Teaching Critical Thinking for Transfer Across Domains

Dispositions, Skills, Structure Training, and Metacognitive Monitoring

Diane F. Halpern
California State University, San Bernardino

Advances in technology and changes in necessary workplace skills have made the ability to think critically more important than ever before, yet there is ample evidence that many adults consistently engage in flawed thinking. Numerous studies have shown that critical thinking, defined as the deliberate use of skills and strategies that increase the probability of a desirable outcome, can be learned in ways that promote transfer to novel contexts. A 4-part empirically based model is proposed to guide teaching and learning for critical thinking: (a) a dispositional component to prepare learners for effortful cognitive work, (b) instruction in the skills of critical thinking, (c) training in the structural aspects of problems and arguments to promote transcontextual transfer of critical-thinking skills, and (d) a metacognitive component that includes checking for accuracy and monitoring progress toward the goal.

Here are some scary facts about the critical-thinking practices of college students and the American public in general: Approximately 78% of women and 70% of men read their horoscopes, with many believing that these horoscopes are so often correct that they were written especially for them (Lister, 1992); they phone their personal psychics, at a cost that many cannot afford, for advice on matters that range from how to invest their money to whether a loved one should be disconnected from life support systems; they spend huge sums of money on a variety of remedies for which there is no evidence that they work or are even safe to take—sometimes with disastrous results. In a survey of college students, more than 99% expressed their belief in at least one of the following: channeling, clairvoyance, precognition, telepathy, psychic surgery, psychic healing, healing crystals, psychokinesis, astral travel, levitation, the Bermuda triangle mystery, UFOs, plant consciousness, auras, or ghosts, and more than 65% reported that they personally experienced at least one of these phenomena (Messer & Griggs, 1989).

Beliefs in paranormal phenomena pose a problem for psychologists who want to understand how people create and maintain these beliefs when there is no credible evidence that they have any basis in fact. When psychologists probe for the origin of these beliefs, they find that believers in psychic phenomena often use scientific jargon and fundamental concepts of scientific understanding, but the words do not match their usual definitions and the concepts are misunderstood.

A recent article in the popular magazine *Life* (Miller, 1997) provides insights into paranormal beliefs. Miller quoted from his interview with someone he described as a physicist–astrologer: "To me, astrology was in the most flaky class of crystal-healing, useless poppycock . . . until I began to see the data" (p. 46). The data that changed this physicist into a devotee of astrology were "a few, small, but significant correlations" (p. 46), scattered among a large number of nonsignificant correlations. This evidence sounds like an operational definition of a Type I error to most psychologists, but to most people in the real world (where the real world is defined as those who have, at best, a fuzzy understanding of the principles of probability), these are convincing data. Although the differences may be more apparent, there are many similarities between the methods used by people with little or no scientific training and the scientific method. Like scientists, all people seek meaningful causal connections among the myriad of correlated events that they encounter, often looking especially hard for causal explanations for unusual events. It's not that occult beliefs arise in the absence of reasoning; they are more likely caused by bugs in the reasoning process. Naive and flawed reasoning practices, such as illusory correlations (believing that two variables are correlated when they are not), are resistant to change because they make sense to the individual, and for the most part, the individual believes that they work.

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Author's note. Correspondence concerning this article should be addressed to Diane F. Halpern, Department of Psychology, California State University, San Bernardino, 5500 University Parkway, San Bernardino, CA 92407-2397. Electronic mail may be sent to dhalpern@wiley.csusb.edu.

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Furthermore, for many believers in paranormal phenomena, the laws of the paranormal have to work only some of the time, so believers see no value in disconfirming evidence.

