Critical Thinking Unmasked:

How to Infuse It into a Discipline-Based Course

Supplementary Materials

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"Active" Critical Thinking Verbs by Level of Cognitive Operation in Bloom's and Anderson & Krathwohl's Taxonomies

_____

Application/Applying

apply
break down
calculate
choose
compute
demonstrate
determine
dramatize
employ
give examples
utilize

illustrate
interpret
make use of
manipulate
operate
practice
schedule
sketch
solve
use

Analysis/Analyzing

analyze
calculate
categorize
classify
compare
contrast
criticize
deduce
derive
differentiate
discriminate
discuss
dissect

distill
distinguish
divide
examine
experiment
identify assumptions
induce
inspect
investigate
model
probe
question
simplify
test

Synthesis/Creating

adapt
arrange
assemble
build
change
collect
compose
conclude
construct
create
design
develop
discover
estimate
extend
formulate
forward
generalize

imagine
infer
integrate
invent
make up
manage
modify
originate
organize
plan
posit
predict
prepare
produce
propose
set up
suppose
theorize

Evaluation/Evaluating

agree
appraise
argue
assess
award
challenge
choose
conclude
convince
criticize
critique
debate
decide
defend
discount
discredit
disprove

dispute
evaluate
judge
justify
prioritize
persuade
rank
rate
recommend
rule on
score
select
support
validate
value
verify
weight

Depending on the use, some verbs may apply to more than one level.   © Linda B. Nilson, 2015

CT Skills Assessed by California Critical Thinking Skills Test (CCTST)

Interpretation: Interpretative skills are used to determine the precise meaning and significance of a message or signal, whether it is a gesture, sign, set of data, written or spoken words, diagram, icon, chart or graph. Correct interpretation depends on understanding the message in its context and in terms of who sent it, and for what purpose. Interpretation includes clarifying what something or someone means, grouping or categorizing information, and determining the significance of a message.

Explanation: Explanatory reasoning skills, when exercised prior to making a final decision about what to believe or what to do, enable us to describe the evidence, reasons, methods, assumptions, standards or rationale for those decisions, opinions, beliefs and conclusions. Strong explanatory skills enable people to discover, to test and to articulate the reasons for beliefs, events, actions and decisions.

Analysis: Analytical reasoning skills enable people to identify assumptions, reasons and claims, and to examine how they interact in the formation of arguments. We use analysis to gather information from charts, graphs, diagrams, spoken language and documents. People with strong analytical skills attend to patterns and to details. They identify the elements of a situation and determine how those parts interact, as well as providing insights into the significance of what something means.

Inference: Inference skills enable us to draw conclusions from reasons and evidence. We use inference when we offer thoughtful suggestions and hypotheses. Inference skills indicate the necessary or the very probable consequences of a given set of facts and conditions. Conclusions, hypotheses, decisions, or recommendations that are based on faulty analyses, misinformation, bad data or biased evaluations can turn out to be mistaken, even if they have been reached using excellent inference skills.

Evaluation: Evaluative reasoning skills enable us to assess the credibility of sources of information and the claims they make. We use them to determine the strength or weakness of arguments, judging the quality of analyses, interpretations, explanations, inferences, options, opinions, beliefs, ideas, proposals, and decisions. Strong explanation skills can support evaluation by providing the evidence, reasons, methods, criteria, or assumptions behind the claims made and the conclusions reached.

Deduction: Decision making in precisely defined contexts where rules, operating conditions, core beliefs, values, policies, principles, procedures and terminology completely determine the outcome depends on strong deductive reasoning skills. Deductive reasoning moves with exacting precision from the assumed truth of a set of beliefs to a conclusion which cannot be false if those beliefs are true. Deductive validity is rigorously logical and clear-cut and leaves no room for uncertainty.

Induction: Decision making in contexts of uncertainty relies on inductive reasoning. We use inductive reasoning skills when we draw inferences about what we think must probably be true based on analogies, case studies, prior experience, statistical analyses, simulations, hypotheticals, and familiar circumstances and patterns of behavior. As long as there is the possibility, however remote, that a highly probable conclusion might be mistaken, the reasoning is inductive.

Numeracy is the ability to solve quantitative reasoning problems and to make well-reasoned judgments derived from quantitative information in a variety of contexts. More than being able to compute or calculate a solution to a mathematical equation, numeracy includes understanding how quantitative information is gathered, represented, and correctly interpreted using graphs, charts, tables and diagrams. It is essential in our data-driven world for everyone who hopes to be successful.

DISCIPLINE-RELEVANT CT SKILLS/OUTCOMES

Common CT Skills/Outcomes/Assessments in the Basic and Applied Sciences (Natural and Physical Sciences, Psychology, and Social Sciences)

Which fit your prospective CT course?
- Interpret quantitative relationships in graphs, tables, charts, etc.
- Analyze situations/data to identify and clearly articulate issues/problems/questions.
- Identify and summarize an issue/problem/question and/or the source's position.
- Categorize problems to identify the appropriate algorithms.
- Organize and integrate information/data to solve a problem or resolve and issue.
- Assess alternative solutions and implement the optimal one(s).
- Explain how new information can change the definition of a problem or its optimal solution.
- Evaluate hypotheses and conclusions for consistency with established facts.
- Develop, justify, and explain the limitations of one's own hypotheses, interpretations, positions, or conclusions as well as those of others.
- Identify, analyze, and evaluate key assumptions and the influence of context.
- Evaluate the appropriateness of procedures for investigating a question of causation.
- Evaluate data for consistency with established facts, hypotheses, or methods.
- Separate factual information from inferences.
- Separate relevant from irrelevant information.
- Identify and articulate alternative positions/interpretations of the data or observations.
- Evaluate competing causal explanations.
- Explain the limitations of correlational data.
- Explain the limitations of a data-based position or conclusion.
- Identify and evaluate implications.
- Identify new information that might support or contradict a hypothesis.

Any other CT skills/outcomes/assessments for your scientific field?
-
-
-

Common CT Skills/Outcomes/Assessments in Technical/Problem Solving Fields
(in addition to some of the above)

Which fit your prospective CT course?
- Separate relevant from irrelevant info.
- Analyze situations/data to identify problems.
- Categorize problems to identify the appropriate algorithms.
- Integrate information/data to solve a problem.
- Assess alternative solutions and implement the optimal one(s).
- Explain how new info can change the definition of a problem or its optimal solution.
- Assess problem definitions and conclusions in terms of cost, time, and client preferences.

Any other CT skills/outcomes/assessments for your technical/problem-solving field?
-
-
-

Common CT Skills/Outcomes/Assessments in Rhetorical Fields
(humanities, some areas in social sciences)

Which fit your prospective CT course?
- Determine the relevance of information for evaluating an argument or conclusion.
- Separate facts from opinions and inferences.
- Locate and use primary and secondary sources to conduct research.
- Recognize flaws, inconsistencies, and logical fallacies in an argument.
- Evaluate competing interpretations, explanations, evidence, and conclusions.
- Analyze and develop explanations for historical and contemporary issues, trends, and problems.
- Communicate complex ideas effectively.

