between new ideas and learners' prior experience
>
> Linda Darling-Hammon, *The Right to Learn* (1997, p. 74)
>
> Neuroscientists tell us that the brain organizes information in networks and maps. What better way to teach students to think and organize and express their ideas than to use the very same method that the brain uses.
>
> Pat Wolfe, Foreword, *Student Successes with Thinking Maps* (2004, p. xi)

A BREAKTHROUGH IN EDUCATION?

Have you noticed that over the decades there have been no major breakthroughs in the practice of teaching and learning? Almost daily now, we hear of breakthroughs such as hybrid cars, medical cures for a range of diseases, new farming techniques, micro-credit banking for growing economies in developing countries, nanotechnology implants, search engines such as Google and sites that facilitate social networking such as *myspace*, *facebook* and *youtube*. There are also discoveries of the multiple dimensions beyond three in the "outer space" of the stars and of the complex circuitry of the "inner space" of our brains. So why are there few if any breakthroughs in education? I believe that this is because so few educators, researchers, and foundations funding innovation are focused on communication between teachers and learners, and how information and knowledge is *represented* by teachers and students in order to transform learning. As investigated in this writing, the lack of innovation is directly related to the paradigm of linearity: knowledge is transmitted through linear strings of words and numbers, in spoken or written forms. As offered below through the Thinking Maps language, one pathway to a significant breakthrough in teaching and learning may come when

J.E. Pedersen and K.D. Finson (eds.), Visual Data, 31–49.

educators deeply consider the insights offered by Linda Darling Hammond and Pat Wolfe: the brain maps and networks information and that effective teachers need to explicitly support students' minds as they create cognitive maps in order to learn.

Unfortunately, the great "breakthrough" expectation of the past generation since the advent of the World Wide Web and personal computers has been the hope of "networking" technology, somehow elevating students' thinking and learning into a qualitatively new realm. Yet, computers in classrooms, like the promise of other teaching machines of the past, have brought a quantitative overload of processed content and unlimited unprocessed content, but no significant, direct improvements in students' abilities to process and evaluate information or how to think through the complexity of problems that come with living in the 21st century. As a matter of fact, most educators would probably agree with this oddly contradictory notion: many of our multi-tasking children cannot stay focused and independently think through multi-step problems, and thus easily become bored by school unless they are "entertained."

Alas, education, like philosophy, may not be amenable to breaking news on the cable channels, unless it is the *failure* of educators to transform teaching and learning in this new century. The solutions offered to the problem of "failed" schools deal with everything but close scrutiny to the core dynamics of teaching-learning that remain mired in a strange integration of disproved "old school" behaviorist models and idiosyncratic "new school" progressive teaching techniques. Many educators, concerned political and business leaders, educational entrepreneurs, and even parents in search of solutions have all but given up on a belief that there could be a breakthrough in how we understand the teaching-learning processes and thus have given up the search for tools for transforming how we teach and learn. Instead, many folks turn to a range of financially draining and unproven "solutions" that have very little to do with the fundamental relationships of *how* learners learn and teachers teach. These solutions include "smaller schools," content knowledge teaching and assessments via computers, isolated educational "heroes" who miraculously transform their own classroom or school, charter or private voucher systems, privately run schools, or worse, the growing business of after school test taking programs that show but a momentary blip in test scores. Some in the business world believe the answer lies in making schools work as businesses, led in part by "data-driven" decision making. Instructionally, in the rush to raise test scores, many schools also turn to one-shot workshops on how to implement "best practices" responding to specific testable items. Over the past few years we see that federal accountability measures offering negative reinforcements back educational teachers and administrators into a blind alley of test item analysis. This is a sad state of affairs.

It must be said that from the perspective of the short stretch of "modern" history, we are just now getting started in answering this question. We may be in a methodical climb toward a cumulative understanding of the processes of learning that may slowly break through existing barriers. In the United States, we only began offering "adequate" education to more than the elite in our society just a few generations ago. Those who could learn and/or those who were privileged enough to be given a formal education were the chosen few. Only in the last few generations have we even attempted to fully educate *all* girls, children of color, those in poverty, and those with diverse and/or debilitating emotional and cognitive needs. But there is only halting progress and much backsliding as we try to "close the gap" between the financial haves and have-nots. Of course, some still don't have even an "adequate" learning environment. Jonathan Kozol well documents that the financial-resource inequities bound up in our class-based society, often divided by race and racism, still exists as schools are presently re-segregating. Given the needs of those at the bottom of the equity-resource ladder, and those immigrants needing to learn more than basic literacy, I believe we need to move with urgency *and* insight.

Certainly there have been many significant changes in the modern era of education in the United States: cooperative learning, process writing, social-emotional learning, a shift away from a singular Intelligence Quotient to Howard Gardner's theory of "multiple intelligences." Most recently there is great interest in the neurosciences and translations of brain research into practice. Certainly new brain research may offer a scientific basis for rethinking teaching and learning. But I ask: why haven't there been any breakthroughs in *directly* improving learning by all students? Maybe this is because, as Neil Postman once defined it, education is basically a *conserving* activity, keeping roughly thirty years behind what researchers have proven would make a difference in classrooms. But this is no longer acceptable in an accelerating, "flat world" global community, as described by Thomas Friedman, wherein we have moved away from the need for the conveyor belt *manufacturing mind* to the thinking, problem-solving, information-knowledge creation, *networking mind*.

Are there no breakthroughs to be had? Yes. But there are significant barriers in *how we think* and represent information and knowledge that prevent us from seeing how to transform teaching and learning. What could be the barrier to a breakthrough in learning?

