Introduction to Critical Thinking

CE 4200

Professional Engineering Practice Issues

Spring 2022 Semester

William D. Lawson, PE, PhD

BASIS FOR THIS LECTURE

Introduction to Critical Thinking

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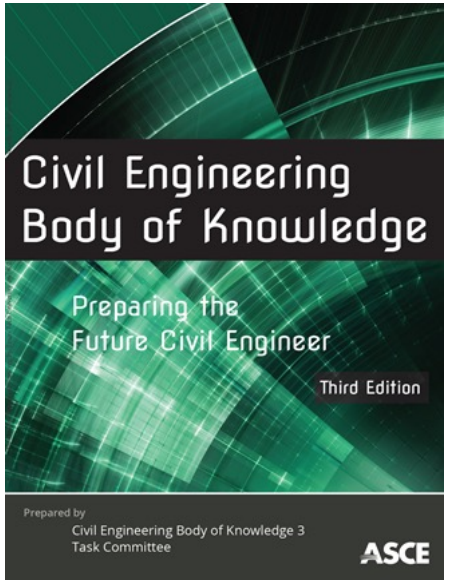
BOK3 Outcomes

1. Mathematics
2. Natural Sciences
3. **Social Sciences**
4. Humanities
5. Materials Science
6. Engineering Mechanics
7. Experimental Methods and Data Analysis
8. **Critical Thinking and Problem Solving**
9. **Project Management**
10. Engineering Economics
11. Risk and Uncertainty
12. Breadth in Civil Engr Areas
13. Design
14. Technical Depth
15. Sustainability
16. Communication
17. **Teamwork and Leadership**
18. Lifelong Learning
19. **Professional Attitudes**
20. **Professional Responsibilities**
21. Ethical Responsibilities



Critical thinking and Problem Solving

CE BOK 3rd Edition

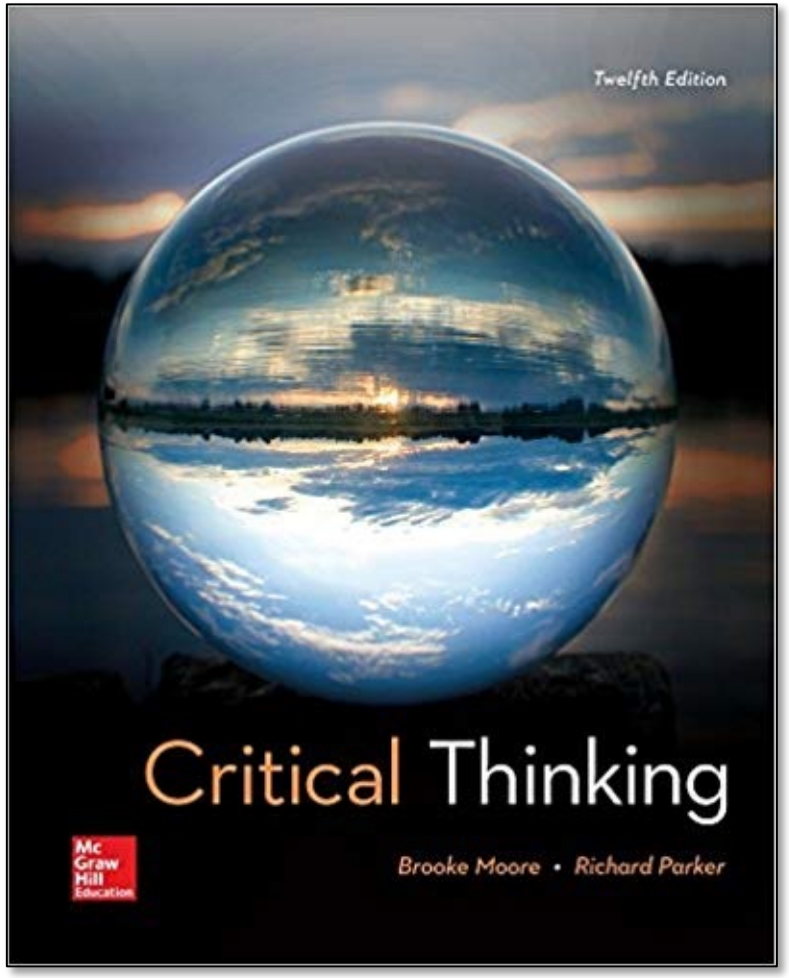
Critical Thinking and Problem Solving

Table 2-8. Critical Thinking and Problem Solving (Cognitive Domain).

