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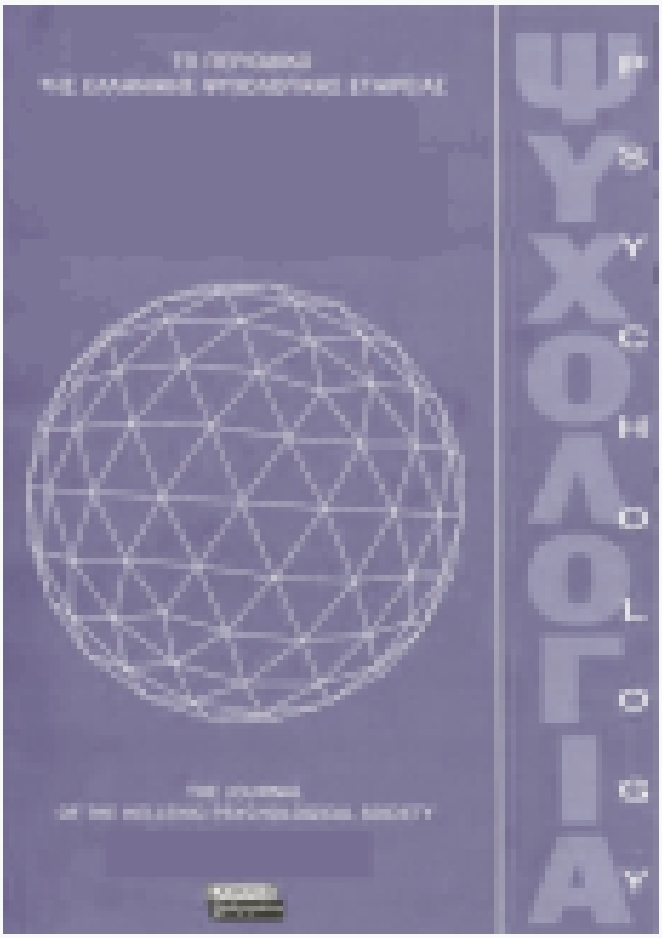

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Esperanto and the tower of Babel: A taxonomy of thinking

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ABSTRACT A taxonomy of thinking is proposed as an organizational framework that can facilitate the development and transfer of new ideas about thinking. "Thinking" is divided into directed and nondirected thinking categories, which are further classified into subcategories. Four types of "directed thinking" are defined —habitual, wishful, superstitious, and critical thinking. Critical thinking, the main focus of this paper, is divided into five skill groups. The hierarchical organization of thinking-related concepts and their definitions will enhance communication among researchers and theorists from psychology, cognitive science, philosophy, education, and other academic disciplines.

Key words: Critical thinking, thinking, thinking taxonomy.

According to a story in the Old Testament in the Bible, the descendants of Noah were constructing a tower so tall that when it would be completed, it would reach into heaven. Unfortunately, their presumption that they could achieve heavenly heights so angered Jehovah that he devised a simple, but effective, plan to disrupt the construction. Jehovah created massive confusion by having the builders speak different languages, which was an effective ploy that disrupted communication. Without a common language the Tower to Heaven could not be built. According to this Biblical tale, the builders were then scattered all over the world, and that is why, to this day, people in different countries speak different languages. The great Tower to Heaven was reduced to a mere Tower of Babel because the builders lacked a common language.

If Paradise could be lost because of language problems, imagine what the absence of a common language could mean to the development of a field of study, especially an interdisciplinary field like critical thinking where the investigators have not developed a commonly agreed upon jargon to facilitate the generation and transfer of new ideas. Instead of reaching upward to the heaven, modern psychologists, cognitive scientists, philosophers, and educators are reaching inward, probing the depth of the human mind and its underlying architecture, the brain. Like our ancestors, we need a common language so that we can communicate in ways that will facilitate our task. Modern psycholinguists have proposed an easy-to-learn, grammatically-simple, universal language called Esperanto, to solve the problems that arise when different peoples lack a common language. So, too, we need an Esperanto for those of us who work in the field of

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critical thinking, where the same terms are used with different references and different terms with fuzzy boundaries obfuscate meaning. I am proposing a set of common meanings and a way of organizing and classifying concepts, sort of an Esperanto or dictionary, to be applied to various thinking-related terms, so that we can move beyond the problems of definitions and explore the vast inner space that sits beneath our skulls.

