Structuring Thought: An Examination of Four Methods

Michael J. Hogan¹

Zachary Stein²

¹ School of Psychology, NUI, Galway, Ireland.
² Harvard University Graduate School of Education.
Abstract

A fundamental thinking skill is the ability to see the structure of thought. Awareness of the structure of thought begins with an intuitive description of the elements and relations that constitute a decision-making process and a description of the relationship between the structure and function of thought. Regardless of how one judges the quality of everyday decisions in light of the goals being pursued, it is useful, as a first step, to construct a structural map of everyday decision-making processes. This allows for objective analysis of everyday decisions and it enhances structural awareness in those who map the thinking process and in those who read the maps. The same applies to scientific thinking. Scientists advocate a particular position in the academic field and explicit mapping of their arguments enhances structural awareness, critical comparison and evaluation, and communication in the field. Overall, the mapping of decision making is a worthwhile goal, a skill that is becoming increasingly prominent and even necessary as part of expert decision making in many fields of applied science. This chapter presents a case for the cultivation of graphicy skills in this context. We describe four thought mapping techniques that offer considerable power and potential to elucidate and enhance thinking and decision making abilities. We suggest that technological advances may allow us to merge various different though mapping techniques and further enhance an interdependent set of graphicy skills that may help to support decision making and adaptive action in context.


Introduction

In an ideal world, and with the right kind of education, we may well progress from lower-order, irrational thinking to higher-order, rational thinking (K. W. Fischer & Bidell, 2006; Piaget, 1955), but this does not prevent us from reasoning to different conclusions, different theoretical orientations, different worldviews, and different decisions for action (Coan, 1968; Koltko-Rivera, 2004; Warfield, 1995). Even if one assumes that irrational thinking and rational thinking can be distinguished by reference to a quality judgment, the structure of thought itself, in everyday usage, when mapped -- a combination of reactive, quick, heuristic, holistic (system 1) thinking, and reflective, analytical, deliberative, procedural (system 2) thinking -- looks much more fluid and subjective than the advocate of objectivity and restrictive rationality daily dreams about (P. Facione & N. Facione, 2007). Ultimately, the flow of thought in human systems is very dynamic and variable, and the only way to truly understand the shape of human thought is to observe the thought and map the shape observed.

Thus, when it comes to understanding human thought we should begin our analysis of the phenomena as we would any other phenomena -- we should begin with wholehearted objectivity, and simply describe what we see. We may wish to use our science of human thinking to enhance our ability to make good decisions and act in a reasonable way. Nevertheless, prior to evaluating what is good and reasonable in the field of thought and action, the thinker does well to see clearly -- perceive without pre-judgment -- the phenomena under investigation. To this end, in this paper, we will briefly describe four thought mapping techniques, each of which highlights different
aspects of individual and group cognition and each of which can be usefully applied in a variety of contexts.

We begin with a description of argument mapping and focus specifically on mapping arguments using Rationale™, a software package developed by Tim van Gelder and colleagues. We draw attention to research findings which suggest that training in argument mapping enhances critical thinking skills in students (van Gelder, Bissett, & Cumming, 2004), and we suggest ways in which this line of research can be developed. Next, we describe the method of Argument and Heuristic Analysis (P. Facione & N. Facione, 2007) and examine the value of mapping not only the arguments people use but also the heuristics (or cognitive shortcuts) they use. People have limited time and energy and the mental shortcuts they use to save time and energy have a significant effect on the quality of their decision making (Gilovich, Griffin, & Kahneman, 2002). In our view, the move from argument mapping to argument and heuristic analysis involves a natural progression: new avenues of basic and applied research are opened up by virtue of the move. Next, we consider the Lectical™ Assessment method of analyzing the structure and complexity level of arguments and we draw attention in particular to the challenge and potential value of carrying out a structural analysis of argument complexity. Finally, we point to the challenge of collaborative cognition and, in particular, the challenge of constructing a structural map of the collective thinking process that guides collective action. We describe Interactive Management, a systems science thought mapping method that allows a group of people to work together to think about and solve complex problems (Warfield, 1974, 2006; Warfield & Cárdenas, 1994). Notably, all four methods involve the use of visual representations that elucidate the structure of thinking and
decision making activity. Thus, before describing these four techniques it will be useful to provide some historical and contextual background on the rationale for using systems of visual representation (or graphacy skills) to enhance awareness of the structure of thought.

**A brief history of graphacy**

Perhaps the most famous pedagogical interaction in history takes place in Plato's *Meno*. Socrates, concerned about the nature of learning and knowledge, questions a young slave boy about the most basic principles of geometry. The exchange hinges upon Socrates literally drawing a set of figures in the dirt at their feet. He *displays* the concepts they are considering. The slave boy is rendered knowledgeable as he explicates the ideas implicit in the Socratic graphic-designs. So begins a long and important relationship between philosophical inquiry and graphacy—the use and understanding of figures, graphs, concept-maps, and other representational devices. The strong claim endorsed in this paper is that this is a non-trivial relationship. Forms of graphical representation facilitate unique and important insights, which can be had no other way. Philosophers, among others, need these representational devices. And while many have deployed them, some have openly confessed dependence.

Take for example, Petrus Ramus, the influential 16th Century philosopher, pedagogue, and logician whose work shaped the teaching of logic for over one hundred years. As Walter J. Ong (1958) has shown, Ramus's work and influence was directly related to the development of the printing industry and his insights about the visual presentation of materials on the printed page. Ramus explicitly addressed the importance of the spatial arrangement of tables and text, seeing it as an integral part of the logical and
pedagogical economy of his work. That is, he saw the arrangement of signs on the page as more than a matter of taste, and began the modern printing practice of combining tables, figures, and text. This attention to the non-arbitrary logic of graphical representations resulted in that his influence was not only on what people thought, but on how people displayed their thinking (Ong, 1958).