Cognitive Domain Level of Achievement	Demonstrated Ability	Typical Pathway
1 Remember (remember previously learned material)	**Identify** and **define** a complex problem, question, or issue relevant to civil engineering.	Undergraduate education
2 Comprehend (grasp the meaning of learned material)	**Explain** the scope and context of a complex problem, question, or issue relevant to civil engineering.	Undergraduate education
3 Apply (use learned material in new and concrete situations)	**Formulate** a possible solution to a complex problem, question, or issue relevant to civil engineering.	Undergraduate education
4 Analyze (break down learned material into its component parts so that its organizational structure may be understood)	**Analyze** a possible solution to a complex problem, question, or issue relevant to civil engineering.	Mentored experience
5 Synthesize (put learned material together to form a new whole)	**Develop** a set of appropriate solutions to a complex problem, question, or issue relevant to civil engineering.	Mentored experience
6 Evaluate (judge the value of learned material for a given purpose)	**Assess** a set of solutions to determine the most appropriate solution to a complex problem, question, or issue relevant to civil engineering.	

Critical Thinking Reference

Textbook for a critical thinking course



Critical Thinking 12th Edition

Brooke Noel Moore

Professor
Department of Philosophy
California State University: Chico

Richard Parker

Professor Emeritus
Department of Philosophy
California State University: Chico

ISBN-13: 978-1259690877

Amazon

- New… from $70.48
- Used… from $49.03
- Rent… from $26.74

Critical Thinking Reference

CE BOK 3rd Edition

- The **Foundation for Critical Thinking** seek[s] to promote essential change in education and society through the cultivation of fairminded critical thinking.
- Critical thinking requires the cultivation of core intellectual virtues such as intellectual humility, perseverance, integrity, and responsibility. Nothing of real value comes easily…


Critical
Thinking
Education
Knowledge
Attention
Defined
Deductive
Outcomes
Insight
Thought
Solving
Syllogism
Perspective
Evidence
Diagram
Creativity
Reasoning
Language
Logic
Challenge
Learning
Experiment
Anecdotes
Hypothesis
Argument
Inductive
Memory
Problem
Rational
Science
illusion
Judgment
Decision-Making
Organization
Retrieval
Bias
Emotion
Encoding
Skeptical
Observation
Assessment
Fallacy
Skeptic
Random
Inquiry

SOME DEFINITIONS

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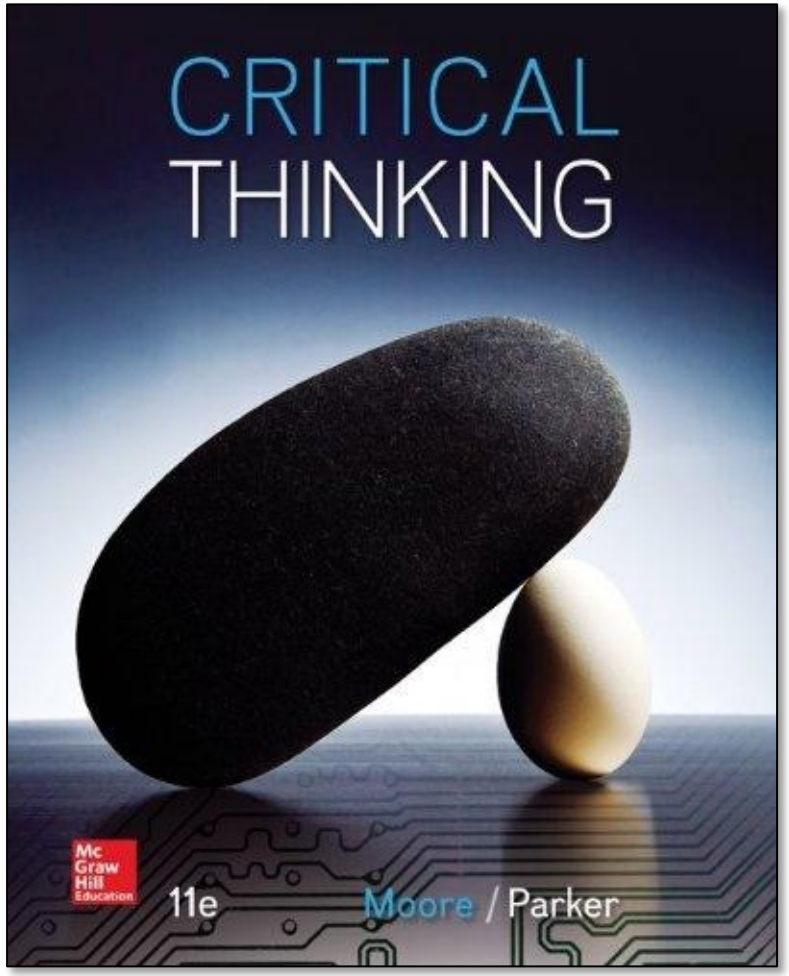
Critical Thinking… Definition

- **Critical thinking** is the careful, deliberate determination of whether we should accept, reject, or suspend judgment about a claim – and of the degree of confidence with which we accept or reject it.

