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Visual Tools for Mapping Minds

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From Parts to the Whole System

Over the past 50 years there has been a radical transformation in our understanding of the scientific underpinnings of life: we have moved from measuring isolated parts of structures to showing patterns within dynamic systems. As this shift has slowly taken place we have not yet changed the fundamental way we present or represent these new understandings in classrooms.

We know that the content—the organized systems of information that we want students to understand (for example, the human body, social-economic-political systems, ecosystems, solar systems)—are all nonlinear in form. Yet we still represent, talk, and write about systems in linear ways, expecting that learners will be able to put all the bits together and see the big picture. Simply, our students cannot "get their minds around" these systems, given the traditional thinking tools we have provided. This mismatch—or cognitive dissonance—between the nonlinear forms of knowledge we attempt to teach and the linear form in which students receive this knowledge is, I believe, the most important barrier to meaningful teaching, learning, and assessment that exists today in classrooms.

As summarized in this chapter, visual tools such as webs, organizers, and thinking process maps are the most compatible and effective tools for moving every student from the basic organization of information, to basic skills instruction and content specific learning, to thinking in patterns and systems (see Figure 63.1). First, let's look at these new sciences and understandings that rely on seeing patterns of organization, or systems.

This chapter is adapted with permission from *A Field Guide to Using Visual Tools*, by D. Hyerle, 2000. Alexandria, VA: Association for Supervision and Curriculum Development.

The Web of Life

In *The Web of Life*, Fritjof Capra (1996) offers a unique integration of quantum physics, information theory, systems thinking, and theories linking the brain, mind, and cognition. Here is a summary view of Capra's definition of a living system:

> A living system has a pattern of organization that is physically structured and activated by a life process that embodies these patterns (1996, p. 79).

The key characteristic of this definition of a living system is the pattern of organization of an organism. Capra highlights the importance of how we represent and thus understand these patterns:

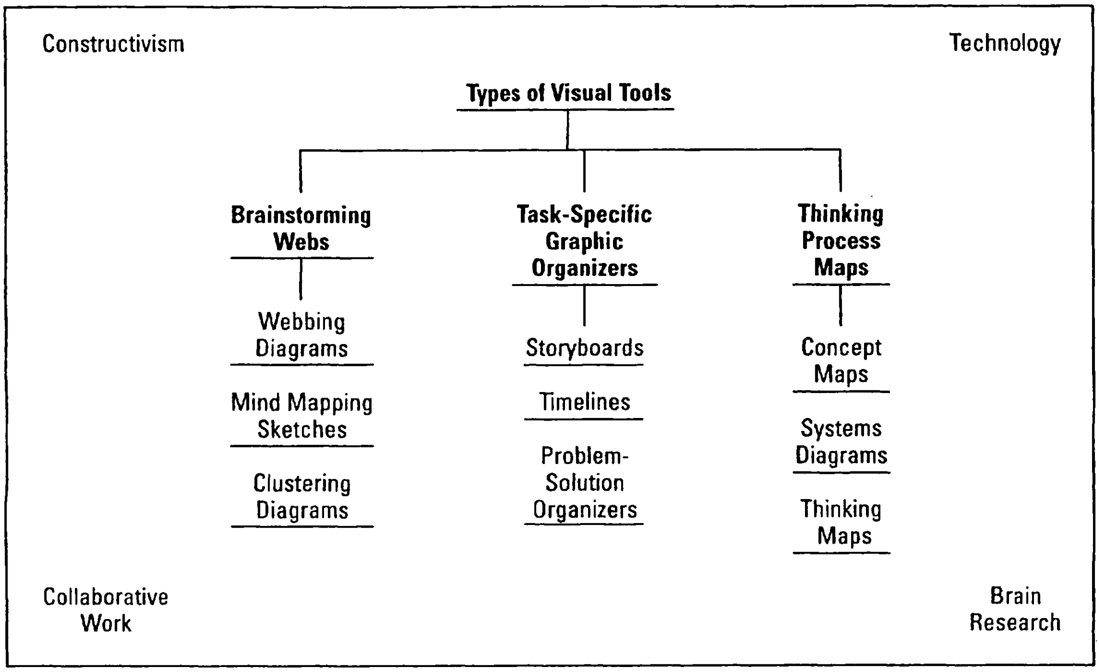
> In the study of structure we measure and weigh things. Patterns, however, cannot be measured or weighed; they must be mapped. To understand a pattern we must map a configuration of relationships (Capra, 1996, p. 81).