A less obscure example is John Venn, the inventor of the Venn Diagram, whose concerns for graphical representations of logical relations have had a wide-ranging impact to this day. He understood his diagrams as more than a mere heuristic (Venn, 1881). On his view, the search for new representational devices is part and parcel of the search for new ideas. Along these same lines, Charles S. Pierce, inspired by Venn, developed alternative modes for representing logical relations, a system that looked more like concept-mapping than propositional calculus. Peirce's existential graphs, unlike Venn's diagrams, were built as a comprehensive system of logical expression (Peirce, 1933; Shin, 2002). Peirce, like Venn and Ramus, reflected explicitly on the benefits of some graphical systems over others and on the non-trivial relation between graphicity and philosophical inquiry, claiming that we need to build representational devices—moving beyond linear text—in order to prove some of the most important ideas in philosophy and logic.

More recently, John Warfield (2002, 2003; 2006; discussed further below) and Robert Brandom has echoed these sentiments about the primacy and importance of graphicity in philosophy and science (Brandom, 2008). Brandom invented a concept mapping system to represent the innovative mode of formal pragmatic analysis he endorses, claiming that the logical insights it yields cannot be seen another way. Warfield
claims, with explicit reference to Peirce, that some forms of communication and inquiry are dependent upon a mixture of figures and text, which disclose complex logical relations while also having clear information processing advantages. Importantly, Warfield draws upon psychological research to show the importance of new forms of graphicity in handling the increasingly complex task demands of post-modern decision-making contexts.

This brings us to the thrust of this paper. We believe that the guiding insight of the lineage traced above is an important one. New forms of graphicity make possible new forms of philosophy, inquiry, and decision making ability. We think new methods have emerged over the past decade that will make it possible to advance knowledge through the explicit and problem-focused deployment of concept-dissecting, decision-process explicating, graphically robust representational devices. And we think that these new graphical systems do more than serve as heuristics. If they are built and used correctly they can make things explicit that would otherwise remain implicit. Yes, they can relieve working-memory load and help organize conceptual spaces for collective consideration, but, so the strong claim goes, they can also expose structural properties of decision-making processes or domains of knowledge to which we would otherwise be blind. They are part of thinking, not merely an aid to it. Thus, part of the exposition that follows is a call to reconsider what thinking is, and a call to expand common-sense notions that it only goes on between our ears.

**Argument mapping with Rationale™**

The method of argument mapping is grounded in the assumption that, when deciding what to believe or what to do, we generate a series of reasons and objections that either
support or refute a specific belief or a specific course of action. We then weigh up each of our reasons and objections, and we arrive at an overall evaluation, ultimately, a decision. Argument mapping itself does not call for any decision to be made, and mapping our arguments using argument mapping software does not necessarily make it very easy for us to decide what to believe or what to do. Nevertheless, argument mapping does help us to structure our arguments and thus begin to analyze and evaluate our arguments.

Consider trying to decide whether or not you should buy a dog. You like dogs, but you do not want to make a decision too quickly. You want to think about it for while. You want to think carefully about your decision. Three important questions for you to consider in this context are:

1) What kinds of things might you think about to persuade yourself that buying a dog is a good idea?

2) What kinds of things might you think about to dissuade yourself: buying a dog is not a good idea right now?

3) How will you arrive at a final decision in this context?

In answer to questions 1 and 2, you might generate the following thoughts: “I should buy a dog, because I’ve always had dogs and I love them; because dogs are peoples’ best friend; and because I can go out walking every evening, keep fit and meet other people with dogs. But walking my dog every evening will mean I cannot pursue my new hobby (sailing); I’ll also feel guilty if I’m forced to leave my dog alone in the house all day; and a new dog would be expensive and I’m really short of money right now”. In this example, we have three reasons and three objections, all of which, presumably, impinge upon the
decision-making process. In answer to question 3 above, we can assume that a rational person will arrive at their final decision by weighing reasons (*Because dogs are peoples’ best friend, etc.*) against objections (*But a new dog would be expensive and I’m really short of money right now, etc.*). The rational person may also be compelled to delve deeper to discover a solid foundation for any given argument. For example, what is the basis for our belief that dogs are peoples’ best friend? Figure 1 illustrates one way in which we might support this belief.

As we continue to go deeper, seeking to build an increasingly solid foundation for our beliefs, the argument map we build in Rationale™ will adopt a pyramid-like structure, with more and more layers of reasons, objections and rebuttals expanding at the base of our central claim. For example, if we were to fully support the belief that *Dogs aid people’s mental wellbeing* (one of the reasons provided for why we believe *Dogs are peoples’ best friend*), we would need to argue the case beneath and point to the research studies that confirm this belief.

More generally, at the basis of every argument are propositions that draw upon different sources of knowledge, be they conclusions drawn from experimental or quasi-experimental research, survey research, case studies, authority/expert opinion, anecdotes, common sense, personal experience, etc. Rationale™ is designed such that different argument types can be labeled using discrete icons. This helps the analyst to assess, at a glance, the overall quality and quantity of evidence presented.
Rationale™ is well suited to mapping arguments presented in dialogue or prose format. Arguments can be translated from text to map and the logical strength, soundness, relevance, and non-circularity of arguments can be evaluated. Working with arguments maps is potentially beneficial. For example, research suggests that students who study argument maps remember more of the core arguments than do students who study homologue texts (Dwyer, Hogan, & Stewart, 2009). Furthermore, research conducted by Tim van Gelder and colleagues reports that semester-long training in argument mapping (i.e., building argument maps and evaluating argument maps) produced significant gains in critical thinking skills as measured by the California Critical Thinking Test (van Gelder et al., 2004). However, this study did not include a control group. Randomized controlled trials are needed to better examine argument mapping as a critical thinking training intervention. Part of the design of these studies might be to focus on the process of skill development, for example, by tracking the ability of students to develop increasingly coherent and integrative text-to-map argument translations and evaluate weaknesses, strengths and routes to enhancement of argument structures. A related objective might be to evaluate the relationship between this developing skill and a students’ ability to engage with increasingly complex arguments in the context of dialogue and collaborative cognition. Also needed are studies that compare the merits of argument mapping training with those of other more traditional methods of enhancing structural awareness, for example, via training in the technique of hierarchical summarization, a text-based argument structuring technique.