~ Moore & Parker



What do we mean by critical thinking?

- **Critical thinking** means making reasoned judgments that are logical and well-thought out. It is a way of thinking in which you don't simply accept all arguments and conclusions you are exposed to but rather have an attitude involving questioning such arguments and conclusions.

~ Tara DeLecce

How do you define critical thinking?

- "Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness...”

~ Michael Scriven & Richard Paul

Conception of Critical Thinking

- "Critical thinking is self-guided, self-disciplined thinking which attempts to reason at the highest level of quality in a fairminded way. People who think critically attempt, with consistent and conscious effort, to live rationally, reasonably, and empathically. They are keenly aware of the inherently flawed nature of human thinking when left unchecked…”

~ Linda Elder

What is the concept of critical thinking?

- **Critical thinking** is that mode of **thinking** — about any subject, content, or problem — in which the thinker improves the quality of his or her **thinking** by skillfully analyzing, assessing, and reconstructing it. **Critical thinking** is self-directed, self-disciplined, self-monitored, and self-corrective **thinking**.

~ The Foundation for Critical Thinking

Consensus Statement Regarding Critical Thinking

- We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.

~American Philosophical Association Delphi Report (1990)

CHARACTERISTICS

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Student Exercise

"Think, Pair, Share"

1. Identify what YOU think are the characteristics of a critical thinker
2. Pair up with the person (or persons) near you and discuss your lists
3. Share observations with the class (instructor-guided)

Who is a critical thinker?

Critical thinking is the ability to think clearly and rationally about what to do or what to believe. It includes the ability to engage in reflective and independent **thinking**. Someone with **critical thinking** skills is able to do the following:

- understand the logical connections between ideas
- identify, construct and evaluate arguments
- detect inconsistencies and common mistakes in reasoning
- solve problems systematically
- identify the relevance and importance of ideas
- reflect on the justification of one's own beliefs and values

~Joe Lau & Jonathan Chan

The Ideal Critical Thinker

- The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit.

~American Philosophical Association Delphi Report (1990)

What are characteristics of a critical thinker?

Strong critical thinkers demonstrate the following characteristics:

- inquisitiveness with regard to a wide range of issues
- concern to become and remain well-informed
- alertness to opportunities to use critical thinking
- self-confidence in one's own abilities to reason
- open-mindedness regarding divergent world views
- flexibility in considering alternatives and opinions
- understanding of the opinions of other people
- fair-mindedness in appraising reasoning
- honesty in facing one's own biases, prejudices, stereotypes, or egocentric tendencies
- prudence in suspending, making or altering judgments
- willingness to reconsider and revise views where honest reflection suggests that change is warranted

~American Philosophical Association Delphi Report (1990)