Any other CT skills/outcomes/assessments for your rhetorical field?
-
-
-

Common CT Skills/Outcomes/Assessments Distinctive to the Arts

Which fit your prospective CT course?
- Identify alternative artistic interpretations.
- Determine how well an artistic interpretation is supported by evidence contained in a work.
- Recognize the salient features or themes in works of art.
- Evaluate work of art according to accepted criteria.
- Distinguish between objective and subjective analysis and criticism in specific examples.
- Conduct objective and subjective analyses of a piece of work.
- Compare and contrast different works to provide evidence of change or growth through history, across cultures, across locations, or in a particular artist.
- Infer the historical context (time, place, artist, motivation, etc.) of a work of art from its characteristics, and justify one's inference.
- Create a respectable piece of art.

Any other CT skills/outcomes/assessments for the arts?
-
-
-

OPERATIONAL TERMS/THINKING VERBS IN CRITICAL THINKING
Do Your Students Know What They Mean?

Analyze: Break something down into parts, such as a theory into its components, a process into its stages, or an event into its causes. Analysis involves characterizing the whole, identifying its parts, and showing how the parts interrelate.

Apply: Decide which generally established principles, approaches, knowledge, theories, laws, or concepts are relevant to a new situation or problem, then using them to clarify that situation or to solve that problem.

Assess/Criticize/Critique/Evaluate: Determine or judge the degree to which something meets or fails to meet certain criteria. If not provided in the question, develop criteria for making judgments.

Categorize/Classify: Sort into major, general groups or categories that you name or identify.

Compare/Contrast: Identify the important similarities and/or differences between two or more elements in order to reveal something significant about them. Emphasize similarities if the command is to compare and differences if it is to contrast.

Create/Devise: Put together, organize, or reorganize elements to make a new approach, product, or solution.

Defend/Justify: Give good reasons to support a position and to explain how/why something happened.

Define/Identify: Give the key characteristics by which a concept, thing, or event can be understood. Place it in a general class, then distinguish it from other members of that class.

Describe: Give the characteristics by which an object, action, process, person, or concept can be recognized or visualized.

Develop: Create, elaborate on, or make more effective, detailed, or usable.

Discuss/Examine: Debate, argue, and evaluate the various sides of an issue.

Explain/Justify: Give the basic principles of or reasons for something; make it intelligible. Explanation may involve relating the unfamiliar to the more familiar.

Generate: Think up or brainstorm good ideas or alternatives.

Infer: Logically conclude on the basis of what is known.

Interpret/Explain: State what you think the author/speaker of a quotation or statement means and why.

Illustrate: Use a concrete example to explain or clarify the essential attributes of a problem or concept; or clarify a point using a diagram, chart, table, or other graphic.

List/Enumerate: Give the essential points one by one, in a logical order if applicable. It may be helpful to number the points.

Outline/Review/State: Organize a description under main points and subordinate points, omitting minor details and classifying the elements or main points.

Predict: Infer from facts and knowledge what will happen on the future.

Propose: Suggest or present for consideration.

Prove/Validate: Establish that something is true by citing factual evidence or giving clear, logical reasons.

Summarize: Briefly restate the main points.

Synthesize: Put together elements in a new way so as to make a novel theory, approach, product, or solution.

Trace: Describe the course or progress of a phenomenon, trend, or development.

References

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Ellis, D. (2000) *Becoming a Master Student* (9th ed.). Boston: Houghton Mifflin.

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Questions/Tasks to Give Students Practice in CT Skills

What does this mean? How should we understand it? How can we make sense of it?

How did you come to that interpretation?

How can we best characterize/categorize/classify this?

What do you think the author(s) intends in this statement?

Is this statement fact or opinion, and why?

How would you compare and contrast these concepts/causes/effects/claims/conclusions?

What is the hypothesis in this study?

How credible is the author's claim?

How much can we trust what this person claims?

How strong are the arguments? What are some counter-arguments?

What errors in reasoning can you find (logical fallacies, faulty statistical reasoning)?

What are you claiming/concluding?

Why did you make this claim/come to this conclusion?

What assumptions are you making to come to that conclusion?

If you assumed XXX, how might your claim/conclusions change?

What are the consequences of accepting this claim/conclusion?

Given what we know so far, what conclusions can we draw? What can we rule out?

What other conclusions satisfy the evidence?

Given what we now know, how confident can we be in our conclusion?

What does/do this evidence/these data imply? Do we have our facts right?

What is/are the evidence/arguments pro and con?

What additional information do we need to answer this question/resolve this issue?

What are some alternatives that we have not yet explored?

What were the specific results/findings of the investigation/research?

How did you conduct that analysis?

How did you reason out this issue?

Why do you think that was the best answer/solution?

How good is your evidence?

What important evidence might be missing?

What additional evidence do you need?

Can you reconcile these two apparently conflicting conclusions?

How would you prioritized the problems and rank them on seriousness and urgency?

How would you assess the degrees of likelihood and uncertainty?

How would you relate this new knowledge/discovery to what you already know?

What analogy might help you solve this problem?

How can you communicate your findings/conclusion using graphics?

How can you put together information from various sources to synthesize a new interpretation/claim/conclusion?

What alternative makes the most sense, and why?

What is the central issue/problem?

How can this information/these observations be classified?

How do you know whether the relationship is causal or spurious?

What patterns in the data can you recognize?

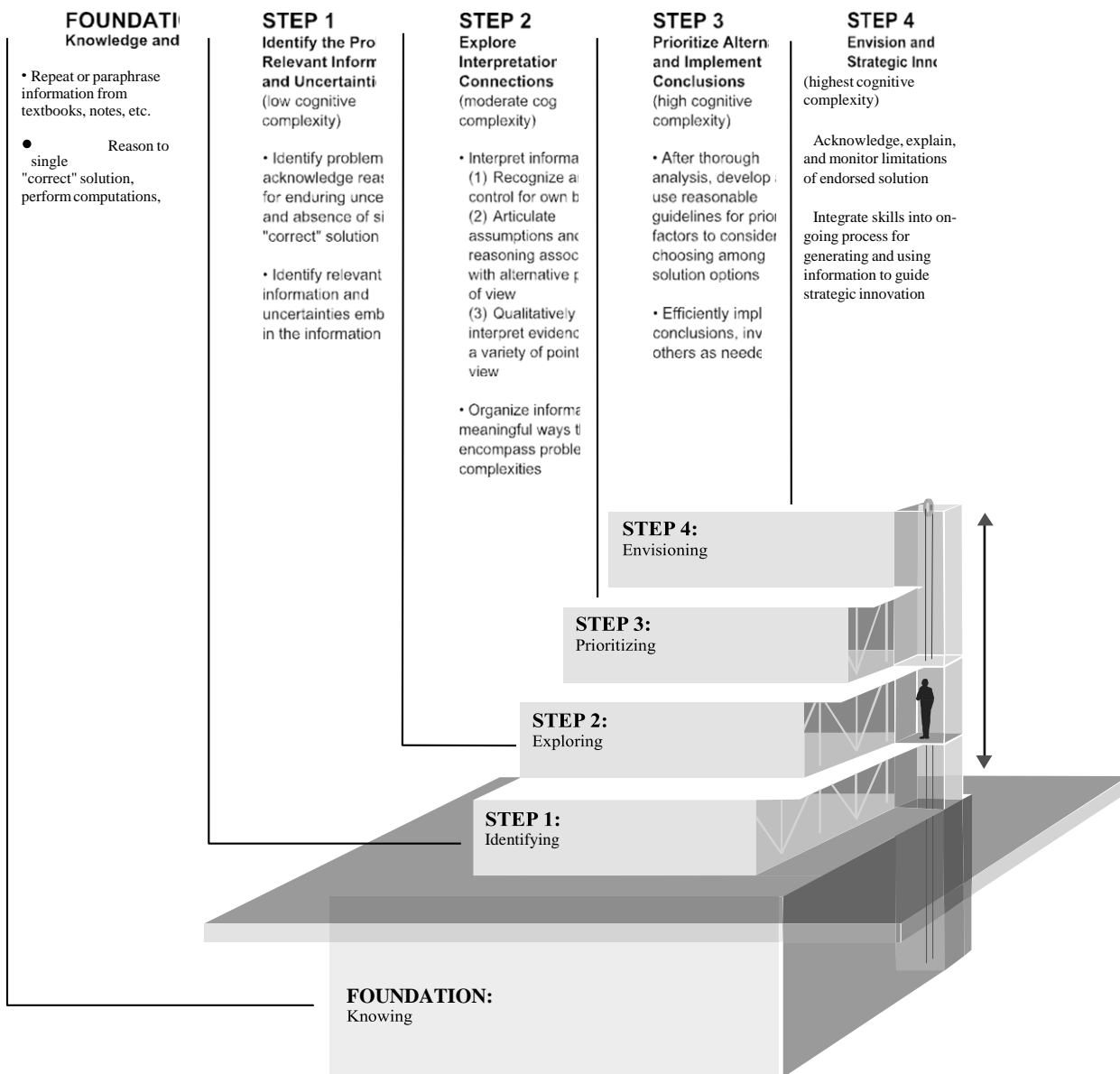In what sequential order did these happenings occur, and what are your reasons?