It is not only the attempted measurement of the parts of patterns that has hindered us from perceiving patterns: the problem is how we ultimately represent these patterns. Our dependency on linear strings of words and numerals for conveying nonlinear concepts prevents us from fully representing and understanding patterns, interdependencies, and systems. From Capra's view, we need to use mapping techniques with our traditional linear languages and mathematical expertise to expand the linear mind-set through which we regularly filter, think about, communicate, and assess ideas.

As a society and as educators, we are only now beginning to address the fundamental importance of interdependent relationships and patterns, the architecture of systems. This awareness is challenging teachers and educational leaders to utilize tools and techniques that support students in mapping the patterns of knowledge—the evolving blueprints—that ground every discipline we teach and that help connect every discipline together into interdisciplinary knowledge.

—Figure 63.1—

Overview of Visual Tools



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THE BRAIN AS A PATTERN DETECTOR

Patterns exist in nature. One only has to look out the window, or to look at the human body's processes to see this. It is no wonder then that the experts in brain-based learning all agree on one thing: the brain as an organism is constantly self-organizing, re-creating organizational patterns. Certainly we get stuck in mental patterns, or behavioral ruts. But the brain is constantly making sense of the world by physically constructing patterns as neural networks. The focus on patterning is thus an entry point to understanding the connection between brain functioning, language, thinking, meaning making, and visual tools:

> The overwhelming need of learners is for meaningfulness. . . . We do not come to understand a subject or master a skill by sticking bits of information to each other. Understanding a subject results from perceiving relationships. The brain is designed as a pattern detector. Our function as educators is to provide students with the sorts of experiences that enable them to perceive "the patterns that connect." (Caine & Caine, 1991, p. 7)

"Visual tools" is an umbrella term for different mental mapping techniques (Hyerle, 1996); they include brainstorming webs, graphic organizers, and thinking process maps. Before turning to a review of the different types of visual tools, let's reflect on why the visual modality is so important. Certainly hands-on activities and manipulatives for kinesthetic patterning are essential, and auditory patterning is a staple of everyday classrooms.

One answer is found in the structure and processing of the brain. Practically, we retain snapshots of our past experiences, and we can visualize future possibilities. Why? The brain as a structure is capable of absorbing 36,000 visual images every hour. The sophisticated visual capacity of our brain system is beyond the conscious processing of our mind. Research approximates that between 80 percent and 90 percent of the information received by the brain is through visual means (Jensen, 1998). Though our auditory and kinesthetic modes of sensing are complex, the overwhelmingly dominant mode through which our brain filters information is through our eyes. From an evolutionary perspective, the human brain has evolved to become positively imbalanced toward being primarily a visual imager and processor.

Even if we each believe that we are dominantly "kinesthetic" or "auditory," consider that each of us is—by far—still taking in more patterns of information "visually" than through other modalities. We need to understand, and thus teach and learn with this imbalanced strength in mind: most of our students and most of us as we read this page, are strong if not dominantly visual processors of patterns. Consider that mostly what happens in classrooms is conveyed in spoken form or through linear text.

Current brain research has provided many insights into how the brain unconsciously takes in and consciously processes information. Wolfe and Sorgen (1991) have described three major stages of information processing within the dynamic system of the brain: paying attention, building meaning, and extending meaning. Most visual tools provide flexible cognitive patterns to students and teachers that are congruent with and facilitate each of these stages. A key to understanding and conceptual development is the capacity for accumulating and linking information in long-term memory. Wolfe and Sorgen (1998, personal communication) highlight the link between brain functioning, memory, and visual tools by pointing to a study by Standing reported in 1973 in *The Quarterly Journal of Experimental Psychology*:

> The impact of visualization on memory and recall has been demonstrated in numerous studies. In one, subjects were shown as many as 10,000 pictures, and then later shown some of these same pictures along with other pictures they had not seen. Under these conditions, they were able to recognize more than 90 percent of the pictures they had already seen. (Hyerle, 2000, p. 31)

As Wolfe and Sorgen noted, visual tools can help students initially process and make sense out of abstract information and also take advantage of the brain's almost unlimited capacity for images. Therefore, the use of visual tools needs to become more than an occasional strategy for isolated activities. These tools need to be fully integrated into classrooms as central to the communication of ideas—from preschool to college and into the workplace.