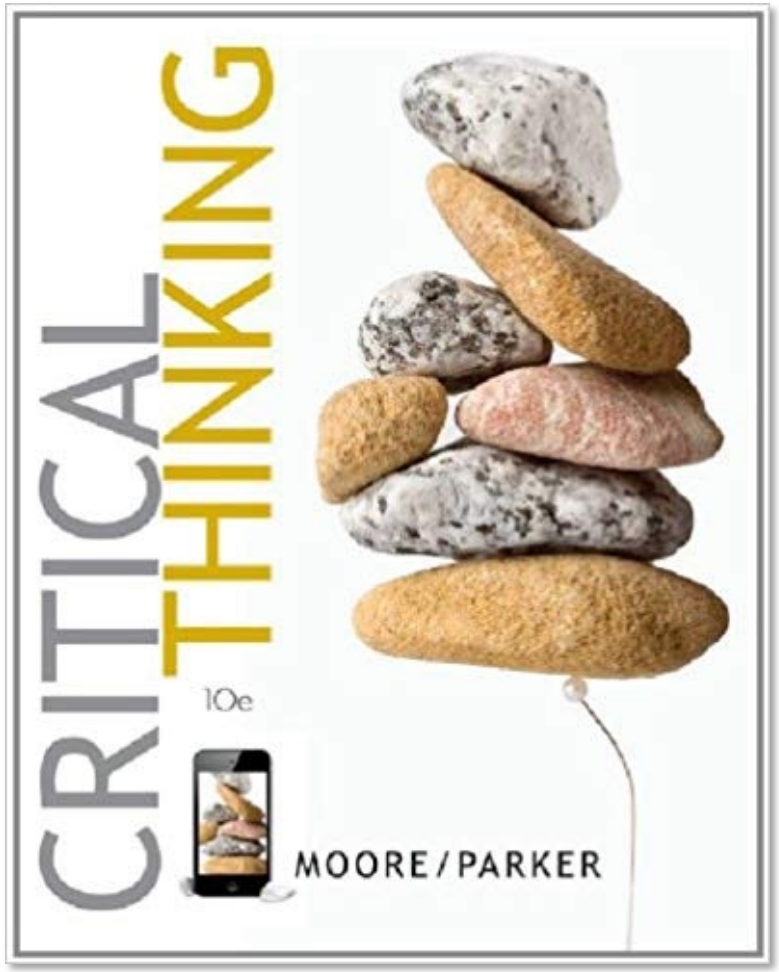
What is the result of critical thinking?

A well-cultivated critical thinker:

- Raises vital questions and problems, formulating them clearly and precisely
- Gathers and assesses relevant information, using abstract ideas to interpret it effectively
- Comes to well-reasoned conclusions and solutions, testing them against relevant criteria and standards
- Thinks open-mindedly within alternative systems of thought, recognizing and assessing, as needs be, their assumptions, implications, and practical consequences
- Communicates effectively with others in figuring out solutions to complex problems

~ The Foundation for Critical Thinking

The Focus of Critical Thinking



- **Critical thinking** includes a variety of deliberative processes aimed at making wise decisions about what to believe and do, processes that center on evaluation of arguments...

~Moore & Parker

A BRIEF HISTORY

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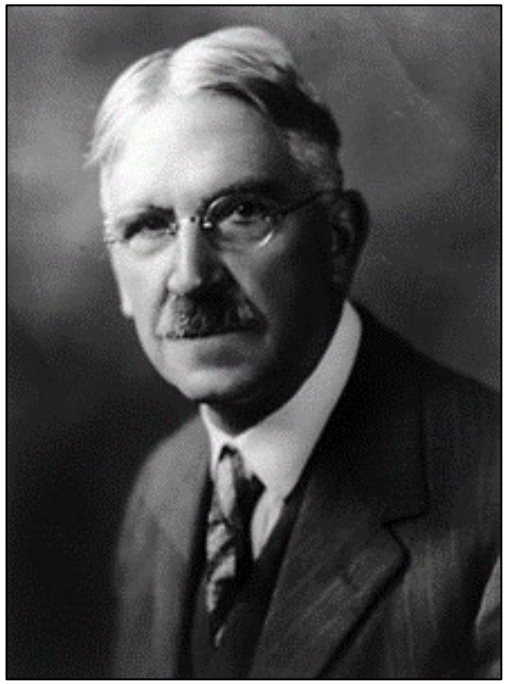
Roots of Critical Thinking

- The intellectual roots of critical thinking are as ancient as its etymology, traceable, ultimately, to the teaching practice and vision of Socrates 2,500 years ago who discovered by a method of probing questioning that people could not rationally justify their confident claims to knowledge. Confused meanings, inadequate evidence, or self-contradictory beliefs often lurked beneath smooth but largely empty rhetoric.

~ The Foundation for Critical Thinking

Who is considered the father of modern day critical thinking?

- The philosopher **John Dewey**, often considered the father of modern day critical thinking, defines critical thinking as: “Active, persistent, careful consideration of a belief or supposed form of knowledge in light of the grounds that support it and the further conclusions to which it tends” (Dewey, 1933, p. 9).



John Dewey, 1859-1952

The Collective Contribution of the History of Critical Thought

The basic questions of Socrates can now be much more powerfully and focally framed and used. In every domain of human thought… it is now possible to question:

- ends and objectives,
- the status and wording of questions,
- the sources of information and fact,
- the method and quality of information collection,
- the mode of judgment and reasoning used,
- the concepts that make that reasoning possible,
- the assumptions that underlie concepts in use,
- the implications that follow from their use, and
- the point of view or frame of reference within which reasoning takes place

THE CRITICAL THINKING PROCESS

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What is the critical thinking model?