The need for definitions

When we use language, we are relying on words to construct a shared mental representation of the information we are trying to convey. In most situations, normal humans use language effortlessly and without conscious awareness as they communicate with each other. If I wrote, "I am now sitting at my computer," the reader would have a clear idea of the intended meaning, even though you may have never met me personally and you have no knowledge of the type of computer that I am using or where the computer is located. These additional details are not needed to convey the intended thought, although they would be needed if I asked you to draw an accurate picture of "me at my computer." A good definition will have enough specificity and detail to allow effective communication, neither more nor less. Whenever we communicate, via language or some other mode such as through art or music, the level of detail that is used depends on the level that is needed to communicate ideas effectively. The definitions and examples that I propose for thinking-related terms have been selected with enough descriptive detail for their intended purpose, even though there will be much that, necessarily, is not contained in each definition.

Language is alive

The meanings of words change over time. Lovers of etymology, the formal term for the study of word origins, are often fascinated with the ways in which words change from their original meanings to their present day ones. For example, in the modern English language, the word "gay" is commonly used as a prideful term for homosexual males. Its original meaning was synonymous to "wanton and licentious" -hardly the positive meaning that it has today (at least for those who support gay rights). So, too, the meanings that I am proposing may be somewhat different from the way the same terms were used by early philosophers in ancient Greece or the early cognitive scientists whose work dates back to the early 1960s. This sort of evolution in word meanings is inevitable. For example, modern communism as it is practiced in China bears little resemblance to the way communism was defined by Karl Marx. The comparison between old and new meanings can be made, but we cannot pretend that the meaning of many words has remained unchanged. The definition that I am proposing for thinking-related terms are based on common usage at the end of the 20th century and start of the 21st. It is not a matter of one definition being more "objectively correct" than another. It is simply a matter of what words commonly convey in their meaning at a particular time in history, and to a lesser extent, to a particular culture or language group.

Having just noted that the meaning of words can change over time and place, it is also true that word meanings are not truly elastic; common word meanings have boundaries. For example, an advertisement for a plastic surgeon touts that he is a "specialist" in a long list of surgeries (nose reductions, tummy "tucks", liposuction, breast enlargements, etc.). This is a hyped contradiction in terms because the term "specialist" refers to a narrow, but deep knowledge of a particular area. One cannot, by definition, specialize in long lists of topics. Such a person would be, by definition, a generalist, who presumably traded depth of knowledge for breadth of knowledge. The misuse of the term "specialist" in the advertisement is a deliberate attempt to mislead readers and to get them to purchase a wide range of plastic surgeries from the physician being advertised. The deliberate

misuse of words to cloud communication is a common advertising scheme for selling a product to confuse consumers.

Communication in the field of critical thinking will advance when words take on more precise meanings.

A taxonomy of thinking

A taxonomy is a classification system that is useful in organizing a vast amount of information. Taxonomies are based on logical "rules" that are used for defining categories and relationships among categories. For example, the biological world is divided into living and nonliving things. Those that are living are further categorized into animals and plants, and so on with numerous subcategories, each sharing essential common features (e.g., all birds have feathers). The taxonomy imposes an order that, in turn, makes learning and recall easier and provides a structure for comprehension. It can serve as a foundation for the advancement of new knowledge. A taxonomy for thinking is proposed here to accomplish the same goals.

An organizational structure for classifying types of thinking is presented in Figure 1. As seen in this figure, "thinking" is the head classification for this tree structure. It is divided into "directed" and "nondirected" thinking, with directed thinking further divided into "habitual", "wishful", "superstitious", and "critical" thinking. These subcategories are divided even further into specific subtypes. Types of critical thinking are defined in the following sections according to rules for their appropriate use.

But what is thinking?

We 've all done it, it seems impossible not to do it, and we believe that we can recognize when others are doing it, but what exactly does it mean to think? If you have ever watched the face of someone working on a difficult problem, there is a concentrated intensity that can be inferred from the individual's facial expressions and other muscles that signal a person "deep in thought". But, no one has ever actually seen thinking, only the secondary signs that we interpret to mean thinking. Modern advances in brain imaging have provided new ways of peeking into human brains. We can now identify those portions of the brain that are most active when someone is working on a problem or analyze the evoked potentials recorded from the scalp of individuals who are subjected to different stimuli (Posner & Raichle, 1994). But these new views of normal, intact brains are mere reflections of thinking, not the actual process. Thinking is still internal and known only to the thinker, just as it always has been, despite our best attempts to "see" thinking as it happens.