THE LINEAR "WALL OF TEXT" AS THE BARRIER

Let's consider that there is a barrier that is limiting our perceptions of how knowledge looks – or more precisely, in our way of *representing* knowledge and thinking – that is preventing a breakthrough in transforming how we actually see learning. Ironically, this barrier is deeply and invisibly grounded in what also has been the greatest strength of our "advanced," literate, technological society: literacy has been defined almost exclusively by what I call the linear *Wall of Text*. I first woke up to this dilemma in the mid 1980s when reading this passage by Novak and Gowin:

> Written and 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 and Gowin; 1984, p. 15)

The *Wall of Text* is the strictly linear representation of information and knowledge as found in textbooks – and from teachers' presentation in verbal and written form – of information and concepts. Teachers' *representations* of knowledge as linear and thus students' efforts at the generation of spoken and written lines of texts are radically limiting teaching, learning, assessment and most damaging of all, thinking. This barrier frames each of us like blinders on racehorses galloping forward to the finish line. Our wider view beyond the blinders and our peripheral vision, is limited by this: The linear Wall of Text as the honored and nearly exclusive way of representing our thinking in the learning process unnecessarily defines our fundamental, holistic, differentiated patterns of thinking and the nonlinear concepts we are learning into the singular, highly routinized sequential forms of communication we call speaking and writing and numerating.

This is a challenge that may make most of us who are educators and academics, who have lived by the text, quite uneasy. It is downright *heretical* to those who believe that *text* as we know it is the apex, the penultimate representation system of the human mind. Text – the page and the spoken word – have been traditionally understood as *sacred.*

Let me make this easier to swallow. What is suggested here is *not* to throw out the Wall of Text, but to seek to find ways to represent the nonlinear thinking that is richly embedded and hidden between the lines of text, to see visual representations as dynamically living side by side text, conceptual patterns buried within text, and to offer rigorous tools for surfacing these nonlinear ideas on a moment to moment basis in classrooms. There are many who have made this point that we must move beyond our extreme focus on linear thinking in education and business, including those who have given us tools and visions for new ways of seeing the world, such as Peter Senge, Tony Buzan, Margaret Wheatley, Frijof Capra and David Bohm. Edward Tufte, whose extensive writings on visual representations, has even fully analyzed the use of PowerPoint and reveals the inherent mind numbing bulleted linearity upon which this "presentation" software rests as it is used in classrooms to boardrooms some 15,000 times every day (Tufte, 2006). The problem clearly stated by these leaders and now brain researchers is that we as human beings *do not think in text*: our brains and mind think in nonlinear networks of information. Our brain-body system also, by most guestimates offered by neuroscientists, receives 75–90% of its information visually through our eyes. The brain "maps" information, *not* text blocks. This information calls out for visual mapping of information that is congruent with thinking processes. It is now clear that in the information overload, high-technology, knowledge-creation landscape of the 21st century, educators and business leaders must support our students in moving *from* seeing knowledge as bound by static text *to* seeing knowledge as also dynamic and richly patterned points of visual information in map form.

The difficulty, at least in the daily life of classrooms and the institutions of schooling and the workplace, has been in bringing forth a practical, theory rich, elegant model for what nonlinear thinking would *look like* for teachers, students and administrators from pre-kindergarten to college and into the workplace. Thinking

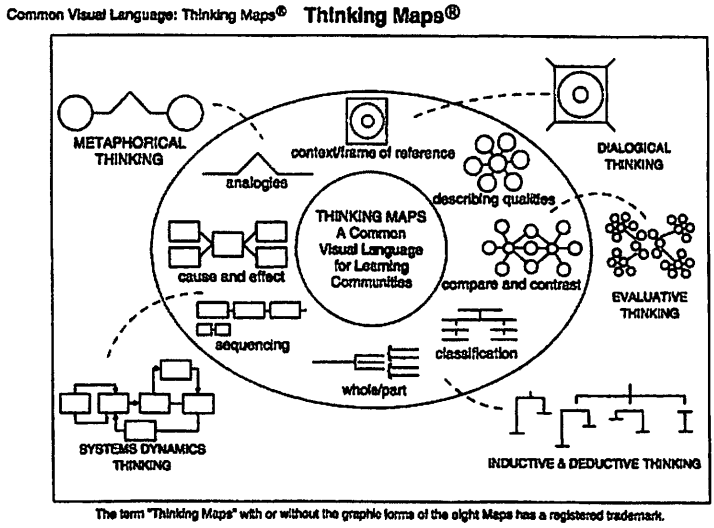

Figure 1. Thinking Maps Language.

Maps, a visual language for learning, is one pathway for opening the mindset to a new way of seeing. For as David Bohm has written:

> If we could learn to see thought actually producing presentations from representations, we would no longer be fooled by it. (Bohm, 1983, p. 69)

A HISTORY OF THINKING MAPS AS A LANGUAGE OF VISUAL TOOLS

Below we will look at examples of such a proven model in schools, a common language of visual-spatial-verbal tools called *Thinking Maps*, as a representation system supporting high quality thinking, communication in the classroom, interpretation of text and, importantly, the dynamic relationship between and among teachers and learners. Thinking Maps is a practical and theory-embedded language of eight *interdependent*, dynamic graphics based on, respectively, eight fundamental cognitive processes.

When I first conceived of this language in 1986, I knew it was emerging from a wide array work in the field by others and supported by many researchers and practitioners who had laid the groundwork for this kind of language. I believed then that it was a critical starting point and leverage point for learners and teachers alike in creating a bridge between the complex patterning of our unconscious brain structures to the conscious processes of our minds making sense of the world around us. This has proven to be the case over the past fifteen years as these tools have been implemented successfully in 5,000 schools where the whole faculty has gone through in depth professional development (Hyerle, 2004).