How can you best describe the relationships between the elements (e.g., cause and effect, sequential, spurious, process)?

What outcome/future trends can you predict/extrapolate/estimate from the available evidence?

Adapted from Bonwell, C. (2012). A disciplinary approach for teaching critical thinking. *The National Teaching and Learning Forum, 21*(2), 1-7; Halpern, D.F. Teaching critical thinking skills across the curriculum. Webinar produced by Starlink and broadcast live December 1, 2004; and Insight Assessment. (2009). *Test Manual for the California Critical Thinking Skills Test.*

STEPS FOR BETTER THINKING
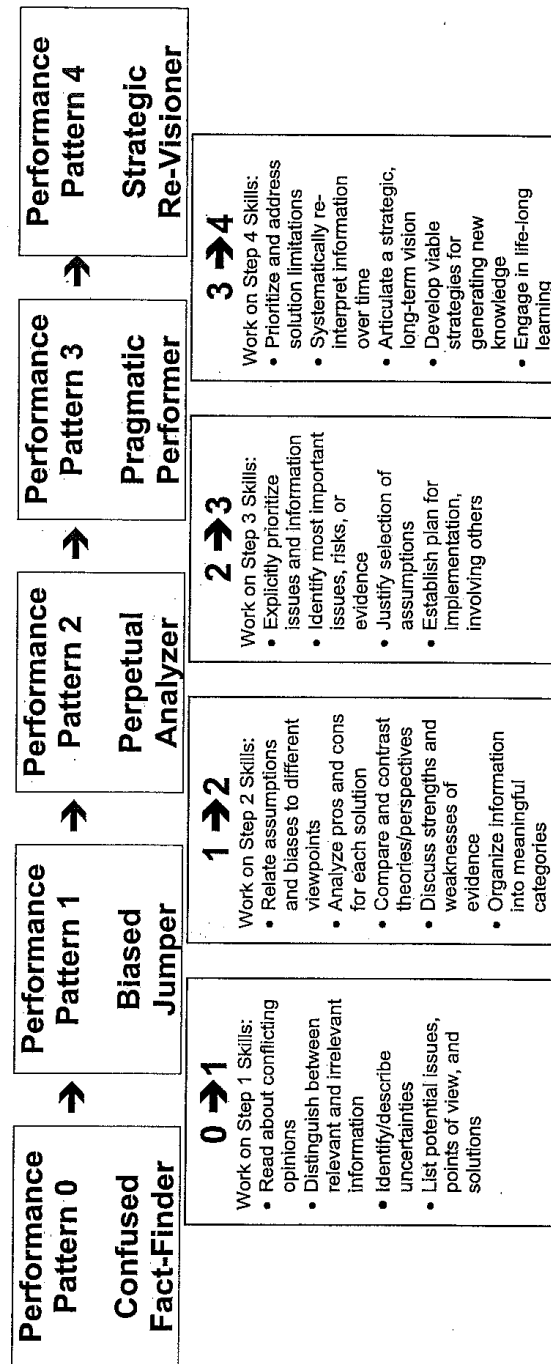## A Developmental Problem Solving Process

FOUNDATI...
Knowledge and...

• Repeat or paraphrase information from textbooks, notes, etc.

● Reason to single "correct" solution, perform computations,

STEP 1
Identify the Pro...
Relevant Inform...
and Uncertainti...
(low cognitive complexity)

• Identify problem acknowledge reas... for enduring unce... and absence of si... "correct" solution

• Identify relevant information and uncertainties emb... in the information

STEP 2
Explore Interpretation...
Connections
(moderate cog... complexity)

• Interpret informa...
(1) Recognize a... control for own b...
(2) Articulate assumptions and reasoning assoc... with alternative p... of view
(3) Qualitatively interpret evidenc... a variety of point... view

• Organize informa... meaningful ways t... encompass proble... complexities

STEP 3
Prioritize Altern...
and Implement Conclusions
(high cognitive complexity)

• After thorough analysis, develop... use reasonable guidelines for prio... factors to consider... choosing among solution options

• Efficiently impl... conclusions, inv... others as neede...

STEP 4
Envision and Strategic Inn...
(highest cognitive complexity)

Acknowledge, explain, and monitor limitations of endorsed solution

Integrate skills into on-going process for generating and using information to guide strategic innovation