Thinking is an internal cognitive activity in which mental representations of objects and ideas are manipulated and transformed. This broad definition allows for a wide variety of processes that can be either conscious or unconscious, effortful or effortless, effective or ineffective, visual or nonvisual, and goal directed or nondirected. We can never have direct knowledge of another person's thinking; it is always inferred from behavior, including self report. At the neural level, a level of analysis that is far removed from consciousness or volition, thinking is patterned firing of neurons and the electrochemical processes that define neural activity. Although neural level analyses are fascinating, they are not a useful level of analysis for cognitive psychologists, educators, philosophers and others who are concerned with the molar aspects of thinking because we are still left with the fundamental question of how neural processes become thoughts and how individuals can direct their own thought processes so that they will be effective and efficient.

Directed and nondirected

When most people think of thinking, they usually have in mind the mental activity that underlies goal-directed behavior. Thinking is

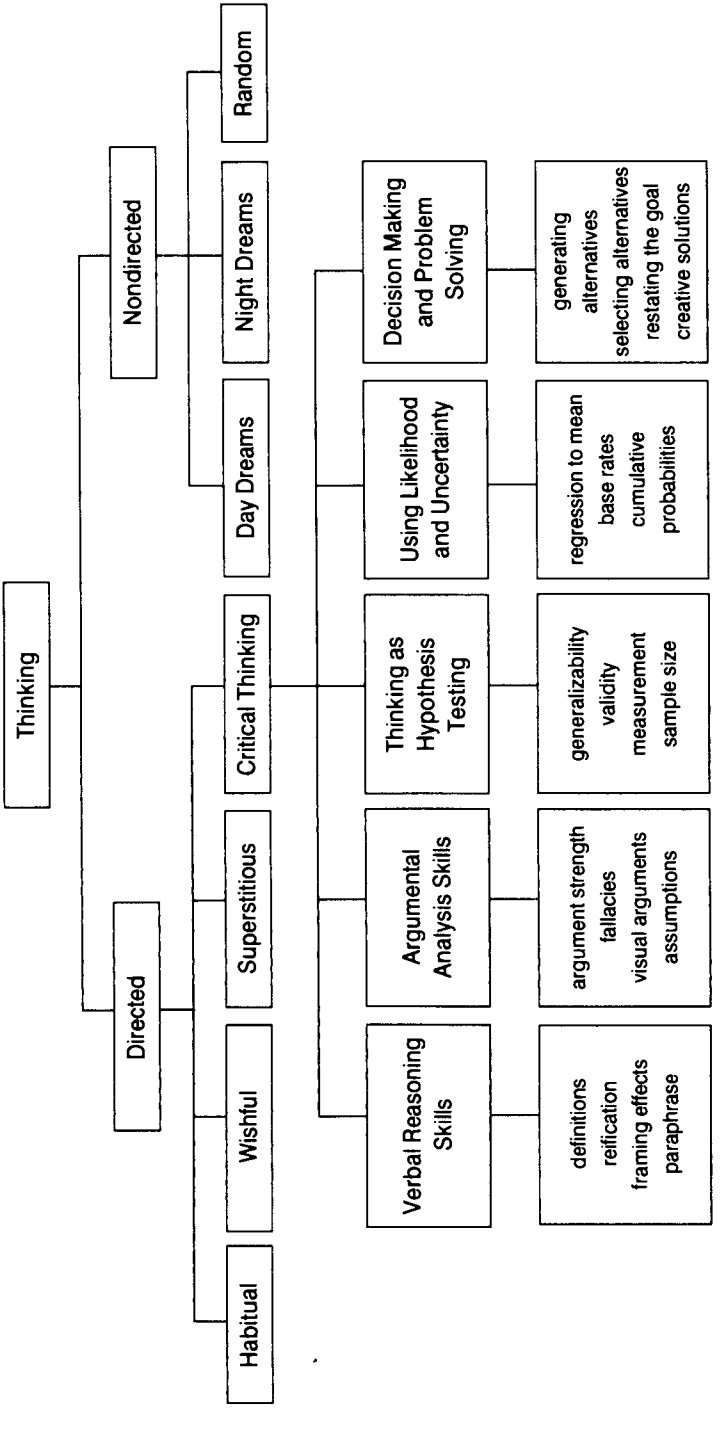

Figure 1:
A taxonomy of thinking

goal-directed when it is being done to achieve a particular end, such as solving a math problem, getting home from school, earning money, winning a game, finding a date, or staying healthy. **Directed thinking** is a type of thinking in which the thinker is attempting to achieve a specific goal; it is purposeful and goal-oriented. Because thinking is never directly known or observed, except perhaps, for our own thoughts, we use analogies to guide the way we think about thinking. A spatial analogy is often helpful. When thinking is directed, the thinker is attempting to reach a desired goal or end-state. For thinking to be goal-directed, there must be a gap between the thinker and the goal. Thinking, the symbolic manipulation of objects and ideas, is the means for reducing the distance between where the thinker is and the thinker wants to be. It is the plan that precedes action. If I wanted to solve a math problem, for example, the solution would be the goal. I would engage in directed thinking to find ways to move from where I am (not at the solution; a state in which the problem is not solved) to the goal.

Nondirected thinking is neither purposeful nor goal-oriented. If you can recall a recent daydream, then this term will be more meaningful to you. *Daydreams* occur during waking hours (regardless of the time of day, which makes "day" dreams a misnomer). Ideas and images often seem to float by during a daydream, without any apparent direction or purpose. Daydreams may be motivated by unconscious desires to achieve a goal, but the daydreams themselves, the sequence of ideas and images, are not tied to any obvious problem or decision. Similarly, *night dreams,* which often involve vivid images and snippets of thought, are not tied to any identifiable goal, and therefore, are classified as examples of nondirected