- **Critical thinking** is that mode of **thinking** – about any subject, content, or problem — in which the **thinker** improves the quality of his or her **thinking** by skillfully taking charge of the structures inherent in **thinking** and imposing intellectual standards upon them.

~ The Foundation for Critical Thinking

What are the six steps of critical thinking?

- Step 1: ORGANISE INFORMATION. We have no difficulty in locating information. ...
- Step 2: STRUCTURE REASONING. ...
- Step 3: CONSIDER EVIDENCE. ...
- Step 4: IDENTIFY ASSUMPTIONS. ...
- Step 5: EVALUATE ARGUMENTS. ...
- Step 6: COMMUNICATE CONCLUSION.

ELEMENTS OF THOUGHT:

THINKING THINGS THROUGH

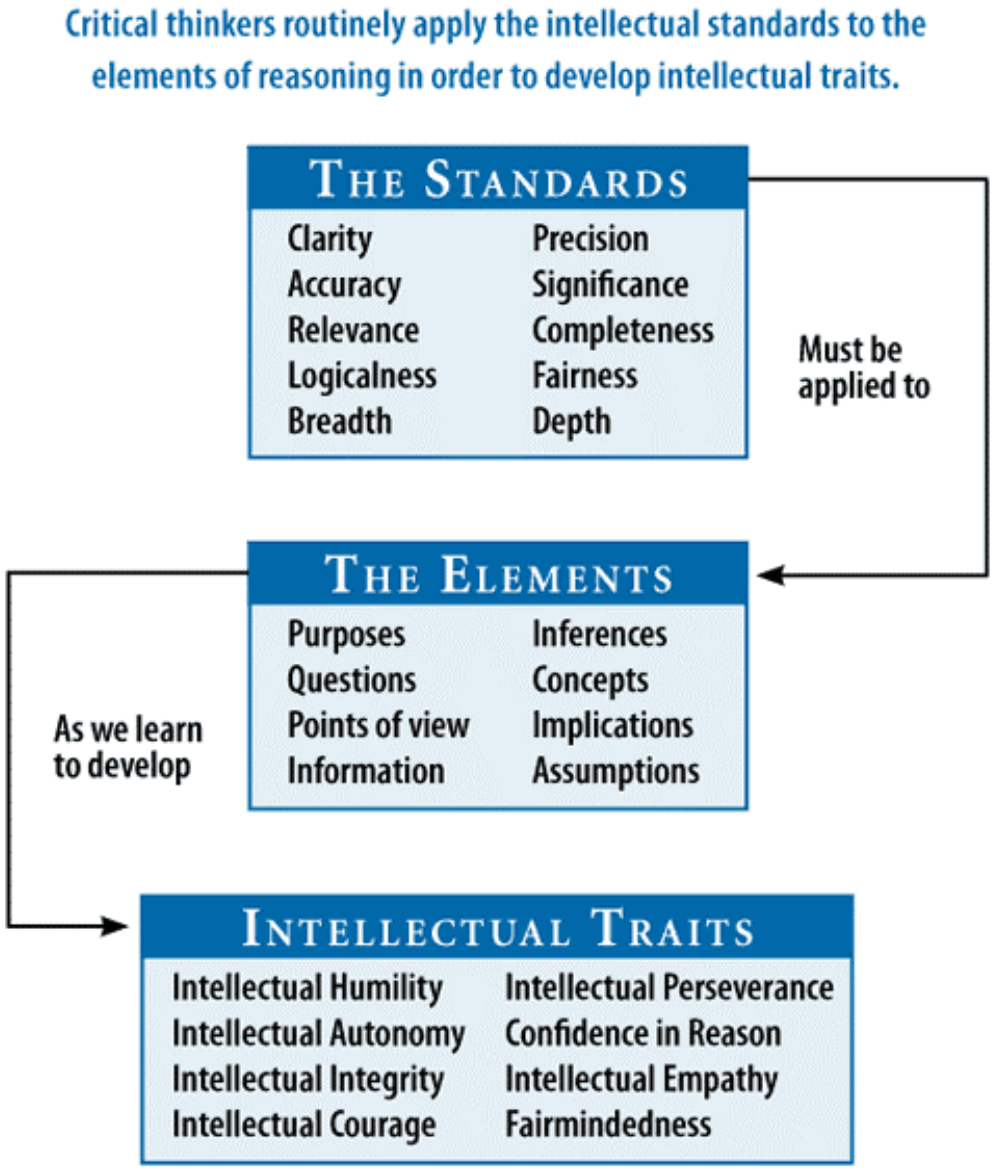
Purpose	What am I trying to achieve or make happen?
Question at Issue	What is the central question I am trying to think through?
Information	What facts, data, or evidence do I need to figure things out?
Concepts	What are the organizing ideas, theories, or principles that influence my thinking?
Assumptions	What am I taking for granted that forms the basis of my thinking?
Interpretation	What are the connections I am making, and conclusions or solutions I am coming to?
Implications	What are the consequences that follow from my line of thinking?
Points of View	What are the other relevant perspectives that I need to consider?

