



A Guide to  
Understanding, Learning, and Practicing  
Critical Thinking

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*Critical Thinking @ Olin*

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## **Sandi's Story**

Sandi, a second-year MBA student, emerged from his interview elated. He just knew that he had passed with flying colors the first-round campus interview for his perfect job. He felt great!

The interview began like many others. A few minutes of pleasant conversation helped Sandi and his interviewer become comfortable with each other. Then, the interviewer presented a complex business issue. The issue involved a manager who was asked by his company's president to implement an innovation. This implementation was critical for the company because without its success, the company would likely not meet its revenue growth objective for the next year—a target that already had been communicated to Wall Street.

Launching the new product was complicated by the fact that cooperation from several departments within the firm, beyond the manager's immediate control, was needed to make implementation successful. Purchasing, manufacturing, marketing, sales, and supply chain logistics all needed to be coordinated for the launch to be a success. Moreover, this new product was unlike prior product launches, which implied that new routines for the product's launch needed to be created.

Within seconds of hearing the business case, Sandi's intuition gave him the answer. The situation seemed nearly identical to a case his organizational behavior professor discussed in class the prior year. Brimming with confidence, Sandi recited the implementation plan he learned in class. He described the sequence of steps he would follow if he were the manager as well as expounded on how dedicated and hard-working he would be. Indeed, Sandi expressed how nothing would get his way. Through force of personality and the authority granted him by the firm's President, he would confront and overcome any and every barrier.

Sandi thought the interviewer looked impressed with his answer. Courteously, Sandi thought, the interviewer asked a few "softball" questions about how Sandi would respond to certain impediments that might arise during his implementation plan. How easy would it be to gain cooperation from the operations manager? With a new type of product what might go wrong in supply chain logistics? How easy would it be to gain cooperation from marketing and sales managers? How easy would it be for sales people to sell a new type of product? Assured that his prior response was spot on, Sandi reiterated his approach and willingness to expend any effort necessary to overcome obstacles.

Three days later, Sandi received a letter from the interviewer thanking him for the time he spent in the interview. The letter stated that many top candidates interviewed for the position and several would be invited to corporate headquarters for the next round of interviews. Unfortunately, Sandi was not invited to the next round. He did not get his perfect job.

What happened? Sandi had the right answer hadn't he? He received high grades in most of his classes. In fact, he frequently expressed to others how he had worked his butt off in business school because doing so would land him his perfect job. How could this outcome have happened when he did everything right?

Sandi began to feel that business school had not prepared him appropriately for the interview. He got angry. In particular, he felt anger toward his organizational behavior professor who must have been wrong about the case and must have taught him poorly. His anger caused him to cast suspicion on the entire business school program. What else had not been taught well? Who else caused him to lose the opportunity for his perfect job?

This monograph describes in general the types of issues that Sandi and other business students and professionals can face when confronted with

complex ill-structured business problems. Not satisfied with simply describing what happened to Sandi, the monograph offers concrete practical steps—what is referred to as critical thinking—that, when followed, can lead to superior problem formulation and solving. To do so, the next section defines critical thinking by first exploring the notion of intelligent thinking. It explains why critical thinking skills are valuable to business students and executives. The monograph then delves into the different types of thinking processes such as deduction and induction and identifies common biases, fallacies, and impediments that can arise from thinking. The next section discusses the importance of disposition; that is, the need to be responsible for your own job. The remaining sections introduce the elements of thinking, processes for thinking about business and policy questions, and methods for learning critical thinking skills. It is hoped that this information will be useful in elevating your thinking skills.

## **Not All Thinking is Intelligent**

Unfortunately for Sandi, his interview, in retrospect, did not go well. While it is clear from the vignette that Sandi did engage in thinking during his interview, perhaps his thinking was in some way not as good as he believed it was. To explore the caliber of his thinking, let's first understand the definition of thinking. While numerous definitions of thinking exist, psychologists tend to describe thinking as mental effort aimed at formulating questions and problems as well as finding answers to questions and solutions to problems.

In business as well as in other fields, it is not just thinking but intelligent thinking to which most people aspire.

*Intelligence is the capacity to learn from experience, using metacognitive processes to enhance learning, and the ability to adapt to the surrounding environment, which may require different adaptations with different social and cultural contexts (Sternberg, 2005, 751).*

Metacognitive processes—processes that take place in your mind and enable thinking—encapsulate many different types of thinking, which are described below. Intelligent thinking uses cognition to learn and enhance learning and to adapt in different contexts by updating, improving, changing, or generating new mental representations. It is your development and application of intelligent thinking that is a primary goal of higher education and, in particular, this monograph.

Intelligent thinking, however, is not easy. Thinking is hard work, much harder than is often acknowledged. Thinking is constrained by the information and knowledge an individual possesses. Thinking also can lead to fallacies, introduce biases, and fail to overcome impediments that conspire to produce incorrect inferences, yield poor decision-making, and generate flawed problem solutions. Expanding limited information and knowledge and overcoming fallacies, biases, and impediments is the hard work that intelligent thinkers must perform.

From the brief summary of the interview, we can identify several of these weaknesses in Sandi's thinking. For instance, perhaps it was excitement, limited time in the interview, or lack of discipline in his thinking process that caused Sandi to quickly jump to a solution. Sandi did not seek out additional information or knowledge. Nor did Sandi explore possible alternative formulations of the problem, which could have provided additional contours to the landscape of the complex business issue. What did co-workers value? What was in their best interest and what were their tradeoffs in launching a new type of product for the company? Sandi may have provided an answer to a problem but was the most relevant problem answer? Sandi did not search for or verbalize his implicit assumptions.

Once the solution was introduced, Sandi was unable to consider other alternatives and issues even when prompted by the interviewer. Sandi failed to explore alternative points of view and the values held by the various managers from other departments. While comparison and

similarity may have led to an answer stored in memory, Sandi did not verify the logic of the proposed solution.

Sandi may have taken the special case from his organizational behavior class and inappropriately assumed it to be a general rule. And, after receiving the rejection letter, emotions caused Sandi to focus attention on seeking external causes for not getting the job instead of first looking within for sources of failure, which ultimately constrains the ability to learn, diminishes learning, and blocks adaptation so that Sandi can do better in the next interview.