thinking. A third type of nondirected thinking is the seemingly *random/unconnected* thinking that individuals with schizophrenia and other psychotic disorders appear to use when we cannot discern any goal or pattern to their speech or behavior. The sprinkling of words without meaning and the use of rhyming words instead of words that are conceptually related, a condition labeled as "word salad", does not seem to be focused on a desired end state. Seemingly random thoughts are the hallmark of the "disorganized thinking" exhibited by schizophrenics. To a lesser extent, some randomness in thinking occurs in normal persons, and when it does, it is also categorized as nondirected.

Four types of directed thinking: Habitual, wishful, superstitious, and critical thinking

Directed thinking can be divided into four types, and to some extent, everyone engages in all four types -habitual, wishful, superstitious, and critical- with individual differences in the relative mix of these four types of thinking and the situations in which each is used. As its name suggests, **habitual thinking** is the (relatively) automatic or effortless use of a well-learned pattern of thought. For example, the route I use to drive to the university everyday is well learned, and I follow it with very little conscious effort. If there is a traffic alert or detour, I switch to a more effortful type of thinking and change my route in ways that depend on the specifics of the situation, such as where I am, when I have to change my route, weather conditions, and other route-relevant variables. Thus, when forced, habitual thinking gives way to more critical thinking that is context-sensitive and uses higher level thought. Habitual thinking is a great time and effort saver, but it can be detrimental at times. If a new and faster route becomes available, but I never think to try it because I am so deeply "stuck" in my habitual route, then the habit becomes a detriment. Similarly, I can solve a wide range of problems quickly and easily with well-learned habitual solutions. Habitual thinking is useful and necessary, but occasionally, thinkers need to reassess situations and seek better alternatives to old ways of thinking.

The classic example of habitual thinking is participant responses to the "water jar problem" (Luchins, 1942). In this problem, participants have to use three different size jugs to measure a

specified quantity of water. The first four problems are all solved with the same sequence of jugs (i.e., fill the second jug, then fill the first one from the second jug, and then pour the contents into the third jug). The fifth problem can also be solved with this sequence of jug fillings and emptyings, but there is a much simpler solution (fill one jug then empty it into a second one). Most people rely on the solution that they used in the first four problems -a habitual way of thinking- and never notice the quicker and more direct solution. Habitual thinking can be helpful in that it saves solution times because there is no need to engage in the more effortful types of thinking, but it can blind us to better solutions.