In summary, the brain and mind have a specialized, continuously evolving, multi-dimensional and dynamic spatial architecture. Architecture provides the basis for a good definition of high quality visual tools: they are dynamic blueprints of the mind's *conceptual* architecture. Visual tools provide one of the most direct routes for most learners—and maybe all but a few learners in our ever more inclusive classrooms—to show and communicate patterns of thinking. Much research and practical use in classrooms now shows that these tools shift learning to levels of understanding well beyond the common presentations of content information as blocks of static text—text that is but a linear wall, often a mere facade of the rich conceptual patterning of human thinking and understanding.

TYPES OF VISUAL TOOLS FOR THINKING

In *Visual Tools for Constructing Knowledge* (Hyerle, 1996) and *A Field Guide to Using Visual Tools* (Hyerle, 2000), three types of tools and related software are defined and reviewed: brainstorming webs, graphic "task-specific" organizers, and thinking process maps. These kinds of tools in different ways concretely support reading across disciplines, writing processes, and content specific learning. But there is an added benefit: they engage learners with lifelong tools for patterning and networking of information, organizing information into knowledge from various sources, seeking and sharing meanings, assessing, and the linking of isolated bits to holistic, interrelated systems. All of these visual tools are influenced by—or framed by—constructivism, brain research, visual technologies, and the requirement in the workplace and classrooms that learners interactively share their thinking in collaborative working groups (see Figure 63.1).

A phrase coined in the business world for thinking creatively is "thinking outside the box." Though this phrase has become a cliché, it provides a useful way to discriminate between types of visual tools. Below is a brief review of some of these types: brainstorming webs for thinking "outside the box," graphic organizers for thinking "inside the box," and thinking process maps for thinking "about the box."

BRAINSTORMING WEBS FOR THINKING OUTSIDE THE BOX

The associative power of the human brain is facilitated through and ignited by a high degree of open-ended brain networking. It is understandable and somewhat haunting that many webs look similar to the pictures we have of neural networks, as neurons are the brain's building blocks that communicate with each other. Axons send information to other neurons while dendrites (Greek for "tree") branch out with the cell body to receive information—networking neuron to neuron at a rate of 10 million billion transmissions per second. As shown in schematic views of a cortex, these connections are reflections of the complex webs we see children draw as they connect ideas on a page.

Brainstorming webs are open systems for thinking outside of the box. This means that there often is no formal or common representation system that is shared among those creating webs. Often private, idiosyncratic graphic languages develop in classrooms, each related to the personality of the thinker. But to believe that brainstorming webs should not or cannot evolve into more formal structures is to deny the great depth of these visual tools. Developers identify different forms of tools that can aid the process of moving from generation to organization to transformation of ideas and concepts. For example, some categories are called clustering and mindscaping tools, and Buzan Organisation, Ltd., has a set of visual techniques called Mind Maps. With advanced development of a brainstorming web—sometimes through software programs such as Inspiration (Portland, OR: Inspiration Software, Inc., 1998)—these visual representations may also be final products for presentation in a classroom or boardroom.

Unfortunately, many learners mistakenly believe that brainstorming webs are only a first step rather than an enduring process that continues and that even extends beyond a final product. I have even heard from teachers that students may brainstorm information and then not even refer to the document during the later processes of completing a project. Often, then, brainstorming webs are perceived as a static visual picture—the snapshot of a burst of creative energy—disconnected from further creative and analytical work, rather than a dynamic representation of evolving mental models.