The interview might have gone differently if Sandi's thinking demonstrated the same attributes that describe intelligent thinkers. The literature on education provides a detailed description of intelligent thinking. Sternberg et al. (1981) synthesized research that characterizes those people who are believed to be intelligent thinkers. They concluded that intelligent thinkers are believed to:

- reason systematically
- solve problems well
- think in a logical way
- deploy a good vocabulary
- make use of the rich stock of information
- remain focused on their goals
- display intelligence in practical as well as academic ways

Unfortunately, with bounded attention spans, limited short-term memory, and high opportunity costs for time to think (Simon 1955), intelligent thinking may be difficult to achieve. Indeed, a case can be made that many individuals regularly do not think intelligently and, instead, display a different set of thinking attributes. Perkins (1995) summarized research on individuals who are not considered to be intelligent thinkers.

The attributes of low intelligence thinking include:

- hasty (*impulsive, little deep processing in examining alternatives*)
- narrow (*assumptions not challenged, points of view not examined*)
- fuzzy (*careless, imprecise, full of compilations*)
- sprawling (*general disorganization, fails to advance or conclude*)

In his diversification decision, Sandi displayed few of the attributes of intelligent thinking and instead displayed several attributes of poor thinking. At a minimum, he was hasty and narrow in his responses and did not probe to seek out additional information. He failed to display systematic reasoning, did not focus on the logic of his analysis, and, ultimately, failed to solve the problem well.

## **What is Critical Thinking?**

As a means to instill in students and business executives the goal and ability to become intelligent thinkers, the Olin Business School introduced an initiative called *Critical Thinking @ Olin*. *Critical Thinking @ Olin* offers a systematic approach to developing intelligent thinking habits—habits that Olin refers to as critical thinking—for students and business executives with the goal of helping them advance their professional careers.

Many definitions exist for critical thinking; but all of them have much commonality. Critical thinking invokes disposition, elements of thought, thinking standards, and processes to advance the likelihood that individuals address appropriate and useful issues **and** develop inferences, answers, or problem solutions that are creative, well reasoned, and useful. The concept of what is “appropriate” and “useful” depends upon what we and others see as the purpose and value in responding to a situation. One of the many useful sources on critical thinking referenced herein comes from the Foundation for Critical Thinking (FCT).

*Critical thinking* is the mental process of actively and skillfully:

- raising vital questions and problems
- formulating them clearly and precisely
- gathering and assessing relevant information using abstract concepts to effectively interpret information
- coming to well-reasoned conclusions and solutions, testing them against relevant criteria and standards
- thinking open mindedly with alternative systems of thought, recognizing assumptions, application, and practical consequences
- and communicating effectively with others in figuring out solutions to complex problems

The *Critical Thinking @ Olin* initiative encompasses four primary building blocks. These building blocks are

1. developing the disposition for intelligent thinking,
2. understanding the elements of thought,
3. understanding standards for intelligent thinking, and
4. practicing processes by which these elements and criteria are applied to problem formulation, problem-solving, judgment, and decision-making.

Each building block is explored below in [Critical Thinking](#).

## **Why is Critical Thinking Useful?**

As described in the vignette of Sandi's interview, critical thinking skills (or more precisely, his lack of critical thinking skills) may have lead to the failed interview. Sandi's situation is not unique. Many have fallen victim to poor critical thinking skills. For instance, consider recruiters who visit Olin to hire our students. Discussions with recruiters who interview at Olin indicate that critical thinking skills are a vital requirement in all fields and positions for which they interview. Yet,

these same discussions reveal that finding students with strong critical thinking skills is difficult. Data shows that recruiters are looking for applicants who can demonstrate critical thinking abilities while examining case studies. Those applicants who do not excel in critical thinking are not likely to advance in the selection process. The focus on critical thinking skills (referred to by some recruiters as analytic skills) also suggests that the skills are not just needed to secure a job but also are useful for advancing careers.

A recent survey of 320 business respondents (UMSL, 2009) indicated that the number one skill gap in new recruits is critical thinking. The absence of critical thinking reduced productivity and diminished employee performance. The President's Council of Economic Advisors provided a report in July, 2009, that identified that the top attribute of a well-trained workforce is that employers value workers who can think critically and solve problems.

Another source of evidence of the demand for critical thinking skills come from job descriptions by employers. The following sampling of sound bites from recruiter web pages gives a sense of the demand for applicants and executives with critical thinking skills.

- **Procter & Gamble:** Features of our Problem Solving Test include three types of questions which require critical thinking and analytical skills...
- **Goldman Sachs:** "...they foster creativity, critical thinking and self-reliance"
- **Deloitte:** (looking for demonstrations of) proven analytical and critical thinking skills.
- **Citigroup:** ... MBAs with concentration in ... Marketing, Analytics, or General Mgt; 3 to 5 years of relevant work experience; Demonstrated leadership; Critical thinking.

- **J&J:** Participants also master the competencies required for ... Human resources leadership, including: Strategic Contribution - Business acumen, Critical thinking, Drive for results.
- **Bank of America:** Strong academics and technical skills ... should be accompanied by proficiencies in critical thinking, leadership, business acumen, and relationship building.

Olin alumni offer a similar perspective. When one well known alumna was asked to describe what is needed by job applicants today compared to those applicants a decade ago, she responded “applicants today must excel in critical thinking.” Many alumni highlight that the constantly changing and global business environment requires workers at all levels of an organization to engage in critical as well as creative thinking. Yet, it is difficult for them to find job applicants who display these skills.

Consistent views from recruiters and alumni and the call for critical thinking skill in job descriptions provides evidence that critical thinking is useful for securing and advancing professional careers in business.

## **Types of Thinking and Problems Encountered**

Thinking occurs in several ways. The most common types of thinking are inductive and deductive reasoning, or some combination of the two. Inductive reasoning draws inferences from data and, in many ways, is the natural way human minds think. The engine for inductive reasoning is the mind’s ability to make comparisons among data, information, and cognitive structures, and evaluate similarity in these comparisons. In essence, the mind excels in analogical processing.

Creativity, analogical reasoning, heuristics, generalizations and abstractions, judgment, abduction, and problem-solving all represent variants of inductive thinking that can lead to new insights and inferences but for which there is no guarantee that the inferences are correct. Inductive reasoning is fast, it allows us to make on-the-spot

decisions. However, while speed of decision (measured in seconds) is important when playing sports, it is seldom as critical in business.

Deduction is vastly different. It is the act of drawing an inference through standard logic based on premises. Premises applied to logic yield inferences, conclusions, or predictions. The truth of these inferences therefore is guaranteed by the validity of the premises and the correctness of the logic. In many ways, deductive reasoning is a human invention, one that is credited to Aristotle.