Wishful thinking is also well documented in the psychological literature. **Wishful thinking** can be seen when people overestimate their chances of success or the likelihood of a desirable outcome. There are numerous examples of wishful thinking, even among the most gifted of scientists. It seems that humans are a generally optimistic species. Seligman (1991) has shown that optimism may have beneficial health effects. He has also documented the way optimistic assessments of uncertain situations affect how many people think and act. It seems that political candidates who are optimistic in their predictions about the future are more likely to garner winning votes than opponents who present less optimistic views about the future. In 9 out of 10 presidential elections in the United States, the candidates who gave the more optimistic speeches were the winners. Wishful thinking represents a systematic bias in assessing possible outcomes. Although wishful thinking is a positive human trait, it becomes a detriment when it distorts objective likelihoods. It can lead to disastrous long-run consequences when individuals fail to consider or to give appropriate weight to negative consequences or the probability of undesirable outcomes.

Critical thinking is the use of those cognitive skills or strategies that increase the probability of a desirable outcome -in the long-run, critical thinkers will have more desirable outcomes than those engaged in the other types of directed thinking (i.e., noncritical thinking), where "desirable" is defined by the individual, such as making good career choices or wise financial investments. Critical thinking is purposeful, reasoned, and goal directed. It is the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions. Critical thinkers use these skills appropriately, usually without prompting and with conscious intent. When we think critically, we are evaluating the outcomes of our thought process -how good a decision is or how well a problem is solved (Halpern, 1996). Critical thinking also involves evaluating the thinking process -the reasoning that went into the conclusion weve arrived at or the kinds of factors considered in making a decision. In the term "critical thinking" the word "critical" is not meant to imply "finding fault," as it might be used in a pejorative way to describe someone who is always making negative comments. It is used instead in the sense of "critical" that involves evaluation or judgment, ideally with the goal of providing useful and accurate feedback that serves to improve the thinking process.

Critical thinking skills are often referred to as "higher order cognitive skills" to differentiate them from simpler (i.e., lower order) thinking skills. Higher order skills are relatively complex, require judgment, analysis, and synthesis, and are not applied in a rote or mechanical manner. Higher order thinking is thinking that is reflective, sensitive to the context, and self-monitored. Computational arithmetic, for example, is not a higher order skill, even though it is an important skill, because it involves the rote application of well-learned rules with little concern for context or other variables that would affect the outcome. By contrast, deciding which of two information sources is more credible is a higher order cognitive skill because it is a judgment task in which the variables that affect credibility are multidimensional and change with the context. In real life, critical thinking skills are needed whenever we grapple with complex issues and messy, ill-defined problems.

By contrast, **superstitious thinking** is a kind of thinking that does not properly use those skills that increase the probability of a desirable outcome. Thus, the distinction between critical and superstitious thinking rests primarily on their empirical outcomes, in the long run. Critical thinking will yield more positive outcomes than superstitious thinking. Consider, for example, individuals who bet their entire life savings on a horse race, where the horse bet upon was selected by the roll of a die. It is possible that these individuals will "get lucky" and win a huge fortune, but, the decision to bet on this horse is not an example of critical thinking because, in the long run, the method or strategy that supported this decision will not lead to desirable outcomes. Thus, critical and superstitious thinking are differentiated by the long-term use of certain thinking skills or strategies, not the outcome on a single trial.

Operant conditioning is often used in the psychological literature to explain the origin and maintenance of superstitious thinking (Skinner, 1938). According to this view, when an act is followed close in time by an outcome, the person (or other organism) performing the act comes to believe that the act causes the outcome to occur. All living organisms strive to understand and predict events in the world, and we strive particularly hard to understand unusual events (Holland, Holyoak, Nisbett, & Thagard, 1986). We also need to rely on the information that is readily available. In the course of everyday living, people rarely have large samples of data collected from a sample randomly assigned to different conditions -the sort of information that would permit a conclusion about cause. Instead, we tend to rely on the faulty heuristics of everyday inductive processes and come to believe in many superstitions. For this reason, critical thinking skills usually have to be taught directly and overtly; few people will learn them without deliberate instruction. I am a staunch advocate for instruction in critical thinking because formal instruction is usually needed for a wide range of critical thinking skills to develop.

Critical thinking skills are identified with standard scientific methods, usually adapted for everyday use. An example should help with this concept. Suppose you are offered an herbal remedy for a headache. If this remedy has been shown to be effective through double-blind tests with large, randomly assigned samples of participants who are representative of the population, then the decision to take this remedy, assuming that there are no known negative effects, is an example of critical thinking. If this sort of evidence were available, it would be reasonable to expect that the decision to take the herbal medication would lead to a desirable outcome. On the other hand, if the remedy has not undergone these scientific tests, then it is superstitious thinking to believe that it will alleviate your headache.