Consider a lead editorial in a recent edition of *USA Today* entitled "Forget Day-Care Research—Trust Your Instincts" (Parker, 1997). The readers of *USA Today* were urged to ignore the results of the National Institute of Child Health and Human Development's seven-year study on day care. Instead, they were asked to rely on Parker's intuition about the negative effects of day care. As Scarr (1997) recently noted, when the results of a scientific study of day care are pitted against intuition or the observations of a single individual, the general public tends to find these two sources of information equally compelling. Everyone has some experience with children and opinions about child rearing, and everyone believes that their personal experiences and those of people whom they trust are as valid and reliable as inferences made from large-scale studies. Numerous adages exemplify these beliefs, including "experience is the best teacher" (a misquote from Benjamin Franklin, who said that it was a dear or expensive teacher; Dawes, 1994) and "seeing is believing." Faceless statistical averages gleaned from large samples are no match for vivid examples that are experienced personally. Even statistically astute psychologists, who quickly criticize experimental designs with small sample sizes (especially when they do not like the conclusions), willingly accept their own personal experiences as valid and sufficient data (Dawes, 1994). This is why testimonials are so compelling, a fact that advertisers use to their advantage, and a single counterexample that supports a favored view ("I know a person who" phenomenon) is often used to disprove a conclusion derived from a large study (Gilovich, 1991). The primacy of personal experience is bolstered by two common themes that are repeated like a mantra in the popular media: (a) Science, like the government, cannot be trusted, and (b) anyone can lie with statistics. When the bases of personal beliefs are viewed in this context, it is easy to understand why large crowds gathered in Roswell, New Mexico, in the summer of 1997 to celebrate the golden anniversary of the landing of alien life-forms on earth. Bertrand Russell summed up the situation well when he said, "Most people would sooner die than think, in fact they do" (as quoted in Bolander, 1987, p. 69).

Given all of these examples, it is not surprising that many colleges in the United States and other places throughout the world now require all students to take a course in critical thinking as part of their general education program. There is virtually no disagreement over the need to help college students improve how they think. Both George Bush and Bill Clinton supported the national education goal for higher education that declared that it was a national priority to enhance critical thinking in college students, although this national priority was never funded (National Education Goals Panel, 1991).

Hunt (1995) examined the skills that will be needed by the workforce in the early decades of the next century and asked, "Will we be smart enough?" The answer to this question will determine the quality of life and the future of the United States and the whole planet. The most important reason for making the enhancement of critical-thinking skills the primary objective of higher education is that the rest of the world has changed and is continuing to change at an accelerating rate. As Hunt persuasively argued, the workforce is one critical place where the dizzying pace of change can be witnessed. The number of jobs available in manufacturing is shrinking; those workers with poor cognitive skills can expect more competition for fewer jobs that pay poorly, while at the same time, there is an increased demand for a new type of worker—this new job category has been dubbed the "knowledge worker" or the "symbol analyst" to describe someone who can carry out multistep operations, manipulate abstract and complex symbols and ideas, efficiently acquire new information, and remain flexible enough to recognize the need for continuing change and new paradigms for lifelong learning. Many of psychology's subdisciplines—human learning, life span development, program evaluation, cognition, social psychology, psychometrics, industrial–organizational psychology, and others—can be used to bring about fundamental changes in educational systems. The rate at which knowledge has been growing is exponential, and the most valued asset of any society in the coming decades is a knowledgeable, thinking citizenry—human capital is the wisest investment.

The information explosion is yet another reason why specific instruction in thinking needs to be provided. People now have an incredible wealth of information available, quite literally at their fingertips, via the Internet and other remote services with only a few minutes of search time on the computer. The problem has become knowing what to do with the deluge of data. The information has to be selected, interpreted, digested, evaluated, learned, and applied or it is of no more use on a computer screen than it is on a library shelf. If people cannot think intelligently about the myriad issues that confront them, then they are in danger of having all of the answers but still not knowing what the answers mean. The dual abilities of knowing how to learn and knowing how to think clearly about the rapidly proliferating information that they will be required to deal with will provide the best education for citizens of the 21st century.

Teaching for Critical Thinking

The goal of helping students improve their critical-thinking abilities represents a major change in the way the teaching and learning process is viewed. The term *critical thinking* refers to 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 "noncritical" thinkers (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, without prompting, and usually with conscious intent in a variety of settings. That is, they are predisposed to think critically. When people think critically, they are evaluating the outcomes of their thought processes—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 one 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 people grapple with complex issues and messy, ill-defined problems.

Can Better Thinking Be Learned?