1 In fact, for the purpose of education in the technique, once students become familiar with the principles of argument mapping using Rationale, these text-to-map translation exercises are an excellent way to reinforce the ability to extract the structure of an argument from a text (e.g., an interview transcript, a journal article, a book chapter, etc.). This is the first step prior to fuller analysis and evaluation of the overall argument structure.
Argument and heuristic analysis

As noted earlier, the structure of thought, when mapped, is much more fluid, reactive, intuitive, and holistic than advocates of objectivity and restrictive rationality may hope for, and the method of argument mapping needs to be supplemented with a method that helps us to analyze both the arguments and the heuristics that people are using when they are trying to decide what to do. Heuristics are cognitive shortcuts that speed the decision making process. However, heuristics also delimit the application of more thoroughgoing reasoning. Facione and Facione (2007) highlight 14 distinct heuristics (see Table 1), often used in parallel, which can influence decision making in a variety of different ways, depending on the situation. Facione and Facione (2007) show how to use interview techniques to gather data about real human decision making episodes. They describe a method of data mapping and data analysis that enables an empirical analysis of human decision making.

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Insert Table 1 around here

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Two important features of thought mapping using the method of Argument and Heuristic Analysis are: first, the sequence of thoughts as they unfold over time in the interview is maintained in the map (i.e., a numbering system is used); second, different types of thoughts -- ideas, reasons, or claims; implicit (non-verbal) ideas; heuristics; watershed ideas, counterarguments, abandoned argument strands, and decisions -- are represented on the map using different graphics.
Consider figure 2. It displays the complete decision map of a woman who ultimately decides not to quit smoking. The map of her interview transcript highlights two options: *I must quit smoking now* (an option that is never spoken in the interview), and *I can’t quit smoking now. I’ll quit someday* (the end-of-interview decision). There are three watershed ideas [numbered 6, 9, and 15, respectively] -- ideas that really shape the direction of ideas and arguments that follow. One of these watershed ideas (15 - *My son is driving me crazy. A teenager…I never know where he is*) pulls the thinker in the direction of an abandoned argument [16 - *I have to be a responsible parent...(and ‘quit smoking’*)], but it also pulls the thinker in the direction of the selected decision: 17 - *Working and parenting takes energy*, and 22 - *I do not have enough energy to quit now*, therefore, 5 & 23 - *I can’t quit now. I’ll quit someday*. During the early part of the interview, the woman gravitates toward the conclusion that she must quit smoking now, but as the interview progresses her defenses mount and she argues that she cannot quit smoking now. She uses a representativeness heuristics to draw out the relationship between the death of her father from heart disease and the probability that she might suffer a similar fate, if she does not stop smoking. However, she decides that she needs to smoke to function well and this along with her belief that she does not have sufficient energy to give up right now is the argument that shapes her final decision.

Noreen and Peter Facione have recently used their method of argument and heuristic analysis to examine the quality of decision-making in health care settings (N. Facione & P. Facione, 2007). By comparing arguments and heuristics used by a group of 15 women delaying diagnosis of breast cancer symptoms with a group of 13 women who quickly sought a diagnosis, Facione and Facione reported that diagnosis-seekers offered
more arguments for diagnosis-seeking than for diagnosis-delay. Those who delayed diagnosis offered fewer arguments for diagnosis-seeking and many more for diagnosis-delay. Delayers also abandoned sound and usually compelling arguments to seek diagnosis, relying instead on false information and poorly reasoned arguments. By reference to the full set of arguments and heuristics used by women to delay diagnosis, Facione and Facione recommended that interventions aimed at decreasing patient delay need to challenge mistaken beliefs of control over possibly advancing cancer, and the tendency to abandon sound arguments for seeking prompt diagnosis. A good intervention would also need to challenge the tendency to satisfice when scheduling diagnostic visits, simulate a benign diagnosis rather than the prevention of late-staged cancer, and prioritize fear control over protection of life. Overall, a close evaluation of the structure of thinking in this context revealed a problematic pattern that can be structurally unpacked and used as the basis for counter-pattern restructuring in an intervention designed to challenge and ultimately change the thought patterns that shape poor decision-making. Whether or not these interventions are successful remains to be seen – much depends on how easy it is to alter particular patterns of thinking.

Insert Figure 2 around here

Dynamic differences in thought complexity as mapped using Lectical Assessment

An examination of the thinking process in action reveals significant variation both within and across individuals, including variation in the level of organization and complexity of argument structures (T. Dawson, 2004; T. L. Dawson, 2002; K. W. Fischer & Bidell,
The Lectcial Assessment system (or LAS) is the outcome of decades of research in cognitive developmental psychology. It is a form of structural analysis that can be used to measure the complexity of arguments, concepts, and performances, allowing them to be placed at different developmental levels, or different level of complexity. Dawson, the creator of the LAS, has built a rigorous method for insuring the psychometric validly and reliability of the LAS (for more info go to: www.lectia.info). The system is build around the basic construct of **hierarchical complexity**. The construct of hierarchical complexity can be understood most easily through an acquaintance with the conceptual tools used to identify it.

The ability to ‘look through’ the content of reasoning is necessary in order to fully grasp what it means to identify the level of complexity manifest in an argument or text. Consider, for example, the meaning of one word, *person*, as described across the different levels of hierarchical complexity identified by the LAS (see Table 2). In attempting to describe what a person is, people can draw upon a huge variety of concrete and abstract concepts that are more or less integrated in their overall presentation at different levels of hierarchical complexity. When examining the different ways people use the concept *person*, the LAS method of analysis focuses less on content and more on the hierarchical complexity, or the underlying structure of the concept being used. Examining differences in complexity through concept mapping will serve to demonstrate the process of ‘looking through’ the content and enacting the perspectives that reveal the deeper structure of complexity behind arguments. To simplify this examination, we employ an idealized example, illustrated with a series of concept maps.
The development levels displayed in Table 2 have been researched for decades by a group of Neo-Piagetians, including Fischer, Case, and Commons (Case, 1992; Commons, Trudeau, Stein, Richards, & Krause, 1998; K. Fischer, 1980). One way to think about the LAS is that it operationalizes the broad structural descriptions of these levels. The representational levels begin with the onset of language, serving to organize action schemes and facilitate concrete forms of communication and thought. Over time representational concepts come to be complexly interrelated, moving through linear mappings toward multivariate systems. Eventually, abstract concepts emerge from representational systems, serving to chunk whole systems of concrete concepts in terms of overarching qualities and ideas and facilitating such higher-level skills as long-term planning and counterfactual reflective hypothesis formation. Abstract concepts are first combined into linear mappings that become increasingly complex, eventually forming multivariate systems of abstract concepts, which in turn give way to principles. Principles are dialectically rich and informationally dense constructs that subsume whole systems of abstract concepts. These are built to serve broad functions in discourse and behavior regulation, and are rare in populations lacking forms of rigorous higher education (Dawson-Tunik, 2004).