Many superstitions can be thought of as sloppy or incomplete applications of critical thinking principles. Few people will take an herbal concoction that they know nothing about in the hope that it will cure a pain, but many people will take it when their only knowledge about the remedy is an endorsement from a single person ("it worked for me") or an advertisement where the seller has an obvious financial stake in getting people to believe that the herb is effective. In these examples, the decision that the herbal remedy is effective is based on a sample that is too small (sample size of 1) to yield meaningful conclusions and data that are biased in ways that make them invalid. It is fairly easy to see how many superstitions rest on critical thinking skills that are only partially understood. Superstitious beliefs do not arise in the complete absence of data -they rely on incomplete or shoddy data, such as the testimonial of a single person or information provided by a source that is obviously biased.

Critical thinking skills

A skills approach to critical thinking is predicted on two basic assumptions: (1) that there are clearly identifiable thinking skills which students can be taught to recognize and apply appropriately, and (2) when recognized and

applied in appropriate circumstances, the students will become better thinkers. There are many lists of skills that satisfy these criteria. Such lists usually include understanding how cause is determined, recognizing and criticizing assumptions, analyzing means-goals relationships, giving reasons to support a conclusion, assessing degrees of likelihood and uncertainty, incorporating isolated data into a wider framework, and using analogies to solve problems. Five categories of critical thinking skills are proposed as an organizing framework (with more complete lists presented in other publications, Halpern, 1996):

(1) ***Verbal reasoning skills*** - This category includes those skills needed to comprehend and defend against the persuasive techniques that are embedded in everyday language. Specifically, these skills include recognizing and defending against inappropriate use of emotional language, misuse of definitions, reification, understanding framing effects, and using questioning and paraphrase techniques to identify assumptions, alternative goals, and reasons and counter-reasons.

(2) ***Argument analysis skills*** - An argument is a set of statements with at least one conclusion and one reason that supports the conclusion. In real-life settings, arguments are complex with reasons that run counter to the conclusion, stated and unstated assumptions, irrelevant information, and intermediate steps. Specifically, these skills include judging the overall strength of an argument, recognizing common fallacies (e.g., straw person, black or white fallacy, association effects), and techniques of visual arguments.

(3) ***Skills in thinking as hypothesis testing*** - The rationale for this category is that people function like intuitive scientists in order to explain, predict, and control events. These skills include generalizability, sample size, accurate assessment, and validity, among others. These skills are sometimes labeled "scientific thinking" skills.

(4) ***Using likelihood and uncertainty*** - Because very few events in life can be known with certainty, the correct use of cumulative, exclusive, and contigent probabilities should play a critical role in almost every decision. A more detailed list would include applications of regression to the mean, recognizing base rate neglect, and related topics in probability.

(5) ***Decision making and problem solving skills*** - In some sense, all of the critical thinking skills are used to make decisions and solve problems, but the ones that are included here involve the generation and selection of alternatives and judging among them. Decision making is often used to refer to situations in which the primary task is to select from among a range of alternatives (decide which is best); problem solving is often used to refer to situations in which the primary task is to generate alternatives (e.g., come up with ways to get around a barrier).

The important distinction between well-defined and ill-defined problems and decisions is a critical component for the skills that belong in this category. A **well-defined problem** has a single goal that is easy to recognize, such as the answer to a problem in mathematics or a historical fact. By contrast, **ill-defined** problems are somewhat vague with many possible solutions, some of which are better than others. The tasks of writing a poem or finding ways to save money are examples of ill-defined problems. Well-defined and ill-defined problems and decisions often call for different solution strategies, making this a key dimension for determining how to attain a desired goal.

Creative thinking occurs when the solution is both unusual and highly effective. Creative thinking is subsumed under the decision making and problem solving category because of its importance in generating alternatives and restating problems and goals. When novel and useful alternatives are generated or selected, then the thinking that led to these outcomes earns the "creativity" label.

Critical thinking is more than skills

Although the skills of critical thinking are obviously needed to improve the probability of a

desirable outcome, mere knowledge of the skills won't make anyone a critical thinker unless there is also (1) the disposition to use the skills, (2) a metacognitive monitoring process in which the individual assesses whether the process is "working", and (3) the ability to recognize when a particular skill is likely to be useful (Halpern, 1998).