To illustrate, consider the following deductive reasoning. *Premise or Warrant:* Increasing the price of a good reduces the quantity demanded. *Data:* The price of gasoline increased dramatically in the summer of 2008. *Claim:* Therefore, the quantity of gasoline demanded in the summer of 2008 is much less than it would have been but for the price increases. You might use this kind of deductive logic, albeit perhaps with many other premises and data, to predict the price and quantity of gasoline consumed at some point in the future. The validity of any prediction is predicated on the accuracy and precision of the premises, the data, and logic used in the deduction.

In contrast, consider how you might use inductive reasoning to observe price fluctuations in the stock market and inductively derive inferences of when to buy and when to sell stock. Where deductive reasoning provides a guarantee of the solution based on the validity of premises and correctness of logic, inductive reasoning offers no such guarantee. Indeed, induction alone may provide an inference that fits the data well but this fit provides no guarantee that buying and selling stocks according to your inference will generate profits in the future.

### ***Induction and Its Biases and Impediments***

Inductive thinking can stimulate a variety of biases and impediments. The biases and impediments arise for many reasons, the most prevalent of which is that one of the primary modes of thinking involves

comparison and similarity. For instance, consider Sandi's complex business case. The vignette describes how he quickly identified a similar case.

This identification likely occurred through mental comparisons and some set of attributes along which Sandi determined that the two cases, his interview case and the class case, were sufficiently similar analogs. The mind is amazing in its ability to generate comparisons. These comparisons can lead to new insights for solving problems and may provide the foundation for creativity. Yet drawing inferences from such comparisons, or what some call "gut feel", can be problematic because of correctness is not guaranteed. Some of the most common biases are listed in the following table.

### **Common Thinking Biases and Impediments**

- Propensity to jump to solutions economizes on thinking time and reduces exploration of alternative problem formulations and solutions. It also relies on using heuristics to frame and solve problems, which is based narrowly on past experiences. Self-serving support of ego often locks individuals into initial solution.
- Framing bias accepts and uses a narrow approach or description of the situation or issue and narrows alternatives. It involves the drawing of conclusions based on how data or questions are presented, which limits alternatives.
- Anchoring relies heavily on a past reference or on one trait or piece of information when making decisions, which narrows alternatives.
- Confirmation bias involves searching for, criticizing, distorting, or dismissing information to maintain or strengthen an existing belief, which narrows alternatives. It is likely when individuals don't seek evidence to disconfirm an hypothesis or belief locks in previously stated solutions.

- Self-serving bias arises when evaluating ambiguous information in a way beneficial to your interests, which locks in previously stated solutions
- Self-justification bias arises by believing our own perceptions are accurate, realistic, and unbiased, which locks in previously stated solutions. The bias increases with self-confidence and narrows alternatives.

Many of these biases and impediments arise from what Simon (1955) defined as bounded rationality. Humans, he claimed, have bounded attention spans, limited short-term memory, and high opportunity costs for time to think. Many of the biases and impediments derive from lack of attention or switching attention to other matters. Also, because short-term memory is utilized for processing comparisons, availability of short-term memory can constrain inductive thinking. Emotions inject additional challenges to thinking. Thinking and, more generally, learning can be negatively impacted by emotions because they can direct attention away from critical issues and consume short term memory for uses other than for thinking. Time pressures from opportunity costs further limit thinking.

The list covers biases that are common and prevalent. For more exhaustive lists of biases see:

- [http://en.wikipedia.org/wiki/List\\_of\\_cognitive\\_biases](http://en.wikipedia.org/wiki/List_of_cognitive_biases)
- <http://www.au.af.mil/au/awc/awcgate/psych-intel/index.html>

### ***Deduction and its Fallacies***

Deductive thinking also can involve a variety of potential fallacies and impediments. One potential impediment in deductive thinking is the precision and accuracy of premises. Premises are part of our knowledge sets. With limited knowledge of premises the range of feasible deductions is narrowed. Theories taught in the various courses at Olin

are designed to expand this knowledge range and provide you with a sophisticated set of theories that, in essence, offer a wide array of premises with which to think critically about data and information. It is these theories that are left for you to discover and learn in your course work and studies at Olin as well as in your continued learning through your life.

Another source of potential critical thinking weakness is the data and information to which premises and logic are applied. Data can include noise that masks the underlying signals. Also, data can be measured with error or aggregated at such high levels that useful signals are lost. In all of these instances, combining data and information with premises can lead to invalid conclusions. Weaknesses in data are set aside in this monograph.

The final potential weakness in deductive reasoning arises from common logical fallacies. If the logic used to draw conclusions is false, then the conclusion is invalid. It is the common fallacies on which this section focuses. Aristotle in his *Organon*, identified a variety of common logical fallacies that can lead to invalid conclusions. Based on Aristotle's original work, modern logicians describe a more detailed set of "material" fallacies that in aggregate equate to Aristotle's four. The following list is originally drawn from Wikipedia, logical fallacies.

### **Fallacies of Logic**

- Fallacy of Accident makes a generalization that disregards exceptions. For example, price discrimination is illegal. The government price discriminates in setting taxes. The government taxes illegally.
- Converse Fallacy of Accident argues from a special case to a general rule. For example, every entrepreneur I have met is successful, so it must be true that all entrepreneurs are successful.

- Irrelevant Conclusion diverts attention away from a fact in dispute rather than addressing it directly. This is sometimes referred to as a "red herring". Subsets include:
  - Purely personal considerations (*ad hominem* attacks)
  - Popular sentiment (appeal to the majority)
  - Fear
  - Conventional propriety (appeal to authority)
- Affirming the Consequent draws a conclusion from premises by assuming X implies Y on the basis that Y implies X. For example, if I raise price on my product then quantity sold will decrease. Because quantity sold declined I should raise my price. Quantity sold can decline for reasons other than price.
- Denying the Antecedent draws a conclusion from premises by assuming Not X implies Not Y on the basis that Y implies X. For example, if I am hired as an employee, I work for the firm. I am not an employee therefore I cannot work for the firm. Many other types of contractual relationships are available to allow you to work for a firm.
- Begging the Question demonstrates a conclusion by means of premises that assume the conclusion. Also known as circular reasoning. For instance, I will make more money if I work harder. The statement assumes that working harder necessarily leads to making more money.
- Call to Perfection argues to postpone some action or policy until some unlikely event or impossible change is achieved. For example, I'll become an entrepreneur when it is not risky to do so. Because entrepreneurship by its nature always presents risk it is likely that the person will never become an entrepreneur.
- Fallacy of False Cause or *Non Sequitur* ("it does not follow") incorrectly assumes one thing is the cause of another. For example, our firm will succeed because our CEO is a nice person. Nice people don't always succeed. Two special cases are common:
  - Temporal succession implies causality.