Table 2 displays the development of the conceptual element *person* across the seven levels identified by the LAS. The column with the heading “A person is…” is composed of text samples that display reasoning about the concept of *person*. These text samples are not taken from actual interviews. They have been created to explain the LAS and do not represent a hypothesis about the way the concept *person* actually develops.
The process of constructing a concept map from a sample of text is similar to enacting the analytical perspectives necessary to score using the LAS. Here, we employ concept maps of the examples in Table 2 to assist us in making clear the construct of hierarchical complexity.

To begin, it is necessary to select a protocol from Table 2. The sample of text from the representational mappings complexity order reads:

A person cooks food a lot, and goes to his job. Like my Dad. My teacher is a person, and I am a person, but I’m a kid too.

First it is necessary to understand the meaning of what is being said. After the initial meaning has been grasped, isolating the conceptual elements of the protocol is the first step in the process of concept mapping it. The conceptual elements in the protocol are displayed on the left in figure 3 below. These conceptual elements are the main ideas used to construct the meaning of the protocol. The right side of figure 3 shows the organization of these conceptual elements. In the ovals are words that connect two or more conceptual elements.

This process of concept mapping visually represents the meaning of the protocol, displaying the organization of conceptual elements. The process of concept mapping involves picking out the conceptual elements of a protocol and grasping the manner in which they are organized. These two analytical skills are the prerequisites to ‘looking
through’ a protocol to the order of hierarchical complexity that is its underlying structure. This protocol has been placed at the level of representational mappings because—as the concept map makes clear—concrete representational concepts are coordinated in a linear fashion.

A second example will help to clarify the process further. The sample of text from the single abstractions complexity order reads:

A person is a human being. Human beings live all over the world; they all know how to think, except little babies. I heard humans used to be monkeys but then we got smarter. People are intelligent. They have feelings and ideas.

The conceptual elements are displayed on the left in figure 4 below, their organization is shown on the right.

As reasoning becomes increasingly complex it becomes apparent that there is more than one way to display the meaning of a protocol in a concept map. However, a step by step look at how the conceptual elements are fitted into the map will show that the map is not arbitrary and the level of complexity is clearly revealed in the concept map. Specifically, by examining the concepts used to describe a person in this protocol and the way they are organized in the flow or argument, it is clear that this protocol is organized at a higher level of complexity than the previous one. Note that while many of the concepts are concrete there are many more of them and they are coordinated in a complex manner. Moreover, certain concepts (e.g., human being) are building towards abstraction, subsuming a variety of concrete ideas (e.g., live all over the world, know how to think, etc.).

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Isolating how each group of conceptual elements is added to the map demonstrates just how the concept maps dissect the meaning of a protocol and reconstruct it in a more formal way. The concept maps make clear how the meaning of a conceptual element is constructed through a process that integrates the differentiated conceptual elements beneath it. For example, as explained above, the conceptual element *human being* as it is used in this example can only be understood as a summary or integration of the conceptual elements beneath it in the map. Displaying the structure of the concepts ultimately allows us to gauge the relative abstraction and complexity of the overall performance—thus measuring the hierarchal complexity of the arguments.

In the examples above the meaning of ‘person’ at different levels of hierarchical complexity is revealed by the concept mapping process, which as a result exposes, through a kind of reconstruction, the integration accomplished by this meaning. The LAS identifies a sequence of conceptual structures with increasingly integrative capacities. These structures appear in all arguments, and are an important factor that should bear on their analysis. For example, if the concept of ‘person’ figures prominently in an argument under analysis—e.g. debates about abortion—the level at which people understand and use this concept is critical. Arguments may be ostensibly about the same thing, while the reality is that those engaged in debate are operating at different levels. This is more than a concern about setting terms. Arguments coming from different level have different structures, and thus different logical properties. Strategies for mediating cross level argumentation are only just beginning to be devised (Rosenberg, 2002; Wilber, 1999). By developing efficient strategies for identifying individual differences in complexity level and the influence of these individual differences on the construction of *relational*
argument structures that emerge when a group of individuals debate and collaborate, it may be possible to reduce unnecessary conflict within groups and move toward greater coherence and ultimately greater collaborative problem-solving power and potential (Bohm, 1994; Bohm & Nichol, 1996).

**Group decision making using Interactive Management**

The three thought mapping strategies described above work on the assumption that decision making is an individual pursuit. However, many everyday decisions are collaborative affairs. In fact, the resolution of complex social problems generally requires some kind of collaborative constructivism, that is, a certain amount of rational coherence at the level of the group that facilitates the decision making of the group.

Interactive Management (IM) is a process of collaborative decision making developed by John Warfield. IM recognizes that multiple viewpoints on social and technical issues are needed to resolve complex problems. Social psychologists have long recognized that group decision-making efforts are often hampered by poor use of logic and the dominance of heuristics that reinforce the solutions of a charismatic leader or those group members who possess power and influence. Under conditions where there is the added pressure of time constraint and high stress, there develops a belief that no solution other than the solution provided can be found. Under such circumstances, people will very often simply give up thinking and thus contribute nothing to the process of decision making (Janis, 1982; Warfield, 1995).

IM is a thought mapping technique that enhances group problem solving. There are a series of steps in the process. First, a group of between 12 and 20 people -- key stakeholders with an interest in resolving a problematic situation -- come together in a
situation room and are asked to generate a set of ‘raw’ ideas (commonly 100 – 300) about what might potentially have a bearing on the problem they all agree exists. Further discussion clarifies the sub-set of ideas that bear upon the most critical problem issues.

Next, using IM software (cf. Warfield, 2007 for more information), each of the critical issues are compared systematically in pairs and the same question is asked of each in turn: “Does this issue have a significant impact on that?” Unless there is majority consensus that one issue impacts upon another, the relation does not appear in the final analysis. After all the critical issues have been compared in this way, a problem structure (or problematique) showing how the issues are interrelated can be viewed and printed for discussion.