There are numerous, qualitatively different types of evidence showing that students can become better thinkers as a result of appropriate instruction. Indicators of positive change include self-reports, gains in adult cognitive development, higher scores on commercially available and research versions of tests of critical thinking, superior responses to novel open-ended questions (graded blindly—without the rater knowing if the student received instruction in critical thinking), and changes in the organization of information, among others (reviewed in Halpern, 1996). The goal of instruction designed to help students become better thinkers is transferability to real-world, out-of-the-classroom situations. With this goal in mind, the ideal learning assessment would occur naturally in the course of one's life, in multiple settings, and would provide comparable measures before, during, and long after the instruction. It would describe what an individual thinks and does when reading a newspaper editorial, selecting a career objective, or voting on a bond issue at times when the individual is not aware of being assessed. Unfortunately, this sort of intrusive and surreptitious assessment is not feasible, but some clever attempts have come close. Lehman and Nisbett (1990), for example, examined the spontaneous transfer of selected thinking skills in an out-of-the-classroom, real-world environment. They phoned students at home several months after the completion of their course work and posed questions under the guise of a household survey. Results were supportive of the idea that the students had learned and spontaneously used the thinking skills that had been taught in their college classes when the questions were asked in an ecologically valid setting (their own homes), with novel topics, several months after the semester had ended. This sort of assessment provides evidence that critical thinking can be learned with appropriate instruction and that it can and does transfer to novel domains of knowledge. There are numerous other successful reports of the transfer of critical-thinking skills to a variety of settings (Kosonen & Winne, 1995; Nisbett, 1993; Perkins & Grotzer, 1997).

A Four-Part Model for Enhancing Critical Thinking

In critical-thinking instruction, the goal is to promote the learning of transcontextual thinking skills and the awareness of and ability to direct one's own thinking and learning. Although thinking always occurs within a domain of knowledge, the usual methods that are used for teaching content matter are not optimal for teaching the thinking skills that psychologists and other educators want students to use in multiple domains because instruction in most courses focuses on content knowledge (as might be expected) instead of the transferability of critical-thinking skills. For this reason, instruction in critical thinking poses unique problems. Fortunately, there already are powerful models of human learning that can be used as a guide for the redesign of education for thinking. The basic principles of these models are taken from cognitive psychology, the empirical branch of psychology that deals with questions about how people think, learn, and remember, or more specifically, how people acquire, utilize, organize, and retrieve information.

It is clear that a successful pedagogy that can serve as a basis for the enhancement of thinking will have to incorporate ideas about the way in which learners organize knowledge and internally represent it and the way these representations change and resist change when new information is encountered. Despite all of the gains that cognitive psychologists have made in understanding what happens when people learn, most teachers do not apply their knowledge of cognitive psychology (Schoen, 1983).

The model that I am proposing for teaching thinking skills so they will transfer across domains of knowledge consists of four parts: (a) a dispositional or attitudinal component, (b) instruction in and practice with critical-thinking skills, (c) structure-training activities designed to facilitate transfer across contexts, and (d) a metacognitive component used to direct and assess thinking. Each of these components is grounded in theories and research in cognitive psychology. The underlying idea is that the

general research-based principles of how adults learn can be used to enhance their critical-thinking skills (Angelo, 1993).

Dispositions for Effortful Thinking and Learning

Critical thinking is more than the successful use of a particular skill in an appropriate context. It is also an attitude or disposition to recognize when a skill is needed and the willingness to apply it. Sears and Parsons (1991) called these dispositions the ethic of a critical thinker. There are large differences among cognitive tasks in the effort that is required in learning and thinking. For example, most people effortlessly learn the plot of a television sitcom they are watching, but they need to expend concerted mental effort and cognitive monitoring to learn how to analyze complex arguments or how to convert a word problem into a spatial display. Similarly, routine problems tend to be solved with habitual solutions, sometimes so effortlessly that the problem solver has no conscious awareness of the process. By contrast, critical thinking requires the conscious exertion of mental effort. In other words, it is cognitive work. Learners need to understand and be prepared for the effortful nature of critical thinking so they do not abandon the process too soon, believing that the thinking should have been easier or accomplished more quickly. The development of expertise in any area requires deliberate, effortful, and intense cognitive work (Wagner, 1997). Not surprisingly, critical thinking is no exception to these general principles.

It is important to separate the disposition or willingness to think critically from the ability to think critically. Some people may have excellent critical-thinking skills and may recognize when the skills are needed, but they also may choose not to engage in the effortful process of using them. This is the distinction between what people can do and what they actually do in real-world contexts. It is of no value to teach students the skills of critical thinking if they do not use them. Good instructional programs help learners decide when to make the necessary mental investment in critical thinking and when a problem or argument is not worth the effort. An extended session of generating alternatives and calculating probabilities is a reasonable response to a diagnosis of cancer; it is not worth the effort when the decision involves the selection of an ice-cream flavor.