Graphic Task-Specific Organizers for Thinking Inside the Box

Unlike webs that facilitate thinking outside the box, graphic organizers are often structured so that students are supported in thinking inside the box. A teacher may create or may find in a teacher's guide a specific visual structure that students follow and sometimes fill in as they proceed through a complex series of steps. Often teachers match specific patterns of content or one content task to a graphic. These highly structured graphics may seem constraining at times. But often these templates are good starting points for students who have trouble systematically approaching a task, organizing their ideas, and staying focused (especially when the task is complex). For example, many organizers are sequential, showing the guiding steps for solving a word problem, organizing content information for a research report, learning a specific process for a certain kind of writing prompt, or for a story board highlighting essential skills and patterns for comprehending a story.

Because these types of visual tools are highly structured, they provide direct facilitation of several habits of mind (Costa, 1991): persistence, self-control (managing impulsivity), accuracy, and precision of language and thinking. Review most any graphic organizer—found in a textbook or teacher created—and you will find that the visual-spatial structure guides students through the steps, box by box, or oval by oval. Teachers report that task-specific graphic organizers provide a concrete system and model for proceeding through a problem that otherwise students would give up on, because they have not developed their own organizational structures for persevering in a problem. An obvious reason is that the visual structure reveals a whole view of the process and, importantly, a vision of an end point.

This kind of structuring also provides some visual guidelines, much like a rope students can hang onto rather than impulsively jumping outside the problem to what Benjamin Bloom called "one-shot thinking." The visual modeling thereby shows students that they can decrease their impulsivity and stay "in the box" when they need to focus on following through to a solution. Oftentimes students don't have a record of their thinking, and the steps and missteps they took along the way. By visually capturing their ideas along a train of thought to a solution, students can review, refine, and share their ideas with others for feedback.

Thinking Process Mapping for Thinking About the Box

Brainstorming webs are used for thinking creatively outside the box of the daily classroom and workplace mental routines. These open webs help us break mental and emotional barriers, reflecting the millions of rapid firing associations occurring in our brains. Typical graphic organizers help students think inside the box. These graphics provide a mental safety net for many students, leading them into success and future independent applications.

A third kind of visual tool—called thinking process maps—is in many ways an outgrowth and synthesis of brainstorming webs and graphic organizers. Thinking process maps are being used in classrooms and the workplace for explicitly focusing learners' attention on fundamental thinking patterns, conceptual development, and metacognition. Developers who have created these tools have a common interest in having learners think about the patterns of content, or about the box itself. These tools support students in asking: What are the thinking processes and structures embedded in this information? How am I thinking? What is the frame of reference or mental model that is influencing my organization of this concept?

These practical and conceptually elegant tools are designed to help students generate and efficiently share recurring patterns of thinking, from fundamental cognitive skills such as comparison, classification, and cause-effect reasoning, to integrated visual languages such as Novak's Concept Mapping (1998), inductive towers (Clarke, 1991), and systems diagraming. While thinking process maps scaffold some habits of mind to brainstorming webs and organizers, these tools also provide a foundation for deeper questioning, multisensory learning, metacognition, and empathic listening.

Thinking process maps provide a concrete way to work with complexity and abstractions, matching the capacities of our brains to see the big picture and the details in both linear and holistic forms. As we look at these different forms, we see that most of them have a common thread: consistent and expandable graphics. This matches, at the deepest levels, the structure and dynamism of the brain. We can see that the brain thrives on a consistent structure that expands dynamically toward novel and more complex configurations.

THINKING MAPS: A SYNTHESIS TOOL KIT

The wide array of visual tools are used for making sense of our own stored knowledge, to assimilate new information and concepts, and to improve our long-term thinking abilities. But one of the problems for students as they go up through the grade levels in elementary school and from classroom to classroom in secondary schools is that they are encountering a haphazard and discontinuous array of graphic tools. Each one of the graphics in isolation may be useful, but students can become overwhelmed when given dozens of graphics over the course of a year, or hundreds over the course of just a few years. These tools could be synthesized, coordinated, and organized in a meaningful way for teachers and students so that whole learning communities can unite around some common visual tools.