STEP 4: Envisioning

STEP 3: Prioritizing

STEP 2: Exploring

STEP 1: Identifying

FOUNDATION: Knowing

Steps for Better Thinking Performance Patterns

← Less Complex Performance Patterns			More Complex Performance Patterns →	
"Confused Fact-Finder" Performance Pattern 0 Step 1, 2, 3, & 4 weak	**"Biased Jumper"** Performance Pattern 1 Step 2, 3, & 4 skills weak	**"Perpetual Analyzer"** Performance Pattern 2 Step 3 & 4 skills weak	**"Pragmatic Performer"** Performance Pattern 3 Step 4 skills weak	**"Strategic Re-Visioner"** Performance Pattern 4 Strategically Integrates Step 1, 2, & 3 skills
Overall Problem Approach: Proceeds as if goal is to find the single, "correct" answer	**Overall Problem Approach:** Proceeds as if goal is to stack up evidence and information to support conclusion	**Overall Problem Approach:** Proceeds as if goal is to establish a detached, balanced view of evidence and information from different points of view	**Overall Problem Approach:** Proceeds as if goal is to come to a well-founded conclusion based on objective comparisons of viable alternatives	**Overall Problem Approach:** Proceeds as if goal is to construct knowledge, to move toward better conclusions or greater confidence in conclusions as the problem is addressed over time
Common Weaknesses: • Fails to realistically perceive uncertainties/ambiguities • Does not seem to "get it", recasts open-ended problem to one having a single "correct" answer • Insists that professors, textbooks, or other experts should provide "correct" answer • Expresses confusion or futility • Uses illogical/contradictory arguments • Cannot evaluate or appropriately apply evidence • Inappropriately cites textbook, "facts," or definitions • Concludes based on unexamined authorities' views or what "feels right"	**Major Improvements Over Performance Pattern 0:** • Acknowledges existence of enduring uncertainties and the viability of multiple perspectives • Begins to use evidence logically to support conclusions **Common Weaknesses:** • Jumps to conclusions • Stacks up evidence quantitatively to support own view and ignores contrary information • Equates unsupported personal opinion with other forms of evidence • Inept at breaking problem down and understanding multiple perspectives • Insists that all opinions are equally valid, but ignores or discounts other opinions • Views experts as being opinionated or as trying to subject others to their personal beliefs	**Major Improvements Over Performance Pattern 1:** • Presents coherent and balanced description of a problem and the larger context in which it is found • Identifies issues, assumptions, and biases associated with multiple perspectives • Attempts to control own biases • Logically and qualitatively evaluates evidence from different viewpoints **Common Weaknesses:** • Unable to establish priorities for judging across alternatives • Reluctant to select and defend a single overall solution as most viable, or provides inadequate support for solution • Writes overly long paper in attempt to demonstrate all aspects of analysis (problems with prioritizing) • Jeopardizes class discussions by getting stuck on issues such as definitions	**Major Improvements Over Performance Pattern 2:** • After thorough exploration, consciously prioritizes issues and information • Articulates well-founded support for choosing one solution while objectively considering other viable options • Conclusion based on qualitative evaluation of experts' positions or situational pragmatics • Effectively incorporates others in the decision process and/or implementation **Common Weaknesses:** • Conclusion doesn't give sufficient attention to long-term, strategic issues • Inadequately identifies and addresses solution limitations and "next steps"	**Major Improvements Over Performance Pattern 3:** • Prioritizes and addresses limitations effectively • Interprets and re-interprets bodies of information systematically over time as new information becomes available • Exhibits a strategic, long-term vision • Spontaneously considers possible ways to generate new information about the problem **Common Weaknesses:** • Not applicable

Specific Learning Activities to Encourage Movement to the Next Level of Performance

Performance Pattern 0	→	Performance Pattern 1	→	Performance Pattern 2	→	Performance Pattern 3	→	Performance Pattern 4
Confused Fact-Finder		**Biased Jumper**		**Perpetual Analyzer**		**Pragmatic Performer**		**Strategic Re-Visioner**

0 → 1

Work on Step 1 Skills:
- Read about conflicting opinions
- Distinguish between relevant and irrelevant information
- Identify/describe uncertainties
- List potential issues, points of view, and solutions

1 → 2

Work on Step 2 Skills:
- Relate assumptions and biases to different viewpoints
- Analyze pros and cons for each solution
- Compare and contrast theories/perspectives
- Discuss strengths and weaknesses of evidence
- Organize information into meaningful categories

2 → 3

Work on Step 3 Skills:
- Explicitly prioritize issues and information
- Identify most important issues, risks, or evidence
- Justify selection of assumptions
- Establish plan for implementation, involving others

3 → 4

Work on Step 4 Skills:
- Prioritize and address solution limitations
- Systematically re-interpret information over time
- Articulate a strategic, long-term vision
- Develop viable strategies for generating new knowledge
- Engage in life-long learning

Note: This page can be downloaded as part of the document titled "Overview of Steps for Better Thinking Performance Patterns" under "Educator Resources" at http://www.WolcottLynch.com.

For more ideas, see *Templates for Designing Developmental Questions* on the next page.

Task Prompts That Give Students Step-by-Step Practice in Increasingly More Advanced CT Skills

Step 1: Identify the Problem, Relevant Information, and Uncertainties (low cognitive complexity tasks)
- ✓ identify problem and acknowledge reasons for enduring uncertainty and the absence of a single "correct" solution
- ✓ identify relevant information and uncertainties embedded in the information (may include "stacking up" relevant reasons and evidence to support some solution or conclusion).

• Explain why people disagree about _____.
• Explain why _____ _____ can't be known with certainty.
• Identify aspects of _____ _____ in which uncertainty is a major factor.
• Explain why even an expert about _____ can't predict with certainty what will happen when _____.
• Create a list of information that might be useful in thinking about _____.
• Create a list of issues related to _____.
• Create of list of different points of view related to _____.
• Identify a range of possible solutions to _____.
• Sort pieces of information to identify reasons and evidence that support a given solution to
_____.

Step 2: Explore Interpretations and Connections (moderate cognitive complexity tasks)
- ✓ interpret information
- ✓ recognize and control for own biases
- ✓ articulate assumptions and reasoning associated with alternative points of view
- ✓ qualitatively interpret evidence from a variety of points of view
- ✓ organize information in meaningful ways to encompass problem complexities

• Discuss the strengths and weaknesses of a particular piece of evidence related to
_____.
• Interpret and discuss the quality of evidence related to _____.
• Interpret and evaluate the quality of the same body of evidence related to ___ _____ from different points of view.
• Compare and contrast the arguments related to two or more solutions to _____.
• Identify and discuss the implications of assumptions and preferences related to one or more points of view about _____.
• Identify and discuss the implications of your own experiences and preferences for how you think about _____.
• Develop one or more ways to organize information and analyses to help you think more thoroughly about _____.
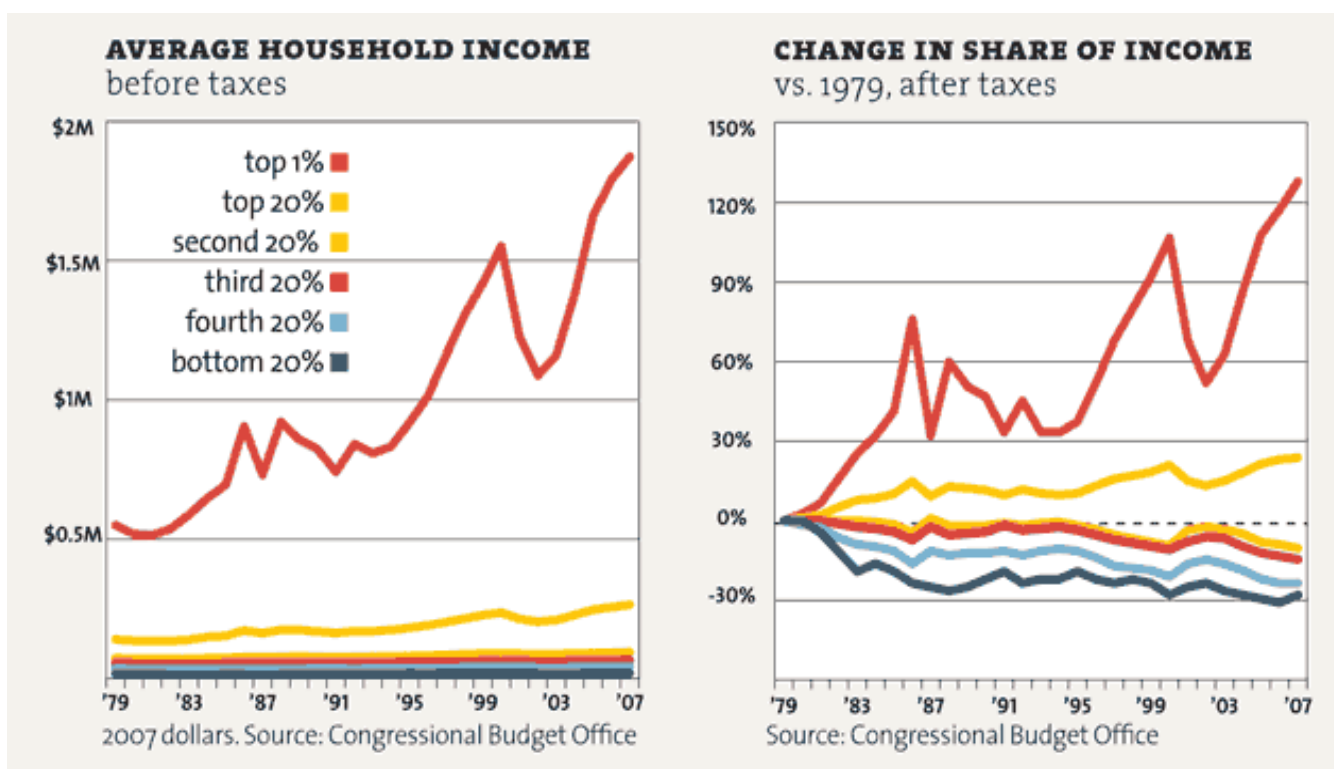
Step 3: Prioritize Alternatives and Communicate Conclusions (high cognitive complexity tasks)
- ✓ after thorough analysis, develop and use reasonable guidelines for prioritizing factors to
- ✓ consider and choosing among solution options
- ✓ communicate appropriately for a given audience and setting