The group reviews the model and, after a further period of discussion and, if necessary, a further period of modeling, the problematique becomes the launch pad for planning solutions to problems within the problem field. The logical structure of problems is visible in the problematique and when generating solutions, action plans are aimed at resolving problems in a logical and orderly manner, from the ground up. The impact of these actions is then modeled for the group. When the group is happy that they have modeled both the problem field and the best possible set of solutions, the IM session closes and each member leaves with a detailed action plan, a specific set of goals to work on, and the roadmap and logic describing how all the various plans and goals of each member will work together to resolve the original problem.

IM has many useful applications. For example, it has been used to good effect in Cyprus to help resolve conflict driven by ethnic divide (Broome, 2004). In this case, a

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2 A room with computers, IM facilitators, IM voting and mapping software, and large wall space that allows relations between problems in the problem set to be mapped.
group of Turkish Cypriots and Greek Cypriots have worked both in isolation (Figures 5 and 6) and together (Figure 7) to map the structure of their vision for peace for the future. Prompted by the question, ‘What are desired goals for our peacebuilding efforts during the next decade?’ Greek Cypriots proposed 72 goals, and Turkish Cypriots proposed 101 goals. Through a facilitated process of categorization, these goals were organized under the following themes: (A) Image of Peacebuilding; (B) Strengthening the Peacebuilding Movement, (C) Bridge Building, (D) Peace Mentality, (E) Peace Culture, (F) Problem-Solving Approaches, (G) Identity Issues, (H) Bicommunal Understanding, (I) Bicommunal Communication and Exchange, (J) Youth and Education, (K) Political and Economic Issues. Each community then voted to identify from their full list of goals a subset they considered most important. Using this subset, the group then used IM software to build a graphical portrayal (or problematique) of individual goals and their perceived interrelationships. This problematique was used as the basis for discussion to shed further light on the structure of their vision for peace. Each group then compared and contrasted their vision with the vision of the opposing group (Figures 3 and 4) before coming together as one group to generate one agreed vision. They began by identifying the shared goals from each community’s vision, and they generated additional goals they wanted to include in the collective vision. Although there was heated debate over the wording of some statements, the two groups eventually agreed a common vision (see Figure 7).

Each of the problematiques presented below is read by starting at the bottom and following the lines of influences upward. Goals at the base of the structure are primary in the causal network. Goals at the top of the structure are long-term or outcome goals that
require the support and fulfillment of goals that lie beneath. The goals in the middle of
the structure are conduits through which the support passes from the base to the long-
term goals. Following the completion of the collective vision statement, or
problematique, the group designed a collaborative action agenda for implementing the
goals in the structure. They generated a set of 245 options, from which they selected a
total of 15 projects to implement during the following year. Most of the activities were
eventually realized in some form and work is still ongoing in Cyprus as the two groups
continue to design pragmatic solutions that help to maintain the peace.

The core principles and methodology of IM can be applied to the resolution of
any problematic situation. However, this tool has not been widely applied to solving
problems in the mainstream science of psychology and education. For example, one of
us has made the call for the application of IM to foster the integration of facts and
perspectives – including positive and negative worldviews – that shape the science of
human flourishing (Hogan, 2008). However, IM has never been applied in this way.

One problem with IM is that it is a time consuming process. For complex
problems, it can take anything up to 6 days to develop a problematique and a correlated
action plan. Furthermore, in order to bring about a solution to the problem, the group of
people involved need to work on the action plan. In this sense, people have to make an
ongoing commitment of time. However, the advantage of the method is that there is
power in numbers -- each group member contributes some small portion of action to the
overall solution -- and with a logical roadmap that describes the consequence of their
collective action in the problem field, those involved can be reasonably confident that
their actions will be effective.
Cultural evolution has been described as a process whereby the ideas, values, beliefs and behaviors of individuals and groups that foster the highest levels of adaptive success are generally imitated by others and thus become increasingly prominent in the culture – that is, until replaced by other ideas, values, beliefs and behaviors that offer even greater success. If, as we believe, group problem-solving strategies such as IM generate effective solutions to problems by capitalizing on our ability to use formal logic in the context of complexity, then it makes sense that mainstream application of IM to significant social and technological problems will become increasingly prominent. However, biological and cultural evolution have also canalized our investment in heuristics that help us to solve adaptive problems very quickly and with minimal cognitive effort (Barkow, Cosmides, & Tooby, 1992). The argument from evolutionary psychology is that many of our core problem-solving routines are evolved adaptations, that is, modular behavioral routines that are activated by specific contexts that are somehow similar to contexts that critically impinged upon on our survival and evolution success in the past. However, cultural evolution has radically altered the nature of many of the problems we now work to resolve. The development of high levels of insight into the structure of our individual and collaborative cognition is not an evolved adaptation that has emerged during the process of our evolution to date. New cultural tools and resources are needed to support our work when solving some the big economic, social, and environmental problems we now face. We advocate greater cultural investment in
the development of the skills and tools of graphicacy. We close this chapter with a brief note on the possibility of integrating various thought mapping technologies into one functional educational tool that includes various ‘modules’ and interdependent skill enhancement structures that will enhance the power and potential of individual and collaborative cognition and action.

**Integrative educational tools**

In a fascinating book that describes and evaluates *Thinking Frameworks* for teaching and learning, Moseley and colleagues (2005) describe and evaluate a total of 41 individual thinking frameworks. The frameworks are largely theoretical descriptions of core thinking skills that are relevant for problem-solving and decision-making activities – recognizing and recalling, comprehending, working with patterns and rules, concept formation, organizing ideas, reasoning, monitoring, evaluating, inferring, creative reconfiguring, and so on. Pointing to different thinking skills is interesting, but one problem with the majority of thinking frameworks that dominate perspectives in the field of learning and teaching is that formist and mechanistic worldviews undergird their design (Pepper, 1942) and there is a noticeable absence of an organismic and contextualist focus on the *integrated process of thinking and action in context*.