This is the idea behind a common visual language called Thinking Maps, which I developed in 1988 (see Figure 63.2). These are eight unique graphic "starter" patterns, each based, respectively, on a fundamental thinking skill (Hyerle, 1995; Hyerle & Grey Matter Software, 1999). This visual language is in many ways a synthesis of the three types of visual tools described here. As a language of visual tools, each of the eight Thinking Maps embodies the generative quality of brainstorming webs, the organizing and consistent visual structure of graphic organizers, and the deep processing capacity and dynamic configurations found in thinking process maps. Learners can use this thinking tool kit—on paper or through Thinking Maps Software—to construct and communicate networks of mental models of linear and nonlinear concepts.

Each map begins with a graphic primitive and may expand to an infinite number of configurations. And, while there are only eight maps, the maps are often used together in a variety of ways. This is analogous to a carpenter with a tool kit: There may be a set number of fundamental tools in the kit, yet an infinite number of combinations and uses helpful for constructing a building. By providing learners with common graphic starting points based on thinking skills definitions and processes, every learner is enabled to detect, construct, and communicate different patterns of thinking about content concepts.

The systematic use of Thinking Maps in whole schools is leading to successful improvements in test results and quality indicators (Hyerle, 2000). Previous research on graphic organizers has often focused on a single kind of graphic for isolated tasks. Thinking Maps results show how teachers and students are using these tools across disciplines and also for specific content tasks. The strongest documentation shows up in reading comprehension and writing scores. Test results across urban, rural, and suburban schools in different states—with wide disparities in needs—have found that reading comprehension and writing scores have changed dramatically, and in several cases over multiple years. A recent study from Mississippi showed statistically significant changes in junior college students who dramatically improved their reading test scores when using Thinking Maps (Ball, 1999).

The most dramatic effects are found as students quite naturally become the center of learning and thinking. After learning how to use each Thinking Map for independent and cooperative learning, students begin moving from novice to more expert applications. With very little modeling, they begin linking several maps together for identifying different patterns in reading comprehension (text structures: sequential, causal, or comparative). They use different maps for responding to writing prompts of different kinds (narrative, persuasive, informative, or personal expression). When accessing several resources for researching topics in the sciences and social studies, students build maps over time. These results are accumulated in schoolwide portfolios.