• Prepare and defend a solution to _____.
• Identify which issues you weighed more heavily than other issues in arriving at your conclusion about _____.
• Explain how you prioritized issues in reaching a solution to _____.
• Describe how the solution to _____ might change, given different priorities on important issues.
• Explain how you would respond to arguments that support other reasonable solutions to _____.
• Identify the most important information needs of the audience for communicating your recommendation about _____.
• Explain how you designed your memo/presentation/report _____ to communicate effectively to your audience.
• Describe how you would communicate differently about _____ in different settings.

Step 4: Integrate, Monitor, and Refine Strategies for Re-addressing the Problem (highest cognitive complexity tasks)
- ✓ acknowledge and explain limitations of endorsed solution
- ✓ integrate skills in on-going process for generating and using information to monitor strategies and make reasonable modifications

• Describe the limitations of your proposed solution to _____.
• Explain the implications of limitations to your proposed solution to _____.
• Describe conditions under which you would reconsider your solution to _____.
• Explain how conditions might change in the future, resulting in a possible change in the most reasonable solution to _____.
• Develop strategies for generating new information about _____.
• Establish a plan for monitoring the performance of your recommended solution to _____.
• Establish a plan for addressing the problem strategically over time.

AVERAGE HOUSEHOLD INCOME
before taxes

top 1%
top 20%
second 20%
third 20%
fourth 20%
bottom 20%

2007 dollars. Source: Congressional Budget Office

CHANGE IN SHARE OF INCOME
vs. 1979, after taxes

Source: Congressional Budget Office

The following items are **multiple true/false**. To the left of each statement, put "T" if it is true and "F" if it is false.

Which of the following statements is/are valid conclusions you can draw from the graphs above:

___ 1. From 1979 to 2007, household income inequality increased among the bottom 20%, fourth 20%, and third 20% of the U.S. population.

___ 2. From 1979 to 2007, the change in the share of income dropped for all but the top 1%.

___ 3. In terms of income, both the top 20% and top 1% benefited from the bull market in technology.

___ 4. The graphs supply evidence in support the trickle-down theory that President Ronald Reagan espoused.

___ 5. The graphs supply evidence of increasing polarization between the highest-income classes and the rest of society.

___ 6. The graphs supply evidence that the wealth of the bottom 80% dropped from 1979 to 2007.

Which of the following statements is/are valid conclusions you can draw from the graphs above?

___ 7. One graph analyzes income data before taxes and the other after taxes. They show that taxes have the effect of redistributing income from the higher paid to the lower-paid households.

___ 8. Because the share of income dropped for most households, the U.S. economy has less money flowing through the system.

___ 9. The stock market crash of 2000 most lowered the household income of the top 1%.

___ 10. From 1979 to 2007, the sector that lost the largest share of household income was the bottom 20%.
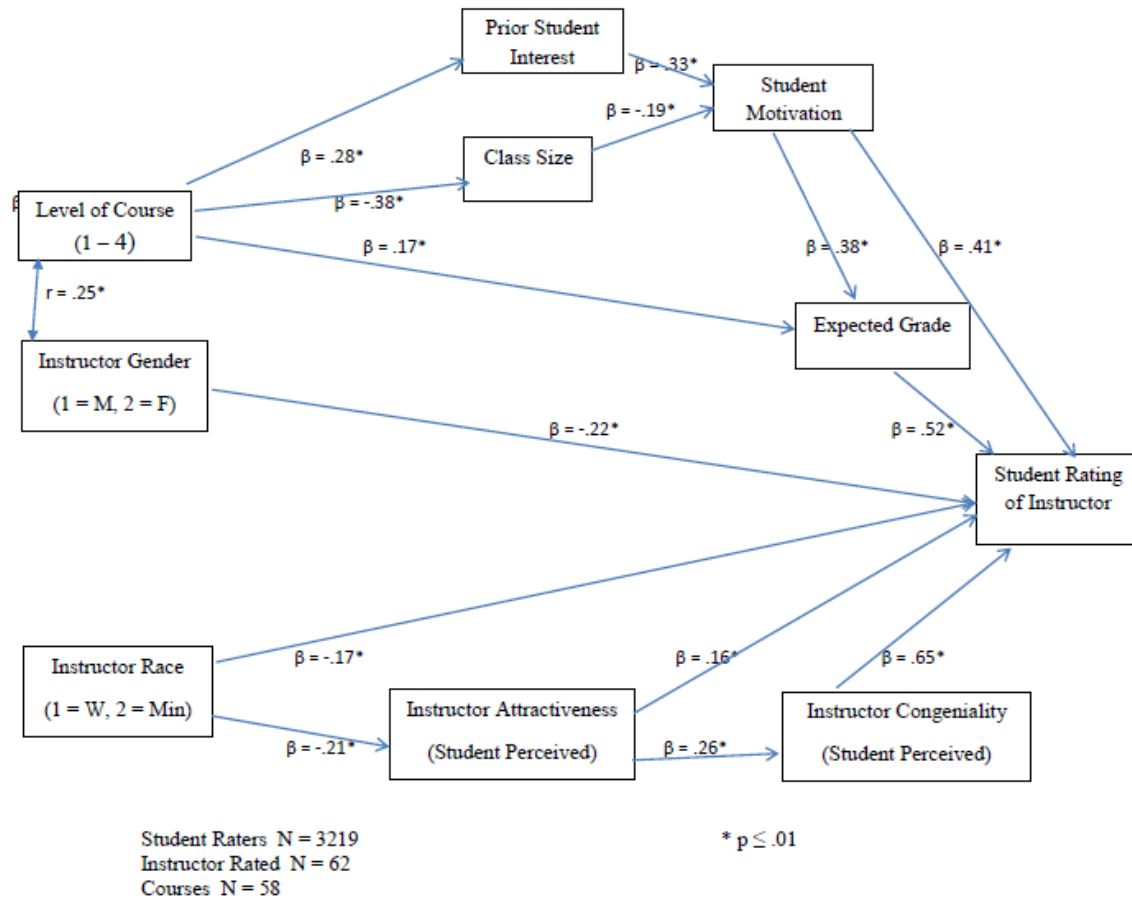
Figure 1