From what context and frame of reference did this language of Thinking Maps emerge? As a novice teacher, I was caught up in an educational movement – the "thinking skills" movement – that rose in the mid-seventies to the late eighties and then was incorporated into many progressive teaching practices since that time in the United States, and to a lesser degree internationally. That was a time when "higher order" thinking as described by Benjamin Bloom's Taxonomy of Educational Objectives (Bloom, 1956) was beginning to deeply influence education. Higher-order questioning and the explicit facilitation of thinking was *the rage*. This sounds odd, of course, since wouldn't one consider "thinking" and the facilitation of thinking to be foundational to the learning-teaching processes of the late twentieth century as our society moved into the information age? I believe that this movement towards a "thinking process" approach to teaching, learning, and assessment was the first sustained, theoretically deep challenge to the dominant view of learning based on the principles of behaviorism and the strict western, logical deductive mindset. The movement toward the explicit "teaching for, of, and about thinking" was well articulated and practiced by many educational leaders and classroom teachers at the time. Art Costa, a leader among many in the field, guided many of us at that time and into the present to see that the direct coaching of thinking skills and Habits of Mind was essential to bringing about a new paradigm of learning, teaching, and leadership. (For the cumulative knowledge and comprehensive documentation of the thinking skills movement, see Developing Minds, edited by Art Costa (ASCD: 1985, 1991, 2000).)

By 1986, after leaving the classroom and working for several years leading professional development in schools based on a range of thinking skills approaches, I was asked to write a workbook for middle school students that would enable them to explicitly learn fundamental thinking skills and to transfer them across all disciplines. I was then using a model of six thinking skills initially developed by Dr. Albert Upton, of Whittier College in California. A graduate student of Upton's, Richard Samson, had modified this fundamental model reflecting the interplay of thought and language, Dr. Richard Samson. The theoretical foundation and the core thinking processes identified were central to my development of Thinking Maps (Upton, 1960; Upton and Samson, 1961). Their work described in detail how these fundamental processes of thinking were not merely "lower order" cognitive processes, but when used interdependently and at different levels of complexity through language, they became the essence of and pathway to higher orders of thinking.

Though not central to his work, Upton did include several traditional "diagrams" that he used to link thought and language: tree diagrams for hierarchical classification, flow charts for sequencing, and brace maps for showing physical parts of whole objects. This is where the model of Thinking Maps crystallized for me and I had a glimmer of a language for learning based on the explicit mapping of cognitive patterns unique and universal to human experience. I asked myself, "What would it look like to link each fundamental cognitive process to a dynamic visual tool?" I could see that a relatively few visual representations could be used broadly as unifying representations of thinking with written forms ... as a visual language that was *congruent* with thinking patterns that virtually *embodied* cognitive processes. I surmised, that if thinking occurred in patterns, and these patterns ranged from hierarchies to causal loops to comparatives, don't we need tools that explicitly represent different types of thinking? Text alone would not do.

I also sensed that individuals within a community of learners could co-construct and collectively show their evolving thinking processes from a blank page – not only in spoken or written text – but also as interdependent *visual patterns*. As David Bohm has written, "many worlds are possible – it all depends on representation, especially the collective representation. To make a 'world' takes more than one person, and therefore the collective representation is the key ..." (Bohm, 1983, p. 69). I thought, we don't need a few disconnected graphics, we need a language of interdependent visual tools that would work together as a language for personal, interpersonal, and collective thinking across cultures. I soon realized that it was crucial to have each unique graphic primitive look and expand in a way that was most congruent with the respective definitions of each fundamental thinking process. The visuals had to be dynamic thus mimicking the neural networking actions of the brain and mind, and that they needed be used together as we unconsciously unite our isolated thinking processes into holistic forms. In *Expand Your Thinking* (Hyerle, 1989) I brought forward, tentatively, a universal visual language for thinking of cognitive maps that could be used together for improving thinking, learning, and communication.

The first full expression of the work was published in a training guide for teachers, *Designs for Thinking Connectively* (Hyerle, 1989). Thinking Maps was therein described as a common visual language of eight interrelated cognitive skills, each with a clear definition and terminology, and most importantly, each with a graphic primitive that was congruent with the process for ease of use, expansion, and communication. The *graphic primitive* for each map is the basic form from which each map may grow in an organic way, from simple to complex, while sustaining the integrity of the graphic, much like iterative patterns of leaves growing on a tree from year to year. For example, the graphic primitive for a Flow Map consists of a rectangle and an arrow. From this starting point for mapping a sequence, the Flow Map may expand in any direction – with smaller substage boxes – with an infinite number of boxes and configurations of relationships. Parallel flows, feedback loops, and even Flow Maps within more expansive sequences may be represented. This language of eight graphic primitives offered teachers and students across schools and schools systems a language for working and thinking collaboratively in linear and nonlinear ways, with simple to complex problems. Students would become independent thinkers who could adapt the maps to their own unique, developing cognitive abilities, thus enabling them to transfer their thinking across disciplines and to the fundamentals of reading comprehension, writing processing, and mathematical problem solving. Having a visual representation of thinking, teachers would also have an additional way to access and *assess* not just *what* students were thinking, but *how* they were thinking.