- Assuming correlation implies causation.
- Fallacy of Many Questions groups more than one question together. “Is it true that you no longer will cheat on your taxes?” A yes or no answer will be an admission of tax evasion.

## Critical Thinking

*Critical Thinking @ Olin* offers a set of critical thinking tools and perspectives to help elevate your thinking skills. You must invest in four areas that are vital for elevating critical thinking skills.

- You must adopt a disposition toward improving your thinking.
- You must understand the elements of thinking, which facilitate more comprehensive thinking.
- You must evaluate your thinking based on intellectual standards that enable reflection and advancement of thinking.
- You must utilize a variety of processes that can help overcome biases, fallacies, and impediments thereby leading to superior problem formulations and solutions.

Each area is discussed below.

### ***Disposition***

Disposition in regards to thinking is a person’s prevailing habit, state of readiness, tendency, or willingness to think in particular ways. Because thinking takes place in the brain, out of sight from potential observers who could comment on and provide feedback on thinking skills, much of critical thinking relies on your disposition towards thinking. The Foundation for Critical Thinking argues that

*Critical thinking is self-directed, self-disciplined, self-monitored and self-corrective thinking.*

This view implies that while faculty, peers, managers, and others may help advance your thinking, ultimately the responsibility for your thinking and its improvement falls on your shoulders. Sandi's story provides an illustration of someone who does not possess a disposition toward critical thinking.

The vignette describes how Sandi thought he had worked hard and received high grades, which should have landed him his perfect job (itself a non-sequitur). Sandi quickly looked for external causes of the failed interview. Sandi began to blame his organizational behavior professor and the entire business school program for not providing the answer. Yet, recruiters typically look to assess thinking skills, not answers. Could Sandi's thinking have been biased or did it rely on fallacies? Sandi's thinking during the interview did correlate with many of the biases and fallacies described above. Can you identify them?

Sandi also engaged in little self-monitoring of thinking during the interview even though the interviewer provided a few "softball" questions. These questions did not cause Sandi to reflect on and question his approach. After the interview and even after receiving a rejection letter, Sandi spent very little time and effort reflecting on thinking quality in the interview. Without such reflection it is difficult to engage in self-correct thinking. In retrospect, Sandi's thinking was not self-directed, self-disciplined, self-monitored, and self-corrective.

Adopting a disposition toward improving critical thinking is a necessary condition for elevating your thinking. Without assuming full responsibility for the quality of your thinking, improvement in intelligent thinking is much less likely, which decreases the likelihood of making superior decisions.

## ***Elements of Critical Thinking***

Alternative approaches to critical thinking identify a variety of thinking elements. *Critical Thinking @ Olin* subscribes to FCT's categorization of eight elements of critical thinking. These eight elements represent touchstones to guide thinking. Each element presents an opportunity to probe and explore the way in which you think. These eight elements are as follows.

### **Eight Elements of Critical Thinking**

- All reasoning is done from some point of view.
- All reasoning has a purpose.
- All reasoning is an attempt to figure something out, to settle some question, solve some problem.
- All reasoning is based on data, information, & evidence.
- All reasoning is expressed through, and shaped by, concepts and ideas.
- All reasoning is based on assumptions.
- All reasoning contains inferences or interpretations by which we draw conclusions and give meaning to data.
- All reasoning leads somewhere or has implications and consequences.

Remembering all eight elements of thinking is difficult. Therefore, the words underlined in each element of thinking are used to create an acronym to help remember the eight elements. PPPICACC (pronounced “pickaxe”) is constructed from the first letter of each underlined word above. To help remember the acronym, think of the image of using a pickaxe to tackle challenging problems.

Intelligent thinking should consider all eight elements of critical thinking when formulating and solving problems. By exploring these elements through questioning and probing, thinkers can enhance their critical thinking by exploring alternatives through the PPPICACC framework.

The following table provides a set of questions that you can use to probe whether you have comprehensively explored the issue at hand. The questions offered are not meant to be exhaustive. Nonetheless, asking yourself these questions will likely advance the quality of your thinking and your ability to formulate and solve business problems.

### **“Pick-axe” Questions to Enhance Critical Thinking**

- **Points of view:** Have you fully explored alternative and relevant points of view? Do you recognize alternative points of view as relevant? Have you earnestly considered and responded to concerns raised from other points of view?
- **Purposes:** Have you clearly stated your purpose? Is it justifiable? Can you clearly state others’ purposes and what they value? Have you distinguished your and others’ purposes from related purposes?
- **Problems:** Have you explored multiple formulations of your question? Have you expressed your question in alternative ways to clarify meaning and scope? Have you formulated the problem comprehensively?
- **Information:** Have you gathered sufficient, accurate, and relevant information that is essential to the issue? Have you searched for information that opposes your position as well as supports it?
- **Concepts:** Do you identify and explain key concepts? Do you use these concepts with accuracy and precision?
- **Assumptions:** Do you state and justify otherwise hidden assumptions? Do you question the validity of your assumptions? Do your assumptions bias your point of view?
- **Conclusions:** Are your inferences supported by deductive logic? Are your inferences consistent with each other?
- **Consequences:** What are the positive and negative long-run consequences of your conclusions? Are consequences ethically appropriate?

Of course, knowing the eight elements of critical thinking and being sure to touch on each element of thinking provides no guarantee of advancing thinking; of overcoming biases, fallacies, and impediments; or of identifying superior problem formulations and solutions. Two other factors combine with disposition and the eight elements to advance thinking: intellectual standards and processes.

### ***Intellectual Standards for Critical Thinking***

How do you know if your thinking is advancing? Touching on the eight elements of thought and responding to the corresponding questions are necessary but are they sufficient for elevating your thinking?

FCT offers nine intellectual standards: clarity, accuracy, precision, logic, relevance, depth, breadth, significant, and evenhandedness. We group these standards into four clusters and provide brief descriptions of each category.

- **Clear and Precise:** Do others fully understand your meaning? Can you elaborate through examples and illustrations? Is your meaning detailed and specific enough to avoid confusion?
- **Accurate and Logical:** Can you verify for others that what you say is true? Have you verified your logic?
- **Relevant, Significant, Deep, and Broad:** Is your statement connected to the issue at hand? How and why? Are you addressing complexities of the issue and encompassing the full range of considerations? Have you identified the most important features of the issue?
- **Evenhanded and Ethical:** Have you thought through the ethical implications of your reasoning? Are you being fair-minded in your thinking? Are you treating alternatives in each element of thinking fairly?