Prior Student Interest

β = .33*

Student Motivation

β = -.19*

Class Size

β = .28*

β = -.38*

Level of Course (1 – 4)

β = .17*

r = .25*

Instructor Gender (1 = M, 2 = F)

β = .38*

β = .41*

Expected Grade

β = -.22*

β = .52*

Student Rating of Instructor

Instructor Race (1 = W, 2 = Min)

β = -.17*

β = .16*

β = .65*

Instructor Attractiveness (Student Perceived)

β = -.21*

β = .26*

Instructor Congeniality (Student Perceived)

Student Raters N = 3219
Instructor Rated N = 62
Courses N = 58

*p ≤ .01

The following four items are **multiple choice.** Mark the letter of the correct answer.

1. The diagram above shows the results of a large study. What is the study's unit of analysis?
    a. Student raters
    b. Instructors rated
    c. Courses
    d. None of the above

2. What is the sample size of the study?
    a. 3281
    b. 3277
    c. 3219
    d. 120
    e. 62
    f. 58

3. What does "p ≤ .01" mean?
   a. The probability that the result is by chance is .01% or less.
   b. The probability that the result is by chance is 1% or less.
   c. The probability that the result is by chance is 1 in 10 or less.
   d. The true population value of β is the sample β $\pm$ .01.
   e. None of the above

4. Which of the following is the ***best*** label for Figure 1?
   a. Effects of Instructor Variables on Student Rating of Instructor
   b. Effects of Instructor Variables on Student Variables
   c. Effects of Course Variables on Student Rating of Instructor
   d. Causal Model of the Effects of Instructor and Student Variables
   e. Causal Model of Major Determinants of Student Rating of Instructor
   f. Causal Model of the Effects of Student Variables on Instructor Variables

The following items are **multiple true/false**. To the left of each statement, put "T" if it is true and "F" if it is false.

 Which of the following statements are valid conclusions you can draw from the diagram above?

___ 5. Class size mediates some of the effect of level of course on student motivation.

___ 6. Students perceive more attractive instructors as more congenial.

___ 7. Students perceive minority instructors as less attractive but more congenial than white instructors.

___ 8. Students' prior interest and class size significantly affect student learning.

___ 9. The instructor variables have stronger effects on student rating of instructor than do the student variables.

___ 10. The model has four dependent variables: student motivation, expected grade, instructor congeniality, and student rating of instructor.

___ 11. Female instructors tend to teach more lower-level courses than do male instructors.

___ 12. Instructors teaching smaller classes are likely to have more motivated students.

English – Poetry

BARTER

by Sara Teasdale

Life has loveliness to sell --

All beautiful and splendid things,

Blue waves whitened on a cliff,

Climbing fire that sways and sings,

(5) And children's faces looking up

Holding wonder like a cup.

Life has loveliness to sell—

Music like a curve of gold.

Scent of pine trees in the rain,

(10) Eyes that love you, arms that hold,

And for your spirit's still delight,

Holy thoughts that star the night.

Spend all you have for loveliness,

Buy it and never count the cost.

(15) For one white singing hour of peace

Count many a year of strife well lost,

And for a breath of ecstasy

Give all you have been or could be.

The main idea of the poem is to urge us

○ to be cautious in life

○ to avoid strife

○ to despise the ugly part of life

○ to enjoy life's treasures

○ not to become involved

The beauty of nature is indicated in line

○ 3 ○ 6 ○ 10 ○ 12 ○ 16

There is a simile (comparison) in line

○ 2 ○ 4 ○ 8 ○ 10 ○ 16

The poet includes the spiritual in life with the words

○ "climbing fire"
○ "children's faces"
○ "arms that hold"
○ "holy thoughts"
○ "year of strife"

The word barter means exchange by trade without money. In the poem the exchange is

○ personal commitment for life's beauty

○ a year of strife for ecstasy

○ spirit's delight for peace

○ children's faces for wonder

○ music for a curve of gold

Statistics

Two researchers were studying the relationship between amount of sleep each night and calories burned on an exercise bike for 42 men and women. They were interested if people who slept more had more energy to use during their exercise session. They obtained a correlation of .28, which has a two-tailed probability of .08. Alpha was .10.

1. Which is an example of a properly written research question?

   a) Is there a relationship between amount of sleep and energy expanded?*
   b) Does amount of sleep correlate with energy used?
   c) What is the cause of energy expanded?
   d) What is the value of rho?

2. What is the correct term for the variable amount of sleep?

   a) Dependent
   b) Independent*
   c) Predictor
   d) y

3. What is the correct statistical null hypothesis?

   a) There is no correlation between sleep and energy expanded
   b) Rho equals zero*
   c) R equals zero
   d) Rho equals r

5. What conclusions should you draw regarding the null hypothesis?

   a) Reject*
   b) Accept
   c) Cannot determine without more information

6. What conclusions should you draw regarding this study?

   a) The correlation was significant
   b) The correlation was not significant
   c) A small relationship exists*
   d) No relationship exists

Biology

One day you meet a student watching a wasp drag a paralyzed grasshopper down a small hole in the ground. When asked what he is doing he replies, "I'm watching that wasp store paralyzed grasshoppers in her nest to feed her offspring."

1. Which of the following is the best description of his reply?

    a) He is not a careful observer.
    b) He is stating a conclusion only partly derived from his observation.*
    c) He is stating a conclusion entirely drawn from his observation.
    d) He is making no assumptions.

2. Which of the following additional observations would add the most strength to the student's reply in Question 1?

    a) Observing the wasp digging a similar hole.
    b) Observing the wasp dragging more grasshoppers into the hole. C.
    c) Digging into the hole and observing wasp eggs on the paralyzed grasshopper.*
    d) Observing adult wasps emerging from the hole a month later.

3. Both of you wait until the wasp leaves the area, then you dig into the hole and observe three paralyzed grasshoppers, each with a white egg on its side. The student states that this evidence supports his reply in Question 1. Which of the following assumptions is he making?

    a) The eggs are grasshopper eggs.
    b) The wasp laid the eggs.*
    c) The wasp dug the hole.
    d) The wasp will return with another grasshopper.