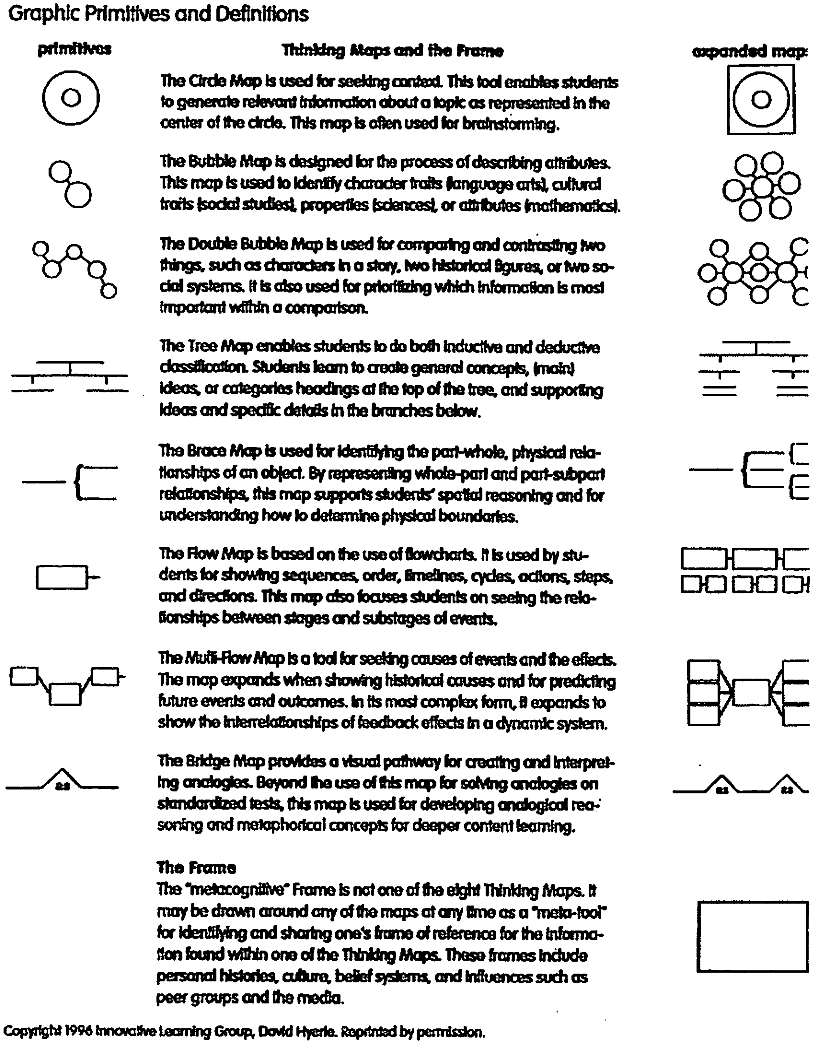

Figure 2. Thinking Maps® graphic primitives and definitions.

THINKING MAPS AS A SYNTHESIS OF VISUAL TOOLS

I was certainly aware during the development of the Thinking Maps language that it was emerging from a range of cognitive science research, but also from the vast array of visual tools used over the previous decades. Upon first look, many times educators and researchers have misconstrued the Thinking Maps language as merely a simplistic variant of Tony Buzan's Mindmapping®, or a set of isolated "graphic organizers" for duplication, or just as an interesting array of semantic maps. This is understandable since the field of visual tools had not been well defined. My own wide experimentation with visual tools and soft-

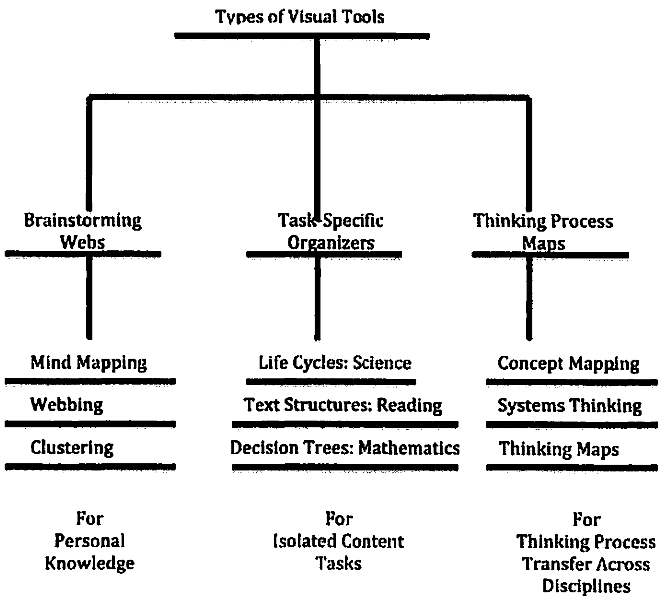

Figure 3. Types of visual tools.

ware programs has been exciting and at times overwhelming as I have worked with many different kinds of tools based on different theoretical frames, such as: Mindmapping®, graphic organizers, flow charting and hierarchical trees, causal loop systems thinking, concept mapping, inductive towers, Total Quality tools, and even traditional forms such Euler Circles and Venn diagrams.

I embraced these different forms, but also wanted to make sense of the variety and purposes of each. In my literature review for my dissertation (Hyerle, 1993) I offered background on the range of visual representations and focused on the purposeful use of each. A comprehensive revision of this book with up to date research and practical guidance in how to implement and use visual tools is available in *Visual Tools for Transforming Information into Knowledge* (Hyerle, 2009, in press). I informally grouped these different types of tools under the conceptual banner "visual tools" and identified three basic categories (see Figure 3).