Specifically, in the formist and mechanistic worldview the tendency is to either (a) simply point to discrete forms (or parts) of thinking that are important aspects of our overall thinking skill, or (b) attempt to overlay this emphasis on the parts with a hypothetical cognitive machinery that describes the functional relations between the parts of thinking that have been classified as important aspects of our overall thinking skill. What emerges is a fascinating neglect of organismic and contextualist worldviews that
focus attention on the integrated process of thinking and action in context. One negative consequence of this is poor linkage between the theoretical models proposed and educational applications that might serve to foster thinking skills. Also, by pulling attention away from a focus on activity in context, many thinking frameworks simply reinforce an *abstract view of thinking* over the reality of thinking and action in context. It is only by understanding the reality of thinking and action in context and the environmental contingencies that influence the process of thinking and action in context that we can begin to design ways to enhance a persons’ awareness of this process and their individual and collaborative ability to successfully pursue a range of valued goals.

We have argued above that cultivating and using graphicacy skills may serve the joint goals of both developing better understanding of the structure of thought and enhancing both individual and collaborative goal pursuit in context. We would now like to suggest that educational researchers focus more attention on developing integrated educational *tools* (rather than integrated *thinking frameworks*) that help us to elucidate and enhance thinking and decision-making processes in context.

Two of the thought mapping techniques we considered above -- Argument Mapping and Interactive Management – already have associated with them very usable software systems that allow one to (a) map argument structures and (b) design problematiques that structure complex problem spaces. Both software systems are pragmatic systems, in the sense that both are designed to facilitate working toward a select goal (e.g., working to establish the foundation of a belief using argument mapping, or working to establish an optimal collaborate path to resolution of a fundamental problem using Interactive Management). We believe that the current design of argument mapping software could
be reconfigured to allow for analysis of the development of argument structures, and the impact of heuristics in both directing and restructuring argument structures at different levels or hierarchical order and complexity during the process of development. (By development here we refer largely to micro-development, that is, development over the course of hours, days, weeks, and perhaps months.)

In other words, we believe it should be possible to design educational software that provides students (guided by experts and working in a collaborative context) with a tool that facilitates their developing understanding of the thought structures that shape decision making and action in context. With the core skill of graphicacy being central to this new educational tool, we believe that students will slowly develop the ability to see the structure of thought in action (i.e., in their own action and in the action of others), and in a collaborative working context they will begin to see how collaborative, relational thought structures impinge upon decision making and action in context (e.g., in the context of collaborative exercises where they are collectively working to establish the basis for a certain belief or working to solve a particular problem that requires collaborative action planning).

Using an educational software tool that facilitates greater awareness of how collaborative, relational thought structures impinge upon decision making and action in context, and with IM software capabilities built into the same educational tool, it will be possible for groups of students to move from individual and collaborative analysis of thought structures to increasingly coherent design activity, that is, in the design of problematiques that help them to characterize problem structures at a higher level of complexity. Finally, in the gradual move from undergraduate to post-graduate training in
thinking, decision-making, and problem solving -- using a core module that runs from first year to final year and from undergraduate to postgraduate training at increasingly higher orders of software complexity -- the focus of college life could begin to move away from discipline-focused to problem-focused training and employment opportunities. Specifically, the focus would be on catalyzing the developing skill of students for the resolution of key problems that involve multiple actors for successful resolutions (e.g., the design of social systems that focus on resolving problems of isolation and depression; the design of solutions to complex engineering problems that a group of postgraduate engineering students might work on under the supervision of a larger professional outfit; and so on). Successful human adaptation hinges upon the ability of human being to catalyze their biological and cultural resources to facilitate problem solving in context. While biological evolution may have run its course in terms of further enhancement of human potential, economic, social, and environmental problems that impinge upon individuals and groups continue to mount, and the only way we can successful resolve these bigger problems is by investing more intelligent effort in the redesign of the tools of culture that help us all to develop our skills and capacities. Integrated software systems that catalyze the power and potential of graphicy use in educational contexts offers one path to greater skill.

**Conclusion**

Few of us deny that our thinking is limited. We have a limited working memory capacity; our rationality is ‘bounded’ by sentiments and heuristics that shape our best decision-making efforts. At the same time, we can map the structure of our thoughts and learn from the maps constructed. We can use argument mapping software to lay out in
plain view the structure of our arguments for analysis. We can use argument and heuristic analysis to map our decision making as it unfolds in real time and consider more deeply the role of heuristics in shaping the outcome of our thinking. We can characterize the level of order and complexity in our thinking using Lectical Assessments. We can work as part of a group and use Interactive Management to map the structural relationships between problems in a problem field and we can use the logic of this structure as the basis for action planning. In other words, notwithstanding our limitations, we can use what mental capacity we have to greater effect and facilitate better thinking, better decision-making, and better action. As the science of thought mapping develops, the applications will continue to grow, and it is our prediction that thought mapping will eventually become the foundation stone for rational, sustainable cultural evolution.
References