4. You take the white eggs to the biology laboratory. Ten days later immature wasps hatched from the eggs. The student states that this evidence supports his reply in Question 1. Which of the following assumptions is he making?

    a) The wasp dug the hole.
    b) The wasp stung the grasshoppers.
    c) The grasshoppers were dead.
    d) Paralyzed grasshoppers cannot lay eggs.*

Possible Reflective Meta-Assignments (Assignment Wrappers)

CT demands explicit awareness, monitoring, control, and evaluation of one's thinking, so add a **meta-assignment** or **assignment wrapper** (grade pass/fail) in which students reflect on and describe their thinking and affective processes (metacognition, self-regulated learning)—e.g.:

- *How did you arrive at your response/solution?*
- *How did you define the task/problem, decide which principles and concepts to apply, develop alternative approaches and solutions, and assess their feasibility, trade-offs, and relative worth?*
- *How did you conduct your design/problem-solving/research process (steps taken, strategies used, problems encountered, how overcome)?*
- *What skills did you use or improve, and when will they be useful in the future?*
- *Evaluate your strategies, performance, and success in achieving your goals.*
- *What goals and strategies will guide your revision (if applicable)?*
- *What learning value did this task have? What would you do differently?*
- *What part of the learning experience challenged what you thought about the subject? Did you find yourself resisting it? If so, how did you overcome your resistance?*
- *What advice would you give next semester's students before they do this assignment (preparation, strategies, pitfalls, value)?*

Selected Bibliography (Partially Annotated) on Critical Thinking

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research, 78*(4), 1102-1134. Available at http://www.jstor.org/stable/40071155?seq=1#page_scan_tab_contents
Main finding: To develop critical skills in students in a course, instructors must have the explicit goal of developing those skills as well as training in ways to do so. Critical thinking does not progress by accident or within the typical course.

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2014). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research.* Available at http://rer.sagepub.com/content/early/2014/09/25/0034654314551063.full
Main finding: List of activities that are most effective in promoting critical thinking skills.

Bloom, B., & Associates. (1956). *Taxonomy of educational objectives*. New York: David McKay. Models at http://www.edpsycinteractive.org/topics/cognition/bloom.html and http://www.celt.iastate.edu/teaching-resources/effective-practice/revised-blooms-taxonomy/

Braun, N. M. (2004). Critical thinking in the business curriculum. *Journal of Education for Business, 79*(4), 232-236.
Nora Braun of Augsburg College points out that in the business world, making decisions is a daily occurrence. Discussions, debates, and guided questioning are some of the techniques that should be used in business courses to classify and evaluate the enormous quantity of available information.

Brookfield, S. D. (2013). Webpage with access to resources and activities for teaching critical thinking. http://stephenbrookfield.com/Dr._Stephen_D._Brookfield/Workshop_Materials.html
In-class exercises at http://www.stephenbrookfield.com/Dr._Stephen_D._Brookfield/Workshop_Materials_files/Developing_Critical_Thinkers.pdf, pp. 17-44.

Brookfield, S. D. (2012). *Teaching for critical thinking: Tools and techniques to help students question their assumptions.* San Francisco: Jossey-Bass. Chapter 1, What is critical thinking? available at http://stephenbrookfield.com/Dr._Stephen_D._Brookfield/Articles_and_Interviews_files/Ch%201%20What%20is%20Critical%20Thinking.pdf

Brookfield, S. D. (1997). Assessing critical thinking. *New Directions for Adult and Continuing Education*, No. 75, Fall, 17-29.

Browne, M. N., & Keeley, S. M. (2010). *Asking the right questions: A guide to critical thinking* (9th ed.). Prentice Hall, NJ.
The authors highlight the applicability of critical thinking skills to life experiences extending far beyond the classroom. Critical thinking habits and attitudes are transferrable to consumer, medical, legal, and general ethical choices, to the benefit of the thinker.

Burbach, M., Matkin, G., & Fritz, S. (2004). Teaching critical thinking in an introductory leadership course utilizing active learning strategies: A confirmatory study. *College Student Journal, 38*(3), 482-493.

Although educators disagree on the definition of critical thinking, they do concur that critical thinking should be the main goal of a course. This study in an introductory level college leadership course finds that students improve their critical thinking skills through active learning.‖

Facione, P. A. (2015 update). Critical thinking: What it is and why it counts. Available at http://www.insightassessment.com/pdf_files/what&why2006.pdf

Facione, P. A. (2011). *Think critically.* Upper Saddle River, NJ: Prentice Hall.
Written from a philosophical perspective, this critical thinking textbook emphasizes the application of critical thinking to the real world and offers positive examples of critical thinking. Chapters cover inductive, deductive, comparative, ideological, and empirical reasoning.

Facione, P. A. (1990). Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations. Available at http://files.eric.ed.gov/fulltext/ED315423.pdf

Facione, N. C., & Facione, P. A. (2008). *Critical thinking and clinical judgment in the health sciences: An international teaching anthology.* Millbrae, CA: California Academic Press.

Facione, N. C., & Facione, P. A. (2007). *Thinking and reasoning in human decision making.* Millbrae, CA: California Academic Press.

Facione, N. C., & Facione, P. A. (2001). Analyzing explanations for seemingly irrational choices. *International Journal of Applied Philosophy, 15*(2), 267-86.

Facione, P. A., & Facione, N. C. (2007). Talking critical thinking. *Change: The Magazine of Higher Education*, *39*(March-April), 38-44.

Facione, P. A., Facione, N. C., & Giancarlo, C. (2000). The disposition toward critical thinking: Its character, measurement, and relationship to critical thinking skills, *Journal of Informal Logic, 20*(1), 61-84.

Fisher, A. (2001). *Critical thinking: An introduction.* New York: Cambridge University Press.
Fisher aims to teach the basic skills or competencies displayed in good critical thinkers: the ability to interpret, analyze and evaluate ideas and arguments.

Hale, J. (2011). Analyzing the thinking process: Interview with Diane Halpern at http://psychcentral.com/blog/archives/2011/04/24/analyzing-the-thinking-process-interview-with-diane-halpern/
Highlights of Halpern's approach to critical thinking

Halpern, D. F. (2013). *Thought and knowledge: An introduction to critical thinking* (5th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Halpern, D. F. (1999). Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker. *New Directions for Teaching and Learning*, No.80, Winter, 69-74.

Diane Halpern, a professor of psychology at California State University, proposes a four-part model to teach critical thinking. The model includes strategies to help students recognize when a certain thinking skill is needed and metacognitively monitor their thinking processes.

Insight Assessment. (2013). California Critical Thinking Skills Tests® Scales, Description. Available at http://www.insightassessment.com/Products/Products-Summary/Critical-Thinking-Skills-Tests/California-Critical-Thinking-Skills-Test-CCTST

Insight Assessment. (2013). Sample items from the California Critical Thinking Skills Test® (CCTST®) at https://www.insightassessment.com/Resources/node_1487

Macpherson, K. (1999). The development of critical thinking skills in undergraduate supervisory management units. *Assessment & Evaluation in Higher Education, 24*(3), 273-284.

Nilson, L. B. (1997). Critical thinking as an exercise in courage. *The National Teaching and Learning Forum, (6)*2, 1-4.
This article reviews many of the logical fallacies that interfere with critical thinking and goes beyond in revealing how "psycho-logical" fallacies – that is, psychological defense mechanisms – also obstruct critical thinking. In other words, critical thinking depends upon mental/emotional health.

Nosich, G. M. (2009). *Learning to think things through: A guide to critical thinking across the curriculum* (4th ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.
Built on Richard Paul's model of critical thinking, this book is written for students to help them learn how to think critically in any subject matter, with an emphasis on the elements of reasoning, standards, and critical thinking processes. It presents instruction and exercises that actively involve students in their own learning, highlight the power and relevance of the discipline of the course, and make connections to other fields.