The first letter of each category forms the acronym CARE. If you CARE about your thinking you are likely to remember these categories. These standards can be applied to your eight elements of thinking (see the table below). Evaluating your thinking against these standards provides feedback and evaluation on the quality of your thinking.

The CARE standards not only enhance your own thinking skills but also encompass the ability to communicate effectively with others. They require that you value the cooperative process of working with others and develop the iterative skills of listening for feedback and adjusting the communication until understanding is achieved. Only by communicating your thinking and listening to others to verify that they understand you can you be assured that you are achieving high standards for your own thinking.

The elements of and intellectual standards for critical thinking provide important guidelines for working in cooperation with others. Being certain your recommendations are clearly understood, presenting data in an objective manner, and taking into consideration alternative points of view, purposes, problems, information, concepts, assumptions, conclusions, and consequences requires a commitment to treating others with respect for who they are and what they have to contribute.

Critical thinking skills give us the capacity to be evenhanded in the process of resolving a problem and evenhanded in the outcome or goals achieved. Being evenhanded is about how we treat others, and, fundamentally, this is an issue of moral values - the values of the person and the values of the firm. Therefore, critical thinking skills provide a foundation for not only effective decision-making but also ethical decision-making.

Improving your thinking requires reflection and evaluation. The table below provides one simple tool for reflecting on your thinking. For each element of critical thinking and for each intellectual standard, you can use the table to inquire and evaluate whether or not you demonstrated

the intellectual standard for a particular element and to what extent you did so. You may find this tool most useful by applying it each day to at least one decision.

### **Critical Thinking Assessment Matrix**

	Clear, Precise	Accurate, Logical	Relevant, Broad, Deep, Significant	Evenhanded, Ethical
<b>Point of view</b>				
<b>Purpose</b>				
<b>Problem</b>				
<b>Information</b>				
<b>Concepts</b>				
<b>Assumptions</b>				
<b>Conclusions</b>				
<b>Consequence</b>				

Enter “0” if you did not demonstrate the standard, “1” if you demonstrated the standard somewhat, and “2” if you demonstrated the standard comprehensively.

Another important feedback device is to revisit your analysis and decisions and comment on at least one thing your analysis did well and at least one thing your analysis could improve upon. Self identifying not only what you do well but also what you can improve upon supports a disposition of critical thinking.

### ***Processes for Thinking Critically***

A central goal of critical thinking is to attenuate if not eliminate biases, fallacies, and impediments in thinking. Doing so will elevate your thinking and also lays the foundation for further learning.

While elements and intellectual standards aid in elevating thinking and overcoming biases, the adoption of various processes is at the heart of

overcoming biases, fallacies, and impediments. Providing a comprehensive list of processes is far beyond the scope of this monograph. Nonetheless, several important processes which are particularly useful in business contexts are discussed.

**Devil's Advocacy:** One of the most common processes applied in business is the Devil's Advocate. First established by the Catholic Church in 1587, the Devil's Advocate, along with the Promoter of the Faith, were individuals selected to engage in a juridical process to evaluate candidates for beatification and canonization. These lawyers argue opposite positions in front of a panel that then makes a decision.<sup>1</sup>

One of the main ideas behind Devil's advocacy is that by interacting with others, particularly by generating conflict, biases and fallacies can be revealed and corrected. Devil's advocacy can usefully serve this purpose. Purposely taking opposing views can lead to constructive conflict that identifies fallacies of logic, weakness in assumptions, misinterpretations of data. This process is the core of the American legal system and is the most common critical thinking practice in business today.

Application of Devil's advocacy, unfortunately, also has several weaknesses. First, task conflict can lead to interpersonal conflict inviting in emotions that can bias decisions and generate grudges that warp decisions and introduce politics into working environments. Indeed, instead of evenhanded thinking and decisions, the goal often becomes evening the score.

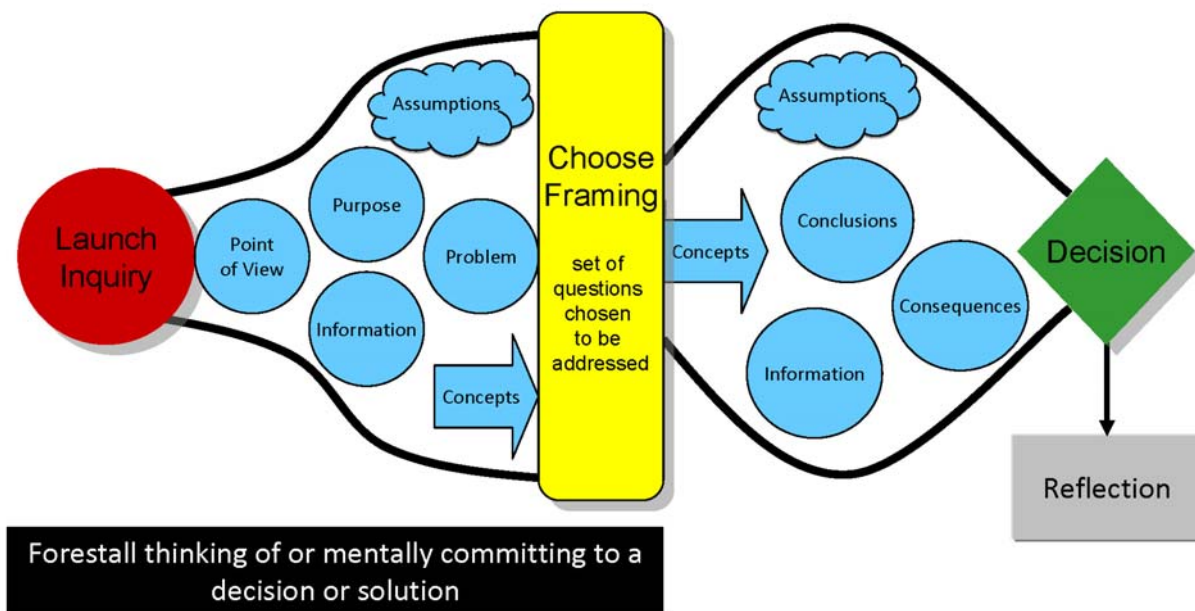
Second, many organizations practice Devil's advocacy by encouraging many to play the role of Devil's advocate with only one promoter of the faith, the one presenting the logic for a decision. Such a structure creates disincentives for people to bring ideas to the fore and can create risk aversion in generating and offering new ideas.

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<sup>1</sup> See Devil's advocate in Wikipedia for further details.