<table>
<thead>
<tr>
<th>Name</th>
<th>Cognitive Maneuver</th>
<th>Disadvantage/Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisficing and temporizing</td>
<td>Given an option that is good enough, decide in favor of that option</td>
<td>Good enough may not be best</td>
</tr>
<tr>
<td>Affect</td>
<td>Take an initial stance in support of or in opposition to a given choice consistent with one’s initial affective response to that choice</td>
<td>Feelings may mislead</td>
</tr>
<tr>
<td>Simulation</td>
<td>Estimate the likelihood of a given outcome based on one’s ease in imagining that outcome</td>
<td>Over-estimation of one’s chance of success or likelihood of failure</td>
</tr>
<tr>
<td>Availability</td>
<td>Base the estimate of the likelihood of a future event on the vividness or ease of recalling a similar past event</td>
<td>Mistaken estimations of the chances of events turning out in the future as they are remembered to have turned out in the past</td>
</tr>
<tr>
<td>Representativeness – Analogical</td>
<td>Infer that because this is like that in some way or other, it is like that in relevant ways</td>
<td>The analogy may not hold</td>
</tr>
<tr>
<td>Representativeness – Associational</td>
<td>Connect ideas on the basis of word association and the memories, meanings, or impressions they might trigger</td>
<td>Jumping from one idea to the next absent of any genuine logical connection and drawing inaccurate inferences from the combined thought process</td>
</tr>
<tr>
<td>Generalizing from One to All</td>
<td>From a single salient instance draw a generalization about an entire group</td>
<td>The one may not be representative of the many</td>
</tr>
<tr>
<td>“Us vs. Them” Dynamic</td>
<td>Reduce problems to a simple choice between two opposing forces</td>
<td>Conflict which excludes reasonable compromise</td>
</tr>
<tr>
<td>“Master – Slave” Power differential</td>
<td>Accept without question a problem as presented by or a solution as proposed by a superior authority</td>
<td>Working on the wrong problems, applying a mistaken solution</td>
</tr>
<tr>
<td>Anchoring with Adjustment</td>
<td>Having made an evaluation, adjust as little as needed in light of new evidence</td>
<td>Failure to reconsider thoroughly</td>
</tr>
<tr>
<td>(Illusion of) Control</td>
<td>Estimate the level of control you have over the actual outcome of events upon the amount of desire or energy you put into trying to shape those events</td>
<td>Over-estimation of one’s power to control events or under-estimation of one’s actual responsibility for what happened</td>
</tr>
<tr>
<td>Elimination by Aspect</td>
<td>Eliminate an option or group of options from consideration upon the discovery of an undesirable feature</td>
<td>Failure to give full holistic consideration to viable options</td>
</tr>
<tr>
<td>Risk and Loss Aversion</td>
<td>Avoid the foreseeable risk of sustaining a loss by not changing the status quo</td>
<td>Paralysis of decision making stuck in the deteriorating status quo</td>
</tr>
<tr>
<td>Zero-out Tendency</td>
<td>Simplify decision contexts by treating remote possibilities as if they are not even possibilities</td>
<td>Failure to appreciate the possibilities that events could actually turn out differently than expected</td>
</tr>
</tbody>
</table>
Table 2: An idealized example of the concept person as it changes across the complexity orders

<table>
<thead>
<tr>
<th>Complexity order</th>
<th>A Person is…</th>
<th>Abstraction</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>My mom?</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; order representation</td>
<td>Mapping: Person is a mapping of several 1&lt;sup&gt;st&lt;/sup&gt; order representations.</td>
</tr>
<tr>
<td>Abstraction</td>
<td>A person cooks food a lot, and goes to his job. Like my Dad. My teacher is a person, and I am a person, but I’m a kid too.</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; order representation</td>
<td>System: Person is a system of 2&lt;sup&gt;nd&lt;/sup&gt; order representations with two variables on the input.</td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representational mappings</td>
<td>I’m a person you are a person. A person does things. Like talk to friends and eat to stay alive so they can have fun.</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; order representation</td>
<td>System: Person is a system of 2&lt;sup&gt;nd&lt;/sup&gt; order representations with two variables on the input.</td>
</tr>
<tr>
<td>Single abstractions</td>
<td>A person is a human being. Human beings live all over the world; they all know how to think except little babies. I heard humans used to be monkeys but then we got smarter. People are intelligent. They have feelings and ideas.</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; order abstraction</td>
<td>Definitional: Person is defined as a 1&lt;sup&gt;st&lt;/sup&gt; order abstraction, which is a conceptual integration of representational systems.</td>
</tr>
<tr>
<td>Abstract systems</td>
<td>A person uses reason; they are animals, but they are different from animals because they think about things better. A person has responsibilities, in life. You know, a person is somebody, with a personality of his own. It’s hard to get to know somebody because the real person is on the inside. A person has a soul.</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; order abstraction</td>
<td>Mapping: Person is a mapping of several 1&lt;sup&gt;st&lt;/sup&gt; order abstractions.</td>
</tr>
<tr>
<td>Abstract mappings</td>
<td>A person is like a whole world in themselves. So, you have to respect the unique emotional temperaments, life circumstances and perspectives of everyone. And you can’t separate one of those aspects from the others because they all interact with each other. That’s why people are so complex. That’s why we need to be conscious of individuality.</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; order abstraction</td>
<td>System: Person is a system of 2&lt;sup&gt;nd&lt;/sup&gt; order abstractions. Here several variables which are at least 2&lt;sup&gt;nd&lt;/sup&gt; order abstractions are coordinated on the input.</td>
</tr>
<tr>
<td>Single principle</td>
<td>The concept of person, as I define it, can be used to coordinate what often seems like a rift between an individual’s unique system of meaning and a society’s complex web of structures and institutions. The concept of ‘person’ is a way of thinking about the mutual-dependence between these two systems. It is in the ‘person’ that the citizen, (as defined by a system of rights, liberties, social roles etc.) and the individual, (as defined by system of unique choices, motivations and meanings), meet and embody their interdependence. You can not really have one system with out the</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; order principles</td>
<td>Definitional: Person is defined as a 1&lt;sup&gt;st&lt;/sup&gt; order principle, which is a conceptual integration of two abstract systems.</td>
</tr>
</tbody>
</table>
other. Only in the social space provided to the citizen can an individual flourish, understand him or herself, and develop. And yet, only with the unique development of motivations and meanings can individuals fulfill their roles as citizens. So I understand ‘persons’ in this way, as they embody the fragile interdependence of the mind and society.
List of Figures

Figure 1. A simple two-level argument map (built using Rationale™) illustrating a set of reasons we might generate in support of our belief that ‘a dog is a person’s best friend’.

Figure 2. The decision not to quit smoking
Adapted with permission from Facione and Facione (2007, Figure 23, p. 160.)

Figure 3. Concept map displaying the structure of representational mappings level performance

Figure 4. A set of concepts mappings displaying the structure of a single abstractions level performance

Figure 5. Vision Statement for Greek Cypriots designed using Interactive Management (IM)

Figure 6. Vision Statement for Turkish Cypriots designed using IM

Figure 7. Collective Vision Statement for Peace Building Efforts in Cyprus
Dogs are peoples' best friend.

- Dogs are loyal.
- Dogs aid people's mental wellbeing.
- Dogs have evolved to have strong hierarchical social instincts -- they respect the leader of the pack: you.
- My dogs have always been faithful.
- Dogs decrease their owners' cholesterol levels.
Other Option

Chosen

1) I want to live

Abandoned argument

Smoking’s going to kill me

21) You’d think that would be enough to stop me

20) … and that’s in my family

18) Dad died of heart disease

7) I can quit smoking

4) I’m an idiot!