A critical thinker exhibits 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.

A Skills Approach to Critical Thinking

Critical-thinking instruction is predicated on two assumptions: (a) that there are clearly identifiable and definable thinking skills that students can be taught to recognize and apply appropriately and (b) if these thinking skills are recognized and applied, the students will be more effective thinkers. A general list of skills that would be applicable in almost any class would 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.

A short taxonomy of critical-thinking skills is proposed as a guide for instruction: (a) verbal reasoning skills—This category includes those skills needed to comprehend and defend against the persuasive techniques that are embedded in everyday language; (b) 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; (c) skills in thinking as hypothesis testing—The rationale for this category is that people function like intuitive scientists to explain, predict, and control events. These skills include generalizability, recognition of the need for an adequately large sample size, accurate assessment, and validity, among others; (d) likelihood and uncertainty—Because very few events in life can be known with certainty, the correct use of cumulative, exclusive, and contingent probabilities should play a critical role in almost every decision; (e) 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 generating and selecting alternatives and judging among them. Creative thinking is subsumed under this category because of its importance in generating alternatives and restating problems and goals.

The categories and skills listed in this taxonomy have face validity and, thus, can be easily communicated to the general public and students. They represent one possible answer to the question of what college graduates need to know and be able to do so that they can compete and cooperate in the world's marketplace and function as effective citizens in a complex democratic community. Taken together, these five categories (sometimes referred to as "macroabilities") define an organizational rubric for a skills approach to critical thinking. They have the benefit of focusing on skills that are teachable and generalizable and, therefore, would help to bridge the gap between thinking skills that can be taught in college and those skills that are needed in the workplace.

Structure Training to Promote Transfer

When one is teaching for thinking, the goal is to have students not only understand and successfully use the particular skill or strategy being taught but also be able to recognize where that particular skill might be appropriate in novel situations. The critical component in an

ecologically valid critical-thinking process is recognizing or noticing that a particular thinking skill may be needed. This is the Achilles' heel of transfer. It can be thought of as a problem of memory because recognizing the need for a particular skill involves the ability of external cues to trigger retrieval processes in long-term memory, so information about a thinking skill can move into working memory, where it can be consciously considered. As is known from cognitive psychology, what gets remembered at retrieval heavily depends on what occurred during learning. Information that is associated with material being learned can function as an effective retrieval cue when the learning is completed. For example, if one went to high school with a next-door neighbor, seeing or thinking about this neighbor in later years would bring a host of high school memories to mind by moving them from their dormant state in long-term memory into the active consciousness of working memory. The problem in learning thinking skills that are needed in multiple contexts is that there are no obvious cues in the novel contexts that can trigger the recall of the thinking skills. Students need to create retrieval cues from the structural aspects of a problem or argument, so when these structural aspects are present in the novel context, they can serve as cues for retrieval. Hummel and Holyoak (1997) identified structure sensitivity as a fundamental property that underlies 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 one is teaching for the transfer of thinking skills, one should ensure that the structural aspects of problems and arguments are made salient so that they can function as retrieval cues. An example should help with this concept.

Suppose that one is teaching students about "sunk costs," a difficult concept for many students to grasp. The general idea is that prior investments are not relevant to decisions about future costs. (If the prior investments are unrecoverable, they are, in effect, sunk or lost.) What is relevant is the value of the object from the present and into the future. Thus, if a friend explains that he or she plans to spend $500 to repair a beat-up, old car because the friend has already spent hundreds on its repair, he or she is making a sunk-costs argument. The decision should be based on whether the car is now worth a $500 repair; all of the previous costs are irrelevant for this decision. The goal of transferable thinking skills would be achieved if students recognize sunk-costs arguments when they are being made in totally different settings and can apply what has been learned about these arguments in the new settings. Psychologists and other educators want students who will retrieve and use their knowledge of sunk costs when they hear a senator urging Congress to spend millions of dollars on a missile system because the military has already invested billions into the missile system in the past or when a friend explains that he plans to marry a longtime girlfriend because they have already spent so many years together.