My dissertation was later published in a refined form by the "Association for Supervision and Curriculum Development" and distributed to the 115,000 members as *Visual Tools for Constructing Knowledge* (Hyerle, 1996). In this book, I offered a detailed introduction and analysis of these different visual tools, noting the strengths and limitations of each in education and how each visually represented information and different theories about the structure of knowledge: *brainstorming webs*, *task-specific organizers*, and *thinking process maps*.

Brainstorming webs represent creative, generative, associative construction of knowledge. These tools are highly dynamic, holistic, often begun from the center of a blank page, idiosyncratic, and used for generative thinking. Tony Buzan's development of Mindmapping® technique (Buzan, 2003) was central to informing the development of different visual brainstorming tools.

Task-specific organizers (often called "graphic organizers") often reflect a more analytic, deductive view of the construction of knowledge. These tools are relatively static graphics used for isolated content or process learning tasks. They often show up as blackline masters in published programs which students are asked to fill in. Graphic organizers support a formal scaffolding of content learning and sometimes thinking processes.

Thinking process maps are based on the direct facilitation of conceptual learning and common patterns of thinking. These tools are often theoretically rich, grounded in fundamental conceptual-cognitive processes and often lead to visual languages such as concept mapping developed by Novak and Gowin based on hierarchical knowledge and "systems thinking" diagrams based on a "causal feedback" view of knowledge.

The most influential research and practice in the field came from the works of Tony Buzan (Mindmapping), Novak and Gowin (concept mapping), and Peter Senge and the late Barry Richmond (causal loop systems thinking and STELLA Software). This is because even though each of these approaches defines "thinking" differently, each one of these methods is theoretically strong, perceives the learner as in charge of the construction of the visual map, and attempts to scaffold conceptual learning rather than prescribed structures of "given" information. Each of these approaches is rigorous in that each animates a visual language based on graphic primitives that are easy to use but that then evolve toward complexity as learners become more fluent with the tools. The learning community such as a school or business then honors the deeper facilitation of individual and collective thinking over time. It is now clear that there are several principles of Thinking Maps as a language that derive from these leaders in the field.

BREAKTHROUGHS IN SCHOOLS

Since 1990, a small group of educators came together with me to focus on implementing Thinking Maps across whole schools and school systems. The model of implementation focused on training all teachers and administrators in the use of this language for improving student learning, teacher performance, and tangentially, for collaborative leadership. The work has been fully documented in a wide-ranging book with chapters by sixteen different authors, *Student Successes with Thinking Maps: School Based Research, Results, and Models for Achievement Using Visual Tools* (Hyerle, 2004). The results show the success of students across every discipline and at the elementary, middle, high school and college levels. The Thinking Maps have been used across schools in England and in the United States, including in large city districts such as New York City, which serves students representing close to 150 different languages and dialects. The work has also had extensive piloting in Singapore (with Chinese, Malayan, and Indian cultures mixing with a traditional English pedagogy) and with smaller pilots in Japan, Mexico, and New Zealand. Teachers across these various learning communities have expressed that there was nothing counterintuitive about the use of the maps across these cultures and languages, as the cognitive skills are not grounded solely in language or a particular culture, but in the processes we as humans use every day around the world for communicating, solving problems and survival.

There are endless examples and documented results of Thinking Maps – from kindergarten to college to school leadership, from literacy development to mathematical and scientific problem-solving – that can be found in the resource materials used for training teachers: *Thinking Maps: A Language for Learning* (Hyerle & Yeager, 2007), and in the research offered at the nonprofit foundation, *Thinking Foundation* (www.thinkingfoundation.org). Beyond direct impact on reading comprehension and writing process, two areas that are beginning to show great promise and significant results are in the fields of special education and second language acquisition. It is clear from the qualitative and quantitative results that the Thinking Maps, because they are based in fundamental cognitive patterns and are visually accessible by all students, provide scaffolding for students with language disabilities as well as a bridge between primary and secondary languages.

PRINCIPLES GROUNDING THINKING MAPS AS LANGUAGE

Every language across the disciplines – such as English, numerical systems, musical notation, and integrated languages such as the table of the elements in science, have a few common elements: consistent graphic primitives that are flexibly used in order to develop simple to complex ideas and communication in a certain "language" community. Thinking Maps is a meta-language for thinking that works across each of these languages and enables teachers and learners to communicate patterns of thinking.

There are at least five principles of Thinking Maps that have surfaced as we work in schools that reveal the transformational use of these tools:

1. there are a relatively few, universal cognitive structures;
2. visual patterns need to be congruent with these cognitive structures;
3. graphic primitives enable definition and expansion of each map;
4. the visual representation supports the integration of content and process through form;
5. the knowledge mapped out is always influenced by the map maker's frame of reference.

These are abstract principles that are discussed below, so using two examples from the field will support bringing these concepts down to earth. The first example has been previously published in *Student Successes with Thinking Maps* (Hyerle, 2004) and shows how students in a first grade class initially responded to their teacher who was asking them comprehension questions about a story they had read, "How Leo Learned to be King." A full analysis of this class-