I must quit smoking NOW (Never spoken)

9) and 10) I met a guy who smoked and without thinking I started smoking again.

19) Smoking Leads to heart disease

12) I have work responsibilities

14) I must remain able to function.

13) To function, I’ve gotta smoke.

6) Maybe I can’t manage to control my smoking.

11) But it takes time to quit and to sustain it.

3) I can’t believe I started smoking again

19) I will quit someday.

22) I do not have enough energy to quit now.

21) I can’t quit smoking (Never spoken)

17) I know I must quit someday.

17) I know I will quit.

9) and 10) I met a guy who smoked and without thinking I started smoking again.

9) Maybe I can’t manage to control my smoking.

5) and 23) I can’t quit now. I’ll quit someday.

16) I have to be a responsible parent.

I did quit for two months.

11) But it takes time to quit and to sustain it.

11) But it takes time to quit and to sustain it.

19) Smoking Leads to heart disease

13) To function, I’ve gotta smoke.

12) I have work responsibilities
A person

- cooks food a lot
- goes to his job

is

- me
- my teacher

but

I'm a kid too

like my dad
A person is a human being.

A human being live all over the world. They all know how to think. Except little babies, they used to be monkeys, but then we got smarter.

A person is intelligent. They have feelings and ideas.
Legend for Figures 1-3:
-- The arrow should be interpreted as:
“Significantly Supports”
-- The letter-number combination after each statement indicates the
category in which the item was grouped (see results section) plus a numerical
label for the item.

To help build a country where everybody's needs are everybody's concern
(E-22)

• To empower Cypriots to envision a Cyprus where people live in peace and
to believe that this is possible now (D-34)
• To learn to accept differences in culture and start thinking of them as
positive, interesting, and enriching factors (E-47)

• To develop public confidence in the peace building process (A-42)
• To provide opportunities for expression and analysis of new ideas (F-63)

To eliminate the fear of losing our “Greekness” when involved in peace building (G-41)

To work toward the establishment of integrated schools (J-69)

To promote confidence in our Cypriot state and in ourselves as citizens of Cyprus (G-49)

To build a solid understanding in both communities of the need to work together for the mutual satisfaction of interests (D-12)

To motivate and organize women to participate in shaping a peaceful political future for Cyprus (C-51)

To enhance breaking with or transcending the past as a way of opening up the future (D-50)

To promote democratic and humanistic values, particularly in the younger generation (E-8)

To modify image of peace building projected by mass media (A-53)

To stress the relatedness of peace building with the Christian religion (A-68)

• To begin to develop non-adversarial attitudes (E-2)
• To develop a peace culture in Cyprus (E-59)

• To involve people from all possible tracks in the peace building effort (C-36)
• To provide opportunities for interaction between the two communities (I-6)

To promote both communities working together on common projects (I-9)

• To establish an effective peace-building movement with a clear vision and a more effective practice (B-14)
• To build intercommunal institutions and centers (I-3)
• To build bridges of mutual empowerment and understanding with Track I level (C-39)
• To build new and strong bridges of communication with Turkish Cypriot peace building groups (C-20)

To develop a creative and generative approach in facing the Cyprus problem (F-48)

To begin to take significant steps toward demilitarization (K-38)
**Vision Statement for Turkish Cypriots**

- To create a mutually acceptable peaceful resolution in Cyprus (K-3)
- To transform the status quo into a bi-communal and bi-zonal federal state (K-18)
- To eliminate the economic differences between the two communities of Cyprus (G-7)
- To provide opportunity for the trainers of conflict resolution to put their learnings into practice (B-36)
- To stimulate the idea of cooperation rather than confrontation (F-38)

- To form a common vision for both communities (H-75)
- To enable T/Cs and G/Cs to have a determining voice in designing their island's future (G-4)
- To advocate realization of Confidence Building Measures (K-58)
- To help secure the equal political status of both communities (G-37)

- To encourage people to accept and respect each communities' basic needs (E-96)
- To make sure that stupidity does not rule over wisdom (D-14)
Collective Vision Statement for Peace Building Efforts in Cyprus

- To help build a country where everybody's needs are everybody's concern (E-1)
- To try and create a proper climate where Turkish Cypriots will ask for Greek Cypriots whatever they want for themselves and where G/Cs will refuse anything for T/Cs that they don't want for themselves (D-10)
- To promote the idea that the security problem of both communities could be lessened by demilitarization (K-26)
- To come up with a solution that will satisfy the security needs of both communities (K-41)
- To minimize the effects of outside powers (K-29)

- To empower Cypriots to envision a Cyprus where people live in peace and to believe that this is possible now (D-2)
- To learn to accept differences in culture and start thinking of them as positive, interesting, and enriching factors (E-3)
- To work for an independent bicomunal bizonal federally united Cyprus with full respect to human needs and rights and develop the appropriate public mentality to support it (K-43)
- To make known and acknowledge the basic needs, fears and aspirations of each community to the other community (H-21)
- To eliminate the "enemy image" (E-11)
- To stimulate the idea of freedom of movement throughout the island (K-19)
- To encourage youths of both communities to get to know each other (I-36)
- To accept and respect each others' identity as T/Cs and G/Cs and see this as a richness rather than an obstacle to peace building (G-32)

- To develop public confidence in the peace building process (A-4)
- To strengthen the peace movements on the citizen level (B-12)
- To promote the idea in G/C community that the existence problem of T/C community is vital for the whole of Cyprus (H-18)
- To help the two communities create a common vision (H-27)

- To try and find ways to bridge the economic differences between the two communities (K-37)
- To build a climate in which the ethnic identities of the two communities are not threatened (G-6)
- To support in both communities the idea of joining the European Union (K-28)

- To provide opportunities for interaction between the two communities (I-8)
- To build inter-communal institutions and centers (I-9)
- To promote bi-communal commercial, cultural, educational and sports activities (I-15)
- To establish an effective bi-communal peace movement (B-30)
- To promote cultural and social relations between the two communities (C-16)
- To promote both communities working together on common projects (I-7)

- To build bridges of mutual empowerment & understanding with Track I people (C-42)