When critical-thinking skills are taught so that they transfer appropriately and spontaneously, students learn to actively focus on the structure of problems or arguments so the underlying characteristics become salient, instead of the domain-specific surface characteristics. The cues for recognizing all three of these situations as sunk-costs arguments are not in the content area. There is not much similarity among an old car, an expensive missile, and a bride-to-be. Information about sunk costs needs to be represented in the learner's memory in a generic form so that it will be recalled whenever this type of argument is made, regardless of the subject matter. On the basis of what is already known about adults' learning, students need spaced practice with different sorts of examples and corrective feedback to develop the habit of "spontaneous noticing." Learning should be arranged to facilitate retrieval of skills in a way that does not depend on the content area.

The representation of information in memory is a difficult and abstract concept. I am not referring to memory in terms of its neurochemical underpinnings but rather the relationship between the way information is stored and the way it is used for a particular purpose. Cognitive psychologists think of *meaning* as the way a concept is embedded in a web of related concepts. A concept has a rich or deep meaning when it has many connections to other concepts. When activated, or brought to consciousness, concepts can act as a recall cue for the related concepts to which they are connected. One way to promote effective organization is through the use of elaboration (and other techniques) that develop interconnected knowledge structures. In general, the greater the number of connections to information stored in memory, the greater the likelihood that it will be recalled.

When a person elaborates a concept, he or she forms many meaningful connections—the concept is related to other relevant concepts. There are many techniques that can be used in elaboration. An especially effective technique is the use of thoughtful questions, which require that learners create the necessary connections. This is also a good technique because recalling a fact or concept is different from learning it. The best way to ensure recall is to practice recall—not mindless practice, but meaningful practice with feedback. The questions used to develop connected knowledge structures need to be drawn from the real-world contexts that are frequently encountered in the workplace and in the exercise of citizenship. This requirement will virtually ensure face validity and will be consistent with the "situated cognition" viewpoint that is popular in the cognitive science literature and with one that I am extending to accommodate recall across domains (Glaser, 1992; Rogoff & Lave, 1984). Real-life thinking is done in a context, and a good learning environment provides a believable context for learning exercises.

Learning tasks, like real-world thinking tasks, should be rich in information. Some of the information available may not be relevant, and part of the learning

exercise involves deciding which information is important to the problem. What is important in the teaching and learning of critical-thinking skills is what the learners are required to do with the information. Learning exercises should focus on the critical aspects of the problems and arguments that utilize the skills. The tasks should require thoughtful analysis and synthesis. For example, the repeated use of "authentic" materials, or materials that are similar to real-world situations, is one teaching strategy to enhance transfer (Derry, Levin, & Schauble, 1995). Thinking skills need to be explicitly and consciously taught and then used with many types of examples so that the skill aspect and its appropriate use are clarified and emphasized. Examples of elaborative questions are presented in Table 1.

Table 1
Examples of Relevant Tasks and Questions That Require Learners to Attend to Structural Aspects of a Problem or Argument

Draw a diagram or other graphic display that organizes the information. (This sort of task makes the structure of a problem or argument clear.)
What additional information would you want before answering the question? (This requires the thinkers–learners to think about what is missing from the information that is given.)
Explain why you selected a particular multiple-choice alternative. Which alternative is second best? Why? (The giving of reasons is a good way to focus on the thinking that went into an answer rather than the answer itself.)
State the problem in at least two ways. (Most real-world problems are fuzzy, that is, they really are potentially many problems, each with its own possible solution.)
Which information is most important? Which information is least important? Why? (This question focuses the learners' attention on the value of different sorts of information.)
Categorize the findings in a meaningful way. (By grouping or labeling individual pieces of information, a structure emerges that is not apparent when they are kept separate.)
List two solutions for the problem. (This encourages a more creative approach.)
What is wrong with an assertion that was made in the question? (This reminds the learners that problems often contain misleading information.)
Present two reasons that support the conclusion and two reasons that do not support the conclusion. (Questions of this sort do not permit black-and-white reasoning.)
Identify the type of persuasive technique that is used in the question. Is it valid, or is it designed to mislead the reader? Explain your answer. (Learners are required to consider the motives and credibility of their information source when responding to these questions.)
What two actions would you take to improve the design of a study that was described? (Learners need to think about better types of evidence or procedures that might have provided different results.)