Dispositions of critical thinking

Critical thinking will not occur unless individuals are willing to exert the conscious mental effort that is needed to optimize desirable outcomes. There is a critical thinking work ethic analogous to what is required in physical work (Sears & Parson, 1991). Lazy or sloppy thinkers may have a large repertoire of critical thinking skills, but not be inclined to use any of them. Similarly, individuals may not be aware of the effortful nature of critical thought and may abandon the thinking process too soon in the belief that thinking should not be so difficult. A successful program of critical thinking instruction will make these dispositional attributes clear, so that individuals can plan for the work of thinking. No one can develop expertise in any area without engaging in the effortful processes of thinking (cf., Wagner, 1997).

Critical thinkers will exhibit the following dispositions or attitudes: (a) willingness to engage in and persist at a complex task; (b) habitual use of plans and the suppression of impulsive activity; (c) flexibility or open-mindedness; (d) willingness to abandon nonproductive strategies in an attempt to self-correct; and (e) an awareness of the social realities that need to be overcome (such as the need to seek consensus or compromise) so that thoughts can become actions (Halpern, 1998).

Metacognitive monitoring

Metacognition refers to what we know about how we think and remember and the way we use this knowledge (Langer, 1989). It is the self awareness of how we think, what we need to do to recall something or to put it into memory for recall at some later time. Critical thinkers are constantly monitoring their thinking and learning and altering their cognitive activity depending on the circumstances. Most people will repeat a string of numbers that they need to recall in 15 seconds as a conscious attempt to remember the numbers, but few people know what they need to do to comprehend and recall a very complex prose passage, or how to decide if irradiated food is safe, or if flu vaccines are a good idea. Individuals can learn to monitor and assess their own learning as well as ways to improve these processes.

Training to transfer

Finally, critical thinkers are able to recognize situations that require different sorts of critical thinking skills, understand the need to allocate cognitive effort according to task demands, and identify other context-sensitive strategies. Although some skills and strategies are more likely to be used in some contexts than in others, there is also considerable evidence for the transcontextual use of critical thinking skills, that is the use of the same skills (e.g., recognizing the misuse of definitions or black-or-white fallacies) in many different sorts of setting involving different sorts of problems (Kosonen & Winne, 1995; Lehman & Nisbett, 1990). Earlier assessments of critical thinking instruction criticized the idea that better thinking could be an outcome of education, based on the belief that critical thinking skills failed to transfer across contexts (e.g., Glaser, 1984). Since then, numerous successful programs documented the transfer of critical thinking skills and dispositions across domains of knowledge and across settings (e.g., school and home), so that we can now conclude that critical thinking will transfer, but transfer is often not easy or automatic. Instructional programs to enhance students' abilities to think critically need to be designed in ways that promote transfer, such as the use of

many types of problems drawn from multiple disciplines and frequent practice with targeted skills, distributed over time, and with a variety of examples. The critical component for transcontextual transfer is teaching students to recognize when skills are appropriate, even when surface attributes of a problem or context are highly dissimilar to the context in which a particular skill was learned or practiced.

In a recent paper by Hummel and Holyoak (1997), they describe the importance of sensitivity to structure of a problem as a fundamental property that underlies all human thought: "First thinking is structure sensitive. Reasoning, problem solving, and learning ... depend on a capacity to code and manipulate relational knowledge" (p. 427). Thus, when teaching for the transfer of thinking skills, it is essential that the structural aspects of problems and arguments are made salient so that they can function as retrieval cues. This sort of training so that the structure of a problem becomes salient is called **structure training.**

Thus, critical thinkers will have the disposition to engage in the effortful work of applying critical thinking skills, the ability to recognize which skills are likely to be useful, a repertoire of skills to select among, and the self knowledge to monitor progress. Any program designed to enhance critical thinking will have to include all four of these components.

Summary

An organizing taxonomy is proposed as a way of advancing the study of and instruction in thinking. Numerous terms have been grouped into a taxonomic hierarchy, a proposal that should advance the field by providing a commonly agreed upon language. Perhaps, this effort at categorizing and defining concepts will move us forward, if not to the heavens via a giant tower, then at least higher than we could move without a common classification framework.

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