Third, although Devil’s advocacy provides a mechanism for checking logic, assumptions, and information for a decision, it does little to evaluate the appropriateness of the problem’s formulations. In other words, it provides no check against solving the wrong problem.

**Sequential Problem Formulation and Solution:** Another process useful in many business contexts as well as for discussing cases in business school classes is Sequential Problem Formulation and Solution (SPFS). The five-step structured process is depicted in the figure below.



**Step 1:** *Explore the problem formulation(s).* Recognizing a problem requires devoting attention (time and energy) to scanning the environment for situations that do meet or are in conflict with your purposes, goals, or values. Should such a state be identified, an inquiry is launched to formulate the problem. In launching an inquiry, the most important rule to follow is to identify as comprehensively as possible alternative problem formulations *without* recommending a solution or decision. As mentioned in the biases section above, jumping to a solution creates a powerful force that leads to many of the biases that contaminate thinking. Fortunately, such jumps, when verbalized, are readily observable by others who can then reinforce the rule.

Use the first six elements of critical thinking to seek out problem formulations from alternative points of view by actively seeking out alternative purposes, exploring availability of information, identifying assumptions, and considering concepts that suggest alternative problem formulations. The goal is to be as comprehensive as possible in developing alternative formulations.

**Step 2:** *Choose the problem formulation(s).* Using critical thinking standards of relevance and significance, begin to winnow your problem formulations. Often, to eliminate a formulation, you must make assumptions about which points of view, information, problems, concepts and assumptions ultimately are relevant and significant. It is vital to apply the CARE standards to the elimination of formulations. Document these assumptions because they represent a set of premises upon which you choose a subset of problem formulations to solve. Even after this elimination, you may be left with multiple problem formulations that need to be addressed.

**Step 3:** *Decide solution method(s).* For each formulation you believe to be promising, identify the assumptions, concepts, and information you will use to address the set of questions in this formulation. What metrics is your decision going to be based on? What criteria are you going to use to include or exclude alternatives? What concepts are you going to use to guide your decision? What data needs to be collected before the decision can be reached? Will there be any quantitative modeling used? Several brainstorming and problem-solving processes are available, some of which describe: a left-hand-side decision map (see below) is one useful tool for fleshing out these issues. At this point, you should still be holding off making any recommendations.

**Step 4:** *Problem solution.* For each remaining formulation, engage in a problem-solving exercise that relies on the latter five elements of critical thinking. Use the assumptions, concepts, and information identified in Step 3 to make your recommendations. This is the solution step; it involves collecting any needed data, building any quantitative models

needed, and making appropriate deductive reasoning arguments. It is an iterative step; do not collect all data you may possibly need, instead collect the minimum data you might need and investigate whether you can make your recommendation. If you find you missed important assumptions, concepts, and information in your previous steps then revisit them before moving forward again. Check your reasoning against the deductive fallacies listed in a prior section of this book. Verify and validate any models built. Right-hand-side decision maps and calculation maps (see below) may be useful in this step. Carefully go over the conclusions and possible consequences of your recommendations.

When solutions have been found for each problem formulation, compare each problem formulation/solution pair and evaluate the value created. Are your solutions complements that should be implemented together as a set? Or, are they independent or substitutes? Choose the solution or set of solutions that create the greatest value.

**Step 5: Reflect on your process.** Search for biases and fallacies. Engage others to evaluate your thinking for each problem formulation/solution pair as well as outcomes. What went well and what didn't go well? What could be done better next time? It is only through reflection that we learn deeply.

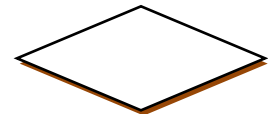
In each of these steps you may find it helpful to explicitly delineate periods of *divergent* and *convergent* thinking. In divergent thinking we are explicitly trying to think broadly; brainstorming is one technique to aid this, but there are others that you will learn in your classes. In convergent thinking, a conclusion is being reached. Alternatives generated during the divergent phase should be evaluated and the most promising ones picked. In group settings many teams have conflict because one member will be focused on the divergent phase while another is ready to converge. The more explicit you can be about which phase you are in, and the more you can delay convergence until you

believe you have been thorough in your divergent exploration, the better your conclusions are likely to be.

**Visual Tools for Improved Decision Making:** Graphical representations of decisions can frequently aid the decision process because they can be understood widely, detail the important elements of the decision, require structured thinking to create, and help verify deductive logic. This booklet provides three different decision maps. These maps are graphical representations of the decision process at different stages in the deliberations. *Left-hand-side* maps (or issue trees) show the key factors influencing the decision while *right-hand-side* maps (or logic trees) illustrate the decision itself. *Calculation maps* (or influence charts) are used to guide quantitative analysis. For any of these maps there is no one correct chart.

All three of these maps use the same graphics as shown below. While the particular shapes are not important, the process of delineating the different components of the decision *is* important. The components are the information, concepts, and assumptions (the ICA of PPPICACC) as well as the intermediate variables used to reach the decision. Within these categories we delineate the objects further.

### *Decision*



Item that needs to be decided  
e.g., should we reschedule our trip?

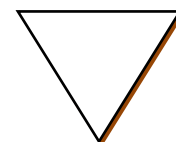
Represented by a diamond

There may be multiple sub-decisions (e.g., price, quantity, etc.)  
which are also represented by decision diamonds

### *Information*

*Fact/datum:* an observation  
e.g., the weather forecast predicts a storm

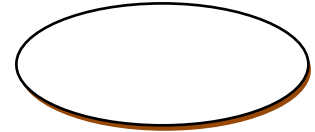
Represented by a triangle



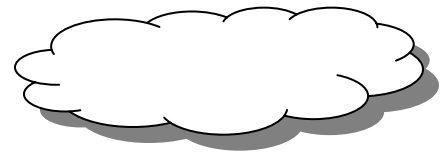
*Calculation:* a quantity that can be evaluated  
e.g., expected revenue under some given conditions  
Represented by a hexagon



*Inference, claim, intermediate variable, or subquestion*  
e.g., my flight is likely to be delayed tomorrow  
Represented by circle or oval



### *Assumptions*



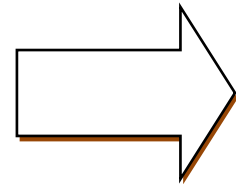
#### *Framing assumption*

Assumption that came from the problem formulation process  
e.g., cash flow is not a concern

#### *Warrant: a heuristic observation or generalization*

e.g., when it is foggy many flights are delayed from takeoff and landing

Represented by a cloud



### *Concept*

*Argument:* an inference accompanied by reasons (consisting of information and/or assumptions)

e.g., Our flight tomorrow is likely to be delayed because the weather forecast predicts fog tomorrow (warrant is unspoken)