Poster brought to you by i2a louisville.edu/ideastoaction
Adapted with permission from *The Miniature Guide to Critical Thinking Concepts and Tools* by Richard Paul and Linda Elder, 2012, Tomales, CA: Foundation for Critical Thinking Press. www.criticalthinking.org

UNIVERSITY OF LOUISVILLE.

What are the 7 critical thinking skills?

1. Analyzing. Separating or breaking a whole into parts to discover their nature, functional and relationships. ...
2. Applying Standards. ...
3. Discriminating. ...
4. Information Seeking. ...
5. Logical Reasoning. ...
6. Predicting. ...
7. Transforming Knowledge.



- The evaluation of our thinking as engineers requires a vocabulary of thinking and reasoning. The intellect requires a voice.
- Richard Paul and Linda Elder, from the **Foundation for Critical Thinking**, have proposed a critical thinking model documented in various sources…

Source: **Applied Disciplines: A Critical Thinking Model for Engineering** by R. J. Niewoehner, United States Naval Academy, USA

How do you practice critical thinking?

1. Ask Basic Questions. “The world is complicated. ...
2. Question Basic Assumptions. ...
3. Be Aware of Your Mental Processes. ...
4. Try Reversing Things. ...
5. Evaluate the Existing Evidence. ...
6. Remember to Think for Yourself. ...
7. Understand That No One Thinks Critically 100% of the Time.

Student Exercise

Practice your critical thinking problem solving and communication skills

RESPOND TO THE FOLLOWING:

Sociologist Erving Goffman has pointed out that all social groups, including professions, develop a protective attitude toward members of their group, even when what some of the members do is seen as morally wrong. A sense of loyalty to the group often overrides what they would otherwise deem immoral.

Consider the arguments for and against exposing people with whom you are personally close or with whom you have close professional ties. Develop a position on this issue that could serve as a guide for anyone in such a position.

The Analysis and Assessment of Thinking

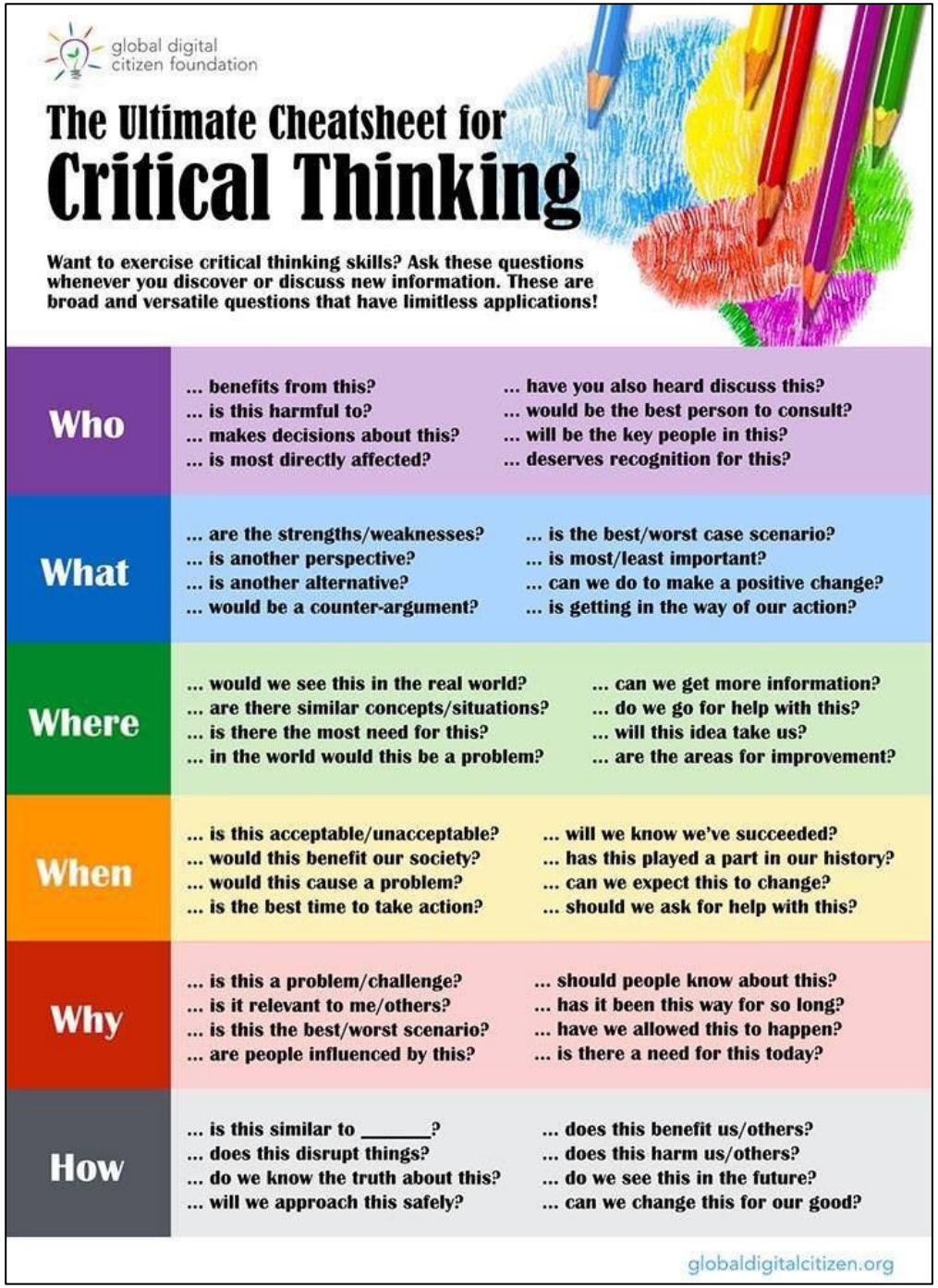
To develop as fair-minded critical thinkers, students need to be able to assess… thinking, as follows:

- All reasoning has a **PURPOSE**
- All reasoning is an attempt to **FIGURE SOMETHING OUT, TO SETTLE SOME QUESTION, TO SOLVE SOME PROBLEM**
- All reasoning is based on **ASSUMPTIONS**
- All reasoning is done from some **POINT OF VIEW**
- All reasoning is based on **DATA, INFORMATION, AND EVIDENCE**
- All reasoning is expressed through, and shaped by, **CONCEPTS** and **IDEAS**
- All reasoning contains **INFERENCES** or **INTERPRETATIONS** by which we draw **CONCLUSIONS** and give meaning to data
- All reasoning leads somewhere, has **IMPLICATIONS** and **CONSEQUENCES**

What are the core critical thinking skills?

- **Core critical thinking skills** include analysis, interpretation, inference, evaluation, explanation, and self-reflection. These **skills** are central to problem solving and decision making in an extremely wide variety of contexts and at all educational and professional levels.

~Dr. Peter Facione/ Insight Assessment FAQs



The Critical Thinking Skills Cheatsheet [Infographic]

by Lee Watanabe-Crockett

Dec 12, 2016 | Critical Thinking

Source: The Global Digital Citizen Foundation

https://globaldigitalcitizen.org

GROWTH IN CRITICAL THINKING

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Critical Thinking Development: A Stage Theory

Linda Elder with Richard Paul

The stages we will lay out are as follows:

- **Stage One:** The Unreflective Thinker.
- **Stage Two:** The Challenged Thinker.
- **Stage Three:** The Beginning Thinker.
- **Stage Four:** The Practicing Thinker.
- **Stage Five:** The Advanced Thinker.
- **Stage Six:** The Accomplished Thinker.

What is an unreflective thinker?

- Unreflective thinkers are largely unaware of the determining role that thinking is playing in their lives and of the many ways that problems in thinking are causing problems in their lives. Unreflective thinkers lack the ability to explicitly assess their thinking and improve it thereby.

What is a beginning thinker?

- When a person actively decides to take up the challenge to grow and develop as a **thinker**, that person enters the stage we call "**beginning thinker**." This is the stage of **thinking** in which one begins to take **thinking** seriously. This is a preparatory stage before one gains explicit command of **thinking**.

What is the practicing thinker?

- Stage Four: The **Practicing Thinker**—Good Thinking Can Be Practiced Like Basketball, Tennis, or Ballet. ... When people explicitly recognize that improvement in thinking requires regular **practice**, and adopt some regimen of **practice**, then, and only then, have they become what we call "**practicing thinkers**."