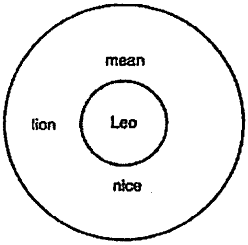

Figure 4.1a Leo Circle Map

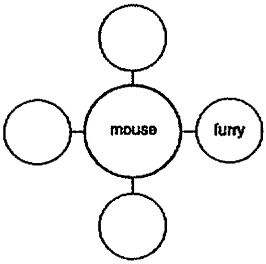

Figure 4.1b Mouse Bubble Map

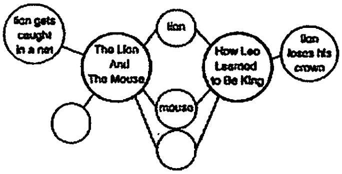

Figure 4.1c Comparing Two Books Using the Double Bubble Map

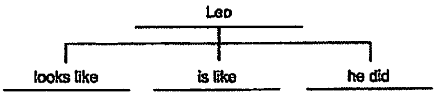

Figure 4.1d Leo Character Analysis Tree Map

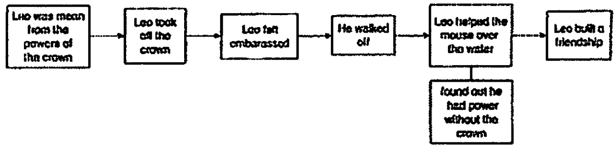

Figure 4.1e Leo Character Development Flow Map

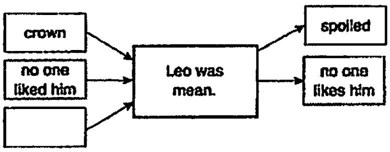

Figure 4.1f Cause of Leo's Being Mean Multi-Flow Map

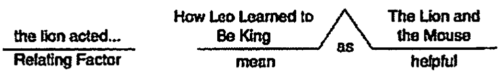

Figure 4.1g Bridging Qualities of Characters Across Text

Figure 4. Thinking Maps® for reading comprehension.

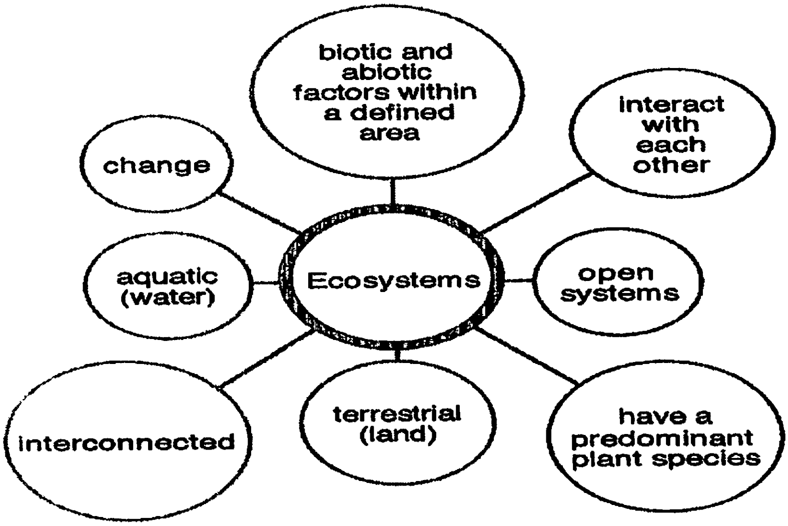

Figure 5a.

room activity and the video clips of the classroom interactions may be viewed at www.thinkingfoundation.org.

As you scan the different maps in Figure 4, please note that they were written on the white board by the teacher and transposed here for clarity. Here is the context: After the students read the book about how a lion turned mean as he gained power as the King, the class talked about the text, and the teacher, Ms. Crystal Smith, asked her students this question: "How would you organize your thinking about this book?" Seven of the eight maps were generated by the students to show how they were thinking and organizing their ideas: context information about Leo (4.a); describing the mouse (4.b); comparing the book to another book (4.c); categorizing character analysis information from the text (4.d); a sequential flow of how Leo developed as the story progressed (4.e); what caused Leo to become so mean as a king (4.f); and bridging by analogy from one story to a common quality of two characters (4.g). After the teacher asked for just a few bits of information in map form from the students, she asked that they each go back to their desks and choose which map or maps helped them the most in understanding the story, and to create a map independently and begin writing from their map about the story.

A second sample of student work is an array of Thinking Maps generated using Thinking Maps Software by an eleventh student at Niles North High School, a suburban school outside of Chicago. Jacki Naughton, a biology teacher at the school, taught all of her students how to use Thinking Maps for scientific problem solving, but also for note taking. The students learned how to work through the Wall of Text by mapping out key concepts as they studied a typical high school

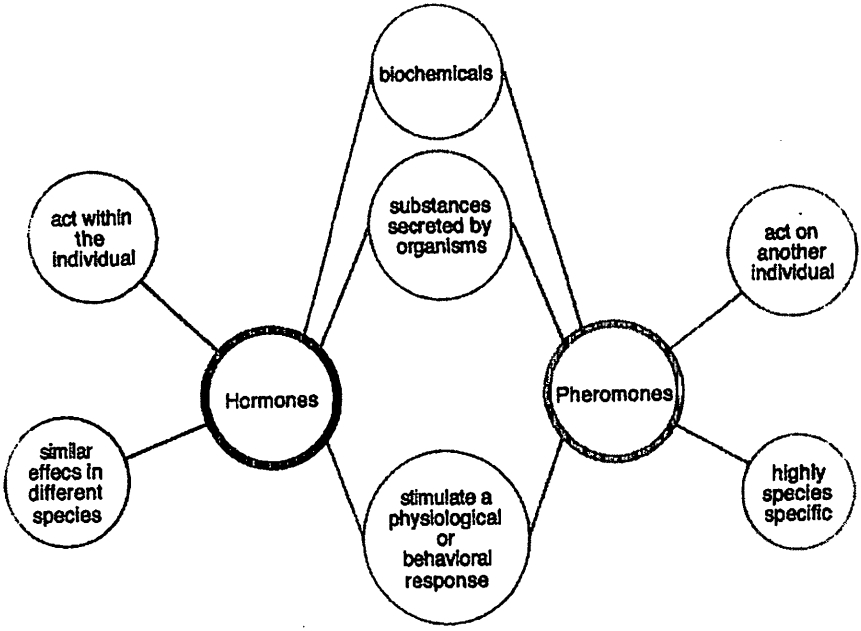

Figure 5b.