#### *Qualitative frameworks*

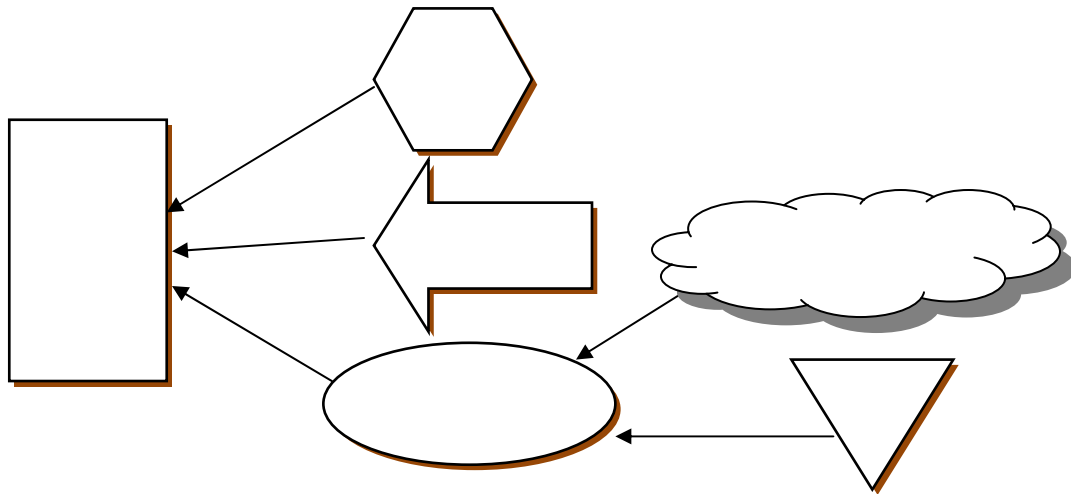
e.g., the three/four C's of marketing

#### *Quantitative frameworks*

e.g., optimization

Represented by a large arrow

## *Left-hand-side Decision Map*



The *left-hand-side* map assumes that a problem formulation has been chosen, which is summarized in the left-hand-side rectangle. The goal is to visually link the problem formulation question (rectangle) to concepts, information, and assumptions that will be used to evaluate the question. This type of map is also called an “issue tree” because the goal is to reflect the issues that must be resolved before the primary question can be answered.

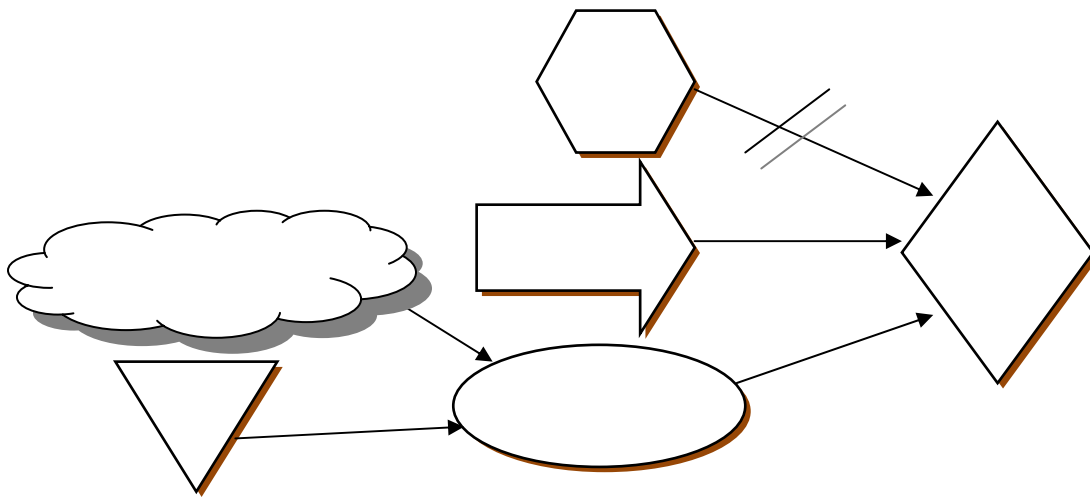
The metrics for the decision should be clearly shown either as calculation cells (hexagons) or intermediate variables (ovals). Any concepts to be used should also be explicitly shown. Any data needed to be collected should be shown as input triangles. Only data that is potentially feasible to obtain should be shown. Important assumptions should be shown in the diagram but other lesser assumptions may be detailed on a separate page.

The map is designed to summarize the framing process. It should be created from a specific point-of-view and purpose. However, no decision should have been reached yet. Indeed, the decision should not even be obvious from the map. Data and intermediate variables still should be unevaluated and shown as such. For example, one input could be the “importance of reputation to company” rather than “reputation is

important to the company” (unless this is to be an assumption rather than an intermediate variable/claim). All potentially important factors, sub-questions, and sub-decisions should be shown on the map.

It is recommended to build the map from left to right, starting with the key framing question and expanding out the issues that must be resolved in order to answer the question. Often it is useful to use a hierarchical approach where most of the elements that feed directly into the rectangle are ovals, or sub-questions. These may consider the key question from the point of view of the individual stakeholders, or break the question into quantitative and qualitative factors. All factors (whether positive or negative) that will influence the decision should be shown on the tree.

### *Right-hand-side Decision Map*



The *right-hand-side* decision map shows all subfactors that influence the decision. This type of map is also called a “logic tree” because it is used to verify the logic of your decision. This tree is created after the decision has been reached (unlike all previous steps of the decision process).

Even factors that detract from the decision should be shown, but with a cross through the arrow to show a negative flow. The factors shown should be same as those of left-hand-side decision map, but evaluated.

The evaluation may be shown on the map or as separate submap (e.g., a calculation map). The left-hand-side map may need to be revisited if new important factors in the decision arise in evaluation phase.

While the map links concepts, information, and assumptions to the decision (diamond), the actual trade-offs among the various factors is not shown. All major factors (positive and negative) that inform decision are shown. However, some factors may remain undetermined if sufficient information for the decision has been found without evaluation of these factors. It is often helpful to label inputs as true (T), plausible (P+), implausible (P-) or unknown (?).

### *Calculation Map*

A calculation map is used to evaluate calculation cells identified in a decision map. The goal is to develop quantitative structure, which can then be translated into an actual calculation, such as into a spreadsheet. This type of map is also called an “influence chart” because the goal is to diagram key variables that influence the output variable. This output variable may then be used as data input (calculation cell) for a final right-hand-side decision map.