Paul, R., & Elder, L. (2013). Critical thinking: Teaching students how to study and learn, Part III. *Journal of Developmental Education, 26*(3), 36-37. Available at http://www.criticalthinking.org/pages/how-to-study-and-learn-part-three/515
Richard Paul, director of research and professional development at the Center for Critical Thinking at Sonoma State University, has written extensively in the field of critical thinking. He and Linda Elder have co-authored many articles on critical thinking which "prove" by polls and surveys taken that educators generally do not know what critical thinking is, or how to teach it. Three templates provided in this article are well written and would be beneficial in most classes. They help students analyze the logic of articles, essays, or chapters. Each template consists of eight questions asking the main purpose, the key question, the most important information, the main references or conclusions, the key idea, the main assumptions of the material, the implications, and the main point of view. By using these templates when reading an article or chapter, students will better understand critical thinking as a process that enable s them to identify and evaluate information. Specifically, a critical thinking approach to reading equips students to know:
• how to analyze the logic of an article, essay, or chapter
• how to figure out the logic of a textbook
• how to evaluate an author's reasoning.
The authors focus on critical thinking as a process and encourage readers to work through the templates so they can help students learn to analyze and assess information in written materials. These techniques transfer quite easily to other topics and disciplines. They first appeared in:

Paul, R., & Elder, L. (2001). *The thinker's guide to how to study and learn*. Dillon Beach, CA: Foundation for Critical Thinking.
Many other teaching resources are available free at www.criticalthinking.org, and these are especially important:
http://www.criticalthinking.org/pages/our-concept-and-definition-of-critical-thinking/411
http://www.criticalthinking.org/pages/a-sample-assignment-format/438
http://www.criticalthinking.org/pages/critical-thinking-development-a-stage-theory/483
http://www.criticalthinking.org/pages/the-state-of-critical-thinking-today/523
http://www.criticalthinking.org/pages/universal-intellectual-standards/527
http://www.criticalthinking.org/pages/valuable-intellectual-traits/528)
http://www.criticalthinking.org/pages/study-of-38-public-universities-and-28-private-universities-to-determine-faculty-emphasis-on-critical-thinking-in-instruction/598

Pierce, W. (2007). Titles and annotations of documents from Prince George Community College. Available at http://academic.pg.cc.md.us/~wpeirce/MCCCTR/annotat1.html
In addition to links to ideas for critical thinking assignments and activities, there is a valuable site with examples of critical thinking rubrics and advice for developing one's own:
http://academic.pg.cc.md.us/~wpeirce/MCCCTR/Designingrubricsassessingthinking.html

Pierce, W. (2007). WWW links to resources for teaching reasoning and critical thinking. Available at http://academic.pg.cc.md.us/~wpeirce/MCCCTR/links~1.html
While a compilation this old has some broken links, those that are still alive are very good.

Perry, W. G. (1968). *Forms of intellectual and ethical development in the college years: A scheme.* New York: Holt, Rinehart & Winston. Models at http://home.ubalt.edu/ub02Z36/Perry_Stages_ACRL-MD.pdf, http://www.cse.buffalo.edu/~rapaport/perry.positions.html, http://perrynetwork.org/?page_id=2%3E

Roth, M. S. (2010, January 3). Beyond critical thinking. *Chronicle of Higher Education*. Available at http://chronicle.com/article/Beyond-Critical-Thinking/63288/
Roth observes that the teaching of critical thinking tends to focus on criticism – seeing through or undermining statements — and cautions against creating a class of self-satisfied debunkers.‖When critical thinking means being a critical unmasker, students may become too good at showing how things do not make sense, which may diminish their capacity to find or create meaning and direction in the books they read and the world in which they live. Roth endorses finding ways to teach students to open themselves to the emotional and cognitive power of history and literature, even though these fields may initially rub them the wrong way or seem foreign. He concludes that we should allow students to see the value-laden practices of a particular culture so they can understand how these values are legitimated. We should also encourage them to cultivate the willingness and ability to learn from material they might otherwise reject or ignore.

Seesholtz, M., & Polk, B. (2009, October 10). Two professors, one valuable lesson: How to respectfully disagree. *Chronicle of Higher Education.* Available at http://chronicle.com/article/Two-Professors-One-Valuable/48901/
The authors team-taught a course that demonstrated critical thinking through civil discourse: how to engage in a civil debate with the goal of advancing understanding of another's point of view, how to evaluate the validity of that viewpoint, and how to benefit from the new perspectives it opens.‖

Tremblay, K. R., Jr., & Downey, E. P. (2004). Identifying and evaluating research-based publications: Enhancing undergraduate student critical thinking skills. *Education, 124*(4), 734-740.
Kenneth Tremblay, a faculty member in the Department of Design and Merchandising and School of Social Work at Colorado State University, reports the results of a study conducted on undergraduate students in a research methods course involving critical thinking. In response to a series of questions, students selected and developed an idea, gathered research-based publications, and read and evaluated the literature. In the evaluation process, students developed critical thinking skills as well as inductive and deductive logic reasoning skills.

Willingham, D. T. (2007). Critical thinking: Why is it so hard to teach? *American Educator*, Summer, 8-19. Available at http://www.aft.org//sites/default/files/periodicals/Crit_Thinking.pdf
According to Willingham, no specific set of critical thinking skills actually exists. He believes that techniques can be taught, but they work poorly if taught in a stand-alone way. Students must have some content or domain knowledge before they can apply any technique. Otherwise, it is difficult to get beyond the "surface structure" of a problem and to know when to look more deeply. Willingham argues that the assessments of critical thinking programs used in the last 25 years are limited or flawed, but most show that skilled teaching/coaching and plenty of opportunity for students to practice techniques, especially across dissimilar material, can increase critical thinking abilities.

Wolcott, S. L. (2016). Steps for better thinking. Available at http://www.wolcottlynch.com/
The site provides a stage-based model of critical thinking, teaching tools, working papers, and an online tutorial in teaching critical thinking.

Critical thinking rubrics online:
- AACU's Critical Thinking VALUE Rubric at http://www.aacu.org/value/rubrics/critical-thinking and http://assessment.arizona.edu/sites/default/files/CriticalThinking.pdf
- St. Philip's College QEP Critical Thinking Rubric at http://course1.winona.edu/shatfield/air/QEPrubricpilots042007jo.pdf
- Facione & Facione's Holistic Critical Thinking Scoring Rubric at http://course1.winona.edu/shatfield/air/critical%20thinking%204.pdf
- Northeastern Illinois University's General Education Critical Thinking Rubric at http://course1.winona.edu/shatfield/air/Critical%20Thinking-long.pdf
- The College of Wooster's Critical Thinking Sample Rubrics, Domain Specific http://www3.wooster.edu/teagle/critical_rubrics.php
- St. Petersburg College's Assessment Rubric for Critical Thinking (ARC) Scenarios http://www.spcollege.edu/criticalthinking/students/rubrics.htm
- Repository of links to CT rubrics (not all live) http://www.uni.edu/adp/documents/LinksforCriticalThinkingRubrics.pdf

Compiled by Linda B. Nilson, July 2016