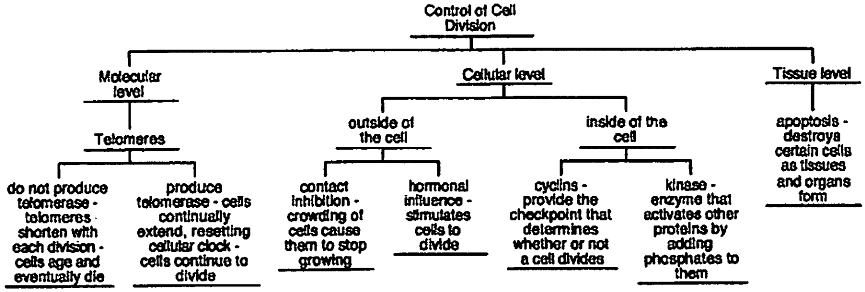

Figure 5c.

textbook. The maps shown here in Figures 5a–d are just five of over 40 Thinking Maps created during the term by this student using Thinking Maps Software as she read the text: properties of an ecosystem (5.a); comparison of hormones and pheromones (5.b); categories of control of cell division (5.c); the causes and effects of telomere response (5.d). This student had become so fluent with all of the Thinking Maps that she could face a complex text and seek the essential conceptual patterns of content knowledge being delivered by the textbook author.

Given these two examples – one by a group of novice map users from first grade reading a fictional story and one by an expert, individual student from the eleventh grade – what can we understand in the way of the five principles noted above that reveal Thinking Maps as a language for learning?

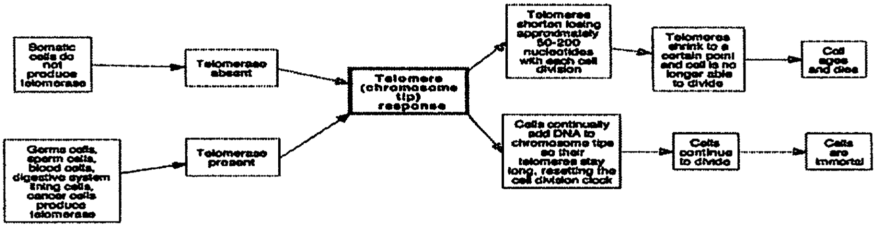

Figure 5d.

Principle 1: There are universal cognitive processes. Though controversial, I have come to believe over the past twenty years of practice and research in different parts of the world, that there exist uniquely human, universal cognitive processes[1] that are a primary foundation for learning and language development. As in the examples, the map links thinking and language use at the deepest level. Every human categorizes information, but will categorize information *differently* depending upon cultural frames of reference and language. In the two examples above we see that these cognitive patterns *transfer* across the study of literature and in the sciences, across age levels and across informal and formal category structures. The first graders could generative informal categories using a Tree Map for grouping ideas about a character, and the eleventh grade student uses the same map to formally define categories about the control of cell divisions. The cognitive skill of categorization – just as we have seen with the other seven processes – is unconsciously at work in the human mind. Importantly, as shown quite well in both examples, the cognitive skills are also used interdependently when we are interpreting and analyzing information and transforming linear text structures into knowledge.

Principle 2: Visual Patterns are Congruent with Thinking Processes. Visual maps representing processes are congruent across a range of these linear and holistic cognitive patterns. As shown in the two examples, with the exception of sequencing, the cognitive processes that animate the Thinking Maps are not grounded in linear, sequential thinking. As discussed above, written and spoken forms of language, though complex and elegant, communicate nonlinear forms of thinking in strictly linear terms. In unison with Thinking Maps, clarity of communication of thinking patterns and content knowledge is enhanced. For example, when an author is writing about categories in the animal kingdom, a hierarchical

[1] As a challenge to this belief in cognitive universals, I would suggest a reading of Richard Nisbett's "The Geography of Thought." He states that he once held the belief that there are common thinking processes across cultures, and then was convinced by research that this was not the case. Yet, I believe that this issue is more a matter of definition of "thinking" because Nisbett goes on to reveal, chapter after chapter, that every culture classifies information, makes comparisons, sequences, and understands causality – *but in different ways*. The Thinking Maps model is based on this assumption: every human being thinks using these universal processes and that these processes emerge and are represented in different ways within the context of specific cultures and languages. Because we all have common cognitive processes, any human being has the capacity to learn, to learn a second language and to adapt in a new culture. The Thinking Maps enables any learner from any culture to map their own patterns from universal cognitive primitives.

tree map more clearly represents the complexity of the category structure and thinking than paragraph after paragraph of formal prose attempting to describe category structures. In the examples shown, the students were easily able to show what they know about the comparisons, cause-effect reasoning, and descriptors and are drawn from across the linear content text. Thinking Maps offer an additional, more congruent representation of different forms and patterns of thinking than linear writing, also unveiling the hidden conceptual structures within written and spoken language. Thus, Thinking Maps create a rich dynamic between the written code and the cognitive code, thus enhancing a deeper comprehension of concepts in text.