The map ignores all available numerical data and starts from the desired output not from the available inputs. The map relies on modeling assumptions, which should be recorded as made.

Maps are built from top to bottom, starting with the outcome measure (hexagon). This outcome measure is then decomposed into independent variables (ovals) that *directly* determine it. The decomposition is then repeated for each variable in turn. Input data (triangles), decisions (diamonds), and assumptions (clouds) should be identified as they arise. Each variable should appear only once, with possible circular relationships appearing on the map.

## Learning Critical Thinking

This monograph defines critical thinking and provides specific tools for improving critical thinking. What are the ways in which you can learn how to improve your critical thinking? This monograph offers two perspectives. One perspective identifies cultural forces that can facilitate the process of enculturation in thinking. The second perspective explores those specific processes that enhance learning. *Critical Thinking @ Olin* employs both perspectives to assist students and business executives to elevate their thinking.

### ***Enculturation***

Critical thinking is not a topic that can be read once in the book and then practiced perfectly. Instead, as highlighted in this monograph, it requires disposition, focus, attention, and relentless practice. One way to develop critical thinking is to generate a culture with practices and resources that are ever present to help students and business executives elevate their critical thinking skills. In a study of “thoughtful” classrooms, Ritchhart (2002) identified seven cultural forces that work to reinforce a culture of intelligent thinking. These forces are:

- Messages from the physical environment about thinking
- Teacher/leader modeling of thinking and dispositions
- The use of the language of thinking
- Routines and structures for thinking
- Opportunities created for thinking
- Conveyance of expectations for thinking
- Interactions and relationships supportive of thinking

Support for these forces must not only come from faculty/leaders and the ways in which they design and run their courses, but also must receive cultural support from students/workers.

## ***Learning Sciences***

In 1956 Edward Bloom identified that not all learning is identical and developed his “taxonomy of learning”. At the lowest level is knowledge, where no thinking is involved. Deep learning involves reaching the upper levels of synthesis and evaluation, where higher-order thinking skills must be used. The levels of Bloom’s taxonomy are identified below.<sup>2</sup>

Many individuals make the mistake of tackling problems by focusing on the lower order skills. This is probably what Sandi did. He could recall historical case discussions but may not have fully comprehended the reasons for the previous situation compared to the present situation. For most leaders, the higher order skills are necessary for success.

### **Bloom’s Taxonomy of Learning**

- *Knowledge* is demonstrated by exhibiting memory of previously-learned materials by recalling facts, terms, basic concepts and answers and by responding to questions like “What is ...?”
- *Comprehension* is demonstrated by the understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas and by responding to questions like “How would you compare and contrast ...?”
- *Application* is demonstrated by using new knowledge to solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way and by responding to questions like “Can you organize \_\_\_\_\_ to show ...?”
- *Analysis* is demonstrated by examining and breaking information into parts by identifying motives or causes, by making inferences and find evidence to support generalizations, and by responding to questions like “How would you classify ...?”

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<sup>2</sup> Much of the material on deep learning is drawn from Wikipedia, 2008.

- *Synthesis* is demonstrated by compiling information together in different ways, by combining elements in a new pattern or proposing alternative solutions, and by responding to questions like “Can you predict an outcome?”
- *Evaluation* is demonstrated by presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria and by asking questions like “Do you agree with ...?”

Learning scientists offer an interdisciplinary approach to studying how people learn. Contributions range from constructivism, cognitive science, educational technology, socio-cultural studies, and studies of disciplinary knowledge. This relatively new learning approach is commonly referenced to as “learning knowledge deeply”. The learning sciences provide a foundation for understanding how to improve learning (Sawyer 2006).

With traditional approaches to learning:

- Learners treat course material as unrelated to what they already know.
- Learners treat course material as disconnected bits of knowledge.
- Learners memorize facts and carry out procedures without understanding how or why.
- Learners have difficulty making sense of new ideas that differ from the textbook.
- Learners treat facts and procedures as static knowledge, handed down from an all-knowing authority.
- Learners memorize without reflecting on the purpose or on their own learning strategies

In contrast, learning science identifies that:

- Learners relate new ideas and concepts to previous knowledge.
- Learners integrate their knowledge into interrelated conceptual systems.
- Learners look for patterns and underlying principles.
- Learners evaluate new ideas and relate them to conclusions.
- Learners understand the process of dialogue to which knowledge is created and examine the logic of an argument critically.
- Learners reflect on their own understanding and their own process of learning

Learning science recommends a number of processes that facilitate learning “deeply.” The most important of these processes are as follows. Look for your instructors using these processes.

- Build knowledge from concrete and then extend to the abstract.
  - Making the abstract first concrete provides scaffolding, facilitates articulation and reflection.
- Facilitate the development of scaffolding
  - Effective scaffolding provides prompts that help learners “figure it out.” Instructors provide supports that are gradually removed.
- Use active learning techniques
  - Students learn better when they participate in constructing knowledge, especially when it builds on their own knowledge (scaffolding). There is also evidence that they retain material better this way.
- Require externalization and articulation
  - Externalizing and articulating knowledge enhances student learning.
  - Thinking about learning process and knowledge yields deeper understanding.

- Articulation is more effective if it is scaffolded—structuring types knowledge into particular forms.
- Collaboration and conversation among learners is critical.
- Encourage reflection of what students learn

## **Conclusion**

This monograph motivates the need for critical thinking. It outlines the difference between inductive and deductive reasoning and the difference between knowledge and deep learning. Learning is a process for which each individual must take ownership. Processes are central to good thinking as well as making good business decisions. This monograph is not comprehensive, but nonetheless provides a variety of processes that can promote critical thinking. The next step is up to you. Remember critical thinking is self-directed, self-disciplined, self-monitored and self-corrective thinking.

## Additional On-line Resources

[http://en.wikipedia.org/wiki/List\\_of\\_cognitive\\_biases](http://en.wikipedia.org/wiki/List_of_cognitive_biases)  
[http://en.wikipedia.org/wiki/Logical\\_fallacies](http://en.wikipedia.org/wiki/Logical_fallacies)  
[http://en.wikipedia.org/wiki/Blooms\\_taxonomy](http://en.wikipedia.org/wiki/Blooms_taxonomy)  
<http://philosophy.hku.hk/think/>  
<https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/psychology-of-intelligence-analysis/index.html>  
[http://www.insightassessment.com/pdf\\_files/what&why2007.pdf](http://www.insightassessment.com/pdf_files/what&why2007.pdf)  
<http://www.au.af.mil/au/awc/awcgate/psych-intel/index.html>

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**This booklet belongs to:**

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