How can students improve critical thinking skills?

7 Steps to Improving Your Critical Thinking

1. Don't Take Anything at Face Value. The first step to thinking critically is to learn to evaluate what you hear, what you read, and what you decide to do.
2. Consider Motive. ...
3. Do Your Research. ...
4. Ask Questions. ...
5. Don't Assume You're Right. ...
6. Break It Down. ...
7. Keep It Simple.

ASSESSMENT OF CRITICAL THINKING

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What is a critical thinking test?

- **Critical thinking tests** measure an individual's ability to make analyse, conceptualise and reason effectively. **Critical thinking tests** can measure **critical thinking** in a number of ways, and **critical thinking tests** often comprise multiple different sub-**tests** within a single **test**.

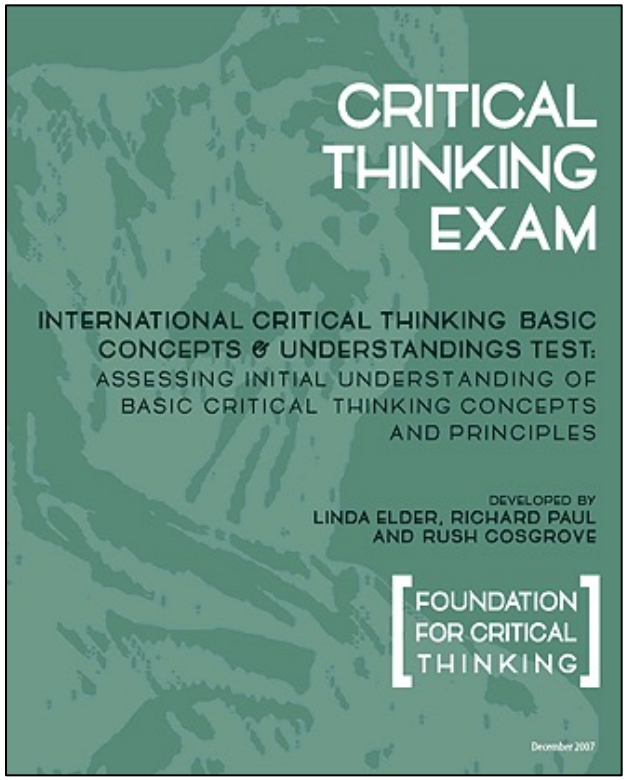
INTERNATIONAL CRITICAL THINKING BASIC CONCEPTS & UNDERSTANDING ONLINE TEST

Test developed by Dr. Linda Elder, Dr. Richard Paul, and Dr. Rush Cosgrove

- The test measures the extent to which students, faculty, or indeed anyone, understand the fundamental concepts embedded in critical thinking. A high score provides evidence of the person having done some critical thinking about critical thinking.
- It focuses on the five essential dimensions of critical thinking:
  1. the analysis of thought.
  2. the assessment of thought
  3. the dispositions of thought
  4. the skills and abilities of thought
  5. the obstacles or barriers to critical thought

Basic Concepts Sample Test

- The **Critical Thinking Basic Concepts & Understandings *Sample* Test** is now available online to all members of the Critical Thinking Community.
- The sample test is intended for use as a demonstration of both the content and grading tools which are available in the full version of this test. The sample test has a limited number of questions compared to the full version, therefore it should not be used for assessment purposes



Course Menu

Student Desktop

Course Tests

Critical Thinking Basic Concepts & Understanding SAMPLE Test

Q: Critical thinking is essential to reasoning well through complicated issues.

- ○ True
- ○ False

Q: Critical thinking and creativity entail two distinctly different processes.

- ○ True
- ○ False

Course Menu

Student Desktop

Course Tests

Critical Thinking Basic Concepts & Understanding SAMPLE Test

Q: One main requirement of critical thinking is	
○	to articulate arguments as well as possible
○	to identify every aspect of another person's thinking
○	to analyze thinking into its most basic components
○	all of the above
○	none of the above
Q: An important fact that supports the need for an analytic dimension of critical thinking is that	
○	people don't typically recognize the importance of assessment in thinking
○	most people don't think
○	the analysis of thinking is presupposed in every subject

Course Menu

Student Desktop

Course Tests

Critical Thinking Basic Concepts & Understanding SAMPLE Test

Q: perspective	
○	element
○	standard
○	trait
○	ability
○	obstacle
○	none of the above
Q: sufficiency	
○	element
○	standard
○	trait
○	ability
○	obstacle
○	none of the above