Principle 3: Graphic Primitives for each Map. Thinking Maps begin with simple, unique graphic primitives and expand, overlap and embed one within the other, reflecting the complexity of depth and breadth in and among cognitive processes. As with any language, graphic primitives are essential for communication. For example, the letters in the alphabet or the numbers 0–9 are the basic, interdependent graphic primitives that engender infinite ways of communicating ideas and mathematical concepts. With the Thinking Maps language, there are eight graphic primitives that generate infinite iterations. When some or all of the maps are used together, the thinker may move to greater complexity. The eight parts of speech of the English language offer a rich but imperfect analogy to Thinking Maps: from the eight parts of speech, the writer or speaker may generate endless strings of sentences. So, too, may a thinker generate endless maps reflecting patterns of thinking. The two examples above, when observed side by side, show how the maps may be used at a novice level and then grow in complexity as the cognitive development of the learner evolves. The power of the novice to expert use has been revealed when we conduct leadership training with teams from school districts – including the superintendent and board members. They are using the Thinking Maps for complex problem solving and strategic planning at the same time that their first graders are using the very same tools in their classrooms.

Principle 4: Integrating Content and Process through Form. Knowledge in and across disciplines exists and grows over time through the interplay of content (what), process (how), and form (pattern). Educators have expended endless energy on the relative importance of teaching for "content" versus teaching for "process" learning. This dichotomy is false and there is a middle way that unites the two in a triad. When using Thinking Maps, learners are simultaneously constructing and *forming* patterns of *content* knowledge and skills using cognitive *processes*. As you look back at the examples, you may ask yourself, "Are these representations of content or process?" This is a trick question, because the answer is *both*. For example, when a first grader identifies multiple causes and effects of Leo the lion king being "mean", and the eleventh grade student patterns the causal relationships in a "telomere response" then they are showing the "form" of the "content" as well as applying the cognitive "process" of cause and effect reasoning.

Principle 5: Frames of Reference. Understanding and growth occur through the personal, interpersonal, cultural, and institutional frames of reference and the wider field which surround and influence perceptions. The field of frame semantics is relatively new, but it draws on the understanding that our background culture, language, and personal experiences deeply influence how and what we perceive (Lakoff and Johnson, 1980). A central tool of the Thinking Maps model is the "Frame of Reference." As a learner is mapping out a view of knowledge, he or she may also draw a rectangular shape around the outside of the map being constructed. Within this "metacognitive" Frame, the learner notes what is influencing his or her perception of the knowledge being constructed. For example, the first grade students might have been asked to think about what in their life reminds them of Leo the Lion, or the mouse that was dominated by the lion. The high school student, when describing an "ecosystem" using the Bubble Map, could have reflected on the ecosystems that she moves through and lives in, and how these descriptions fit her background and cultural frame of reference. The ecosystem of a suburb of Chicago frames one's understanding differently than living in the city center, or in a rural part of the United States or on the savanna in Africa. Each of the maps, uniquely created by hand or on computer by students, surfaces the learners' content knowledge as well as their point of view, thus supporting their cognitive understandings. When students use the Thinking Maps with fluency they also deepen their critical thinking by establishing a reflective, metacognitive stance in the world.

ENDNOTE

There is an unspoken barrier and cognitive dissonance between what is going on in the brain and how we ask our students, and ourselves, to represent our best thinking. As discussed above, most cognitive scientists and educators interested in facilitating thinking and learning processes have primarily focused on assessing spoken and written *representations* of thinking. These representations, like Potemkim villages of the mind, are linear facades of the actual *forms* of thinking; whereas, we know as human beings that our worlds of perception, emotion, and cognition are fundamentally *nonlinear in form*. We teach about concepts and systems and our brain naturally "maps" patterns, storing information in networks across our unique "hemispheres" and "territories" of the brain-mind-body connection. Information is distributed across the brain and linked, weblike, *in form*. The problem is that those studying thinking processes and teaching for so-called "higher-order thinking" have not had a *nonlinear representation* system, or a *language* for showing what and how they know something other than by linear strings of words and numbers. When teachers and administrators participate in a year long process of professional development with Thinking Maps, they are learning how to present contents and processes in a more authentic way than through the normal auditory-linear presentations found in most classrooms. Most importantly, the focus of this professional growth is on the direct teaching of all of their students, across their school, in becoming fluent with the tools for life long learning.

If knowledge continues to be defined by processes of short term information retention in linear strings of words, we are all in trouble in this age of information as decisions will be made in episodic ways, devoid of problems approached as richly patterned, complex and systemic. This is the state of education for students from an "advanced" culture in what Thomas Friedman calls the "flat world" which is now dominated by "knowledge creation" and communication across a range of cultural frames of reference.

As the ageless Albert Einstein famously said, the significant problems we face today cannot be solved at the same level of thinking we were at when we created them. I thought of this quote when, at the end of the movie, *An Inconvenient Truth*, about threats of global warming, Al Gore implored us to think differently about this problem that affects every person on the planet. He asked us not only to think differently about our own ecosystem (as an eleventh grade might do in a science class), but the earth as one ecosystem. I believe that he was suggesting that we not just change *what* we think about this issue that requires an understanding of complex, interdependent variables and systems. This offering was more about challenging us to consider *how* we think in the 21st century. It isn't that we need to think harder, or longer, or more analytically or creatively. We have to do more than think "outside" the box. We need to think in another world of representations in order to surface a different way of thinking about the Walls of Text that are held as books in the hands of learners, or in "hand-held" downloads from the other side of the world. We cannot simply ask our students, as digital natives, to think differently about patterns of relationships, systems, and interdependencies if we do not offer them practical tools for seeking and showing patterns of their own thinking.

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