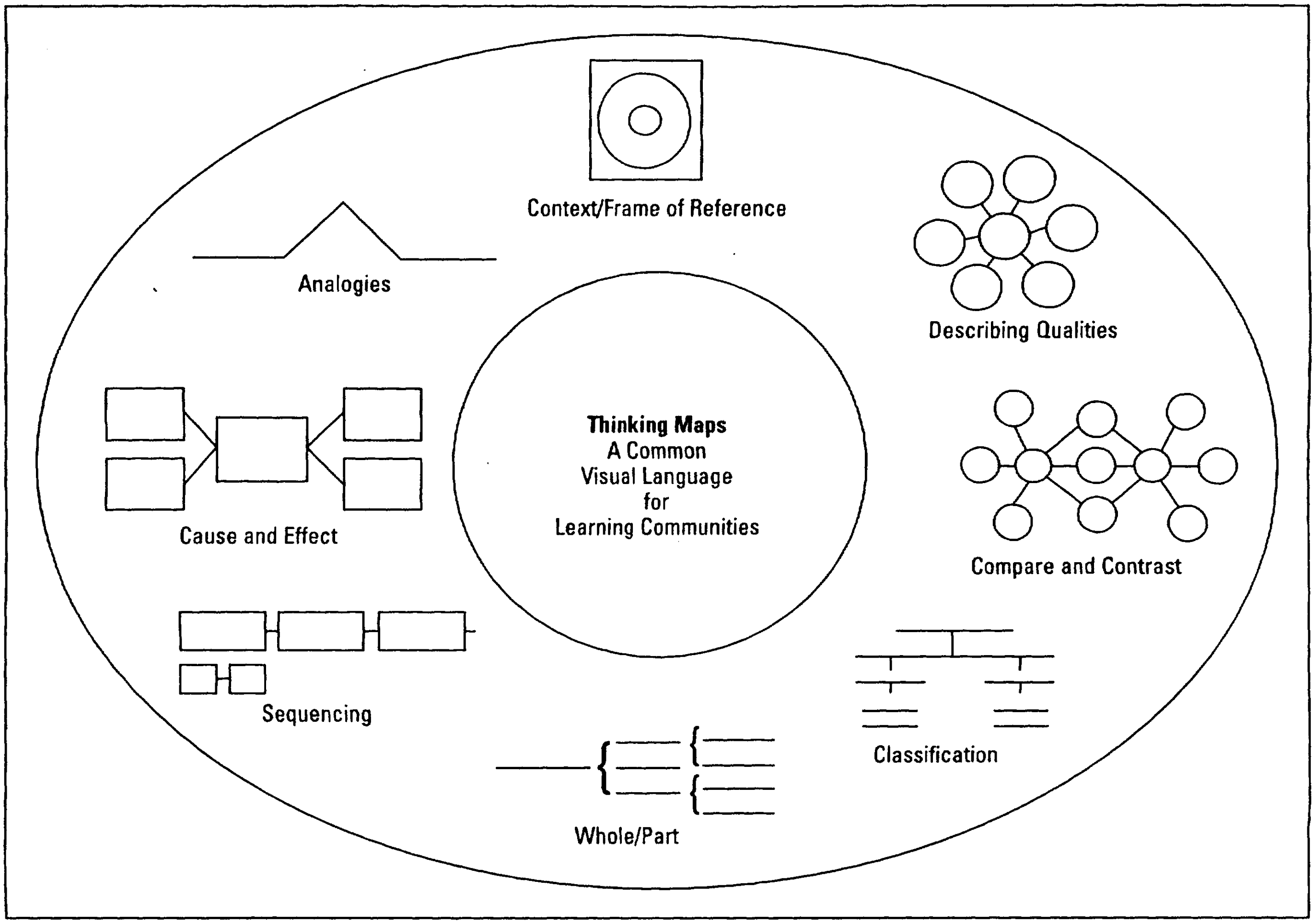
These kinds of results reveal a very different perspective on the use of visual tools from past success stories. Whereas most of us have perceived graphic organizers and webbing techniques as useful and relatively isolated strategies, when systematically used, these tools may become one of the linchpins for student-centered learning and whole school changes in performance.

VISUAL TOOLS FOR ASSESSING MENTAL MODELS

We want students to become self-assessing. We want students to go beyond looking at a final product and think about what they could have done better: we want them to become self-assessing during the processes of constructing knowledge and building final products. Visual tools provide a display of the

—Figure 63.2—

Eight Thinking Processes in Thinking Maps



Source: From *Thinking Maps: Training of Trainers* manual, by D. Hyerle, 1999. Raleigh, NC: Innovative Sciences, Inc.

development of one's thinking, in differing patterns, for all to review. When a student is using visual tools and different software programs systematically and over time, teachers, peers, parents, and administrators may look down and begin a rich dialogue with the student about how the patterns of ideas have evolved. We also begin to see changes in how students pattern their thinking over multiple years.

Unlike any other period in the history of humankind, we also want learners of our time to know that as they are looking down on their maps, they are looking at only one perspective, one mental model. There are multiple models for reality. This is not relativism, but intellectual rigor. In a culturally diverse, information-rich, "networked" world, visual tools provide an additional way of sharing different points of view and cultural frames of reference.

Mental models are those rich schemas through which we filter our emotions (Goleman, 1985), drive our every thought, and hold onto our life experiences. Visual tools—in the most recently developed forms—are a new medium for helping us face our own mental models and begin an internal dialogue about what and how we know something, and how we value it.

Seeing is not believing. Our mental models are, by definition, models built on available resources, beliefs, values, and existing paradigms. These models are evolving and imperfect, much like

> a pane of glass framing and subtly distorting our vision; mental models determine what we see . . . Human beings cannot navigate through the complex environments of our world without these cognitive mental

maps, and all these maps, by definition, are flawed in some way. (Senge, 1990)

Without this critical perspective on mental models, visual tools such as static graphic organizers will merely become another set of worthy techniques for regurgitating the existing structures. Visual tools have great promise as authentic tools for all learners—teachers and students alike—for understanding the ways in which we are thinking and for building new insights.

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