Metacognitive Monitoring

Metacognition is the executive or "boss" function that guides how adults use different learning strategies and make decisions about the allocation of limited cognitive resources. The term is usually defined as "what we know about what we know" and the ability to use this knowledge to direct and improve the thinking and learning process. It refers to the self-awareness and planning functions that guide the use of thinking skills. When engaging in critical thinking, students need to monitor their thinking process, checking whether progress is being made toward an appropriate goal, ensuring accuracy, and making decisions about the use of time and mental effort. Metacognitive monitoring skills need to be made explicit and public so that they can be examined and feedback can be given about how well they are functioning. A few explicit guiding questions can be used as a way of converting what is usually an implicit process into an explicit one. For example, students can be given a problem or an argument to analyze and then asked the following questions before they begin the task: (a) How much time and effort is this problem worth? (b) What do you already know about this problem or argument? (c) What is the goal or reason for engaging in extended and careful thought about this problem or argument? (d) How difficult do you think it will be to solve this problem or reach a conclusion? (e) How will you know when you have reached the goal? (f) What critical-thinking skills are likely to be useful in solving this problem or analyzing this argument? As students work on the problem or argument, they should be asked to assess their progress toward the goal. (g) Are you moving toward a solution? Finally, when the task is completed, the students should be asked to judge how well the problem was solved or how well the argument was analyzed. Well-structured questions will help students reflect on their learning and may provide insights that will be useful in the future.

Correcting Faulty Thinking Patterns

The four-part model being proposed is designed for teaching and learning a large and flexible repertoire of critical-thinking skills, assessing their effectiveness, and developing the disposition to use them. It is, by design, best suited for achieving the goal of transferable thinking skills that are used across domains of knowledge. It recognizes the critical role played by dispositional attributes, provides examples of directed learning activities to facilitate the transfer of general skills across domains, and provides examples for making metacognitive monitoring more active and conscious. How can this model be used to get the horoscope-reading, psychic-phoning students in classes to think more critically about these topics?

First, like students, instructors need to understand that this will be an effortful process. Beliefs that have been constructed over many years and the habits of mind that developed along with them will take multiple learning experiences, distributed over time and settings, before they will be successfully replaced with new ways of

thinking and knowing about the world. Students need to be told to expect that a thoughtful consideration of evidence and arguments will require the expenditure of mental effort so that they do not expect quick and easy answers and will not be surprised by the amount of effort required of them. To change a mental model of how the world works (e.g., the position of the planets at the time of one's birth predicts personality traits), instructors need to understand the mental models that exist prior to instruction and design learning activities that expose the errors in these naive models and make the benefits of the new model obvious. For example, students can more objectively examine their underlying beliefs by making clear, explicit statements about the reasons they believe that horoscopes are valid predictors of the future or sources of sound advice. Counterevidence can then be used to challenge these beliefs. A good demonstration for analyzing horoscopes is to give a class 12 unlabeled horoscopes and have students select the one that is most descriptive of them. After collecting the responses, the instructor can determine if the students scored significantly above chance in selecting the horoscope corresponding to their "sign" (Ward & Grasha, 1986). A follow-up activity is to have the class generate a list of possible "tests" that would provide evidence about the validity of horoscopes. This list will usually lead to an examination of the vague language used in horoscopes, the absence of a rationale for the belief that the time of one's birth is a significant predictor of personality or future events, and more. As information is gathered and reasoning analyzed, students can make judgments about their own degree of belief in horoscopes so that they are consciously monitoring their understanding and thinking processes. Extensions of this exercise to palm reading and graphology can provide the transcontextual practice that focuses on the structural similarities among these ways of predicting future events. The goal of these exercises is not to take any particular dogmatic stand but to give students critical-thinking skills so they can make better informed decisions and solve problems with a greater likelihood of success.

The emphasis in learning activities, such as this one, is on the identification and use of transferable thinking skills so students will be better prepared for the unknown challenges in their future. When psychologists and other educators consider that many college students may be working at jobs that do not exist today and living in the decades beginning with 2060 and 2070, it seems clear that the ability to think clearly and the disposition to engage in the effortful process of thinking are the most critical components of their education. The enhancement of critical-thinking skills is also the most challenging and personally rewarding task in which psychologists and educators can engage.

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