Teaching Critical Thinking

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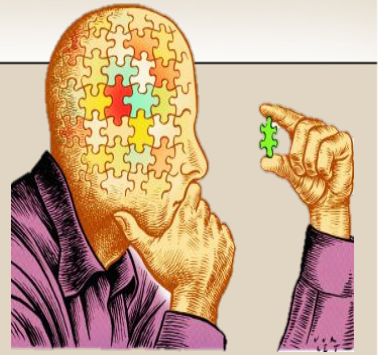
Texas A&M University

Key Components



- Utilize a defined process or model
- Incorporate and practice the model at all levels (faculty, TAs, and students)
- Require reflection and metacognition in all aspects of a course or experience
  - Reflection: conscious exploration of one's experience
  - Metacognition: thinking about one's own thought processes

Program Level Learning Outcome Rubric – Zachry Department of Civil Engineering, Dwight Look College of Engineering, Texas A&M University

8. Problem recognition and solving

After graduation, the student will be able to:

Develop problem statements and solve fundamental civil engineering problems by applying appropriate techniques and tools.

	Performance Indicators	4	3	2	1
		Desired level at graduation.	*Minimum acceptable level at graduation.*	*Intermediate level.*	*Level when student enters CVEN (after completing CBK).*
a.	**Problem Recognition**	**Synthesize** from disparate information a comprehensive statement of a problem suitable for formulating a civil engineering solution.	**Define** the types of problems that an individual civil engineer (her/himself or another person) is competent to address consistent with ethical standards for licensed engineers. **Define** the information required to characterize an engineering problem and formulate a solution.	**Categorize** a wide range of civil engineering problems among subdisciplines and branches of knowledge (e.g., structural problems versus geotechnical problems versus construction management problems, etc.).	**Identify** problems that civil engineers typically solve in practice (e.g., long traffic delays, inadequate water supplies, etc.).
b.	**Problem Generalization**	**Design** solution methods based on approaches in different application areas.	**Explain** generalized concepts and manifestation in different areas.	**Identify** commonalities between civil engineering and problems in everyday life.	**Identify** types of problems found in everyday life.
c.	**Problem Solving**	**Apply**, working independently and in teams, standard civil engineering problem solving techniques with *high levels* of uncertainty and ill-definition.	**Apply**, working independently and in teams, standard civil engineering problem solving techniques with *minor levels* of uncertainty and ill-definition.	**Explain** the use of multiple civil engineering problem solving techniques for well-defined problems in multiple subdisciplines.	**Use** basic mathematical and scientific principles to solve elementary, well defined problems in math and science.
d.	**Critical Thinking**	**Analyze** and **critique** information, perspectives, experiences, and personal thought processes when analyzing problems and synthesizing problem solving approaches.	**Demonstrate** awareness or analysis of one's own learning or thinking processes to recognize and solve problems.	**Summarize** strategies in analyzing one's own learning or thinking processes in order to recognize and solve problems.	**Recognize** one's own learning and thinking processes and fundamental limitations.

Models help support and develop critical thinking skills

- Paul and Elder: Critical Thinking Concepts and Tools
- Wolcott and Lynch: Steps for Better Thinking
- Chaffee: Thinking Critically

Critical Thinker

Paul and Elder (2001)

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- 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 & solutions, testing them against relevant criteria & standards;
- Thinks open-mindedly within alternative systems of thought, recognizing & assessing, assumptions, implications, and practical consequences; and
- Communicates effectively with others in figuring out solutions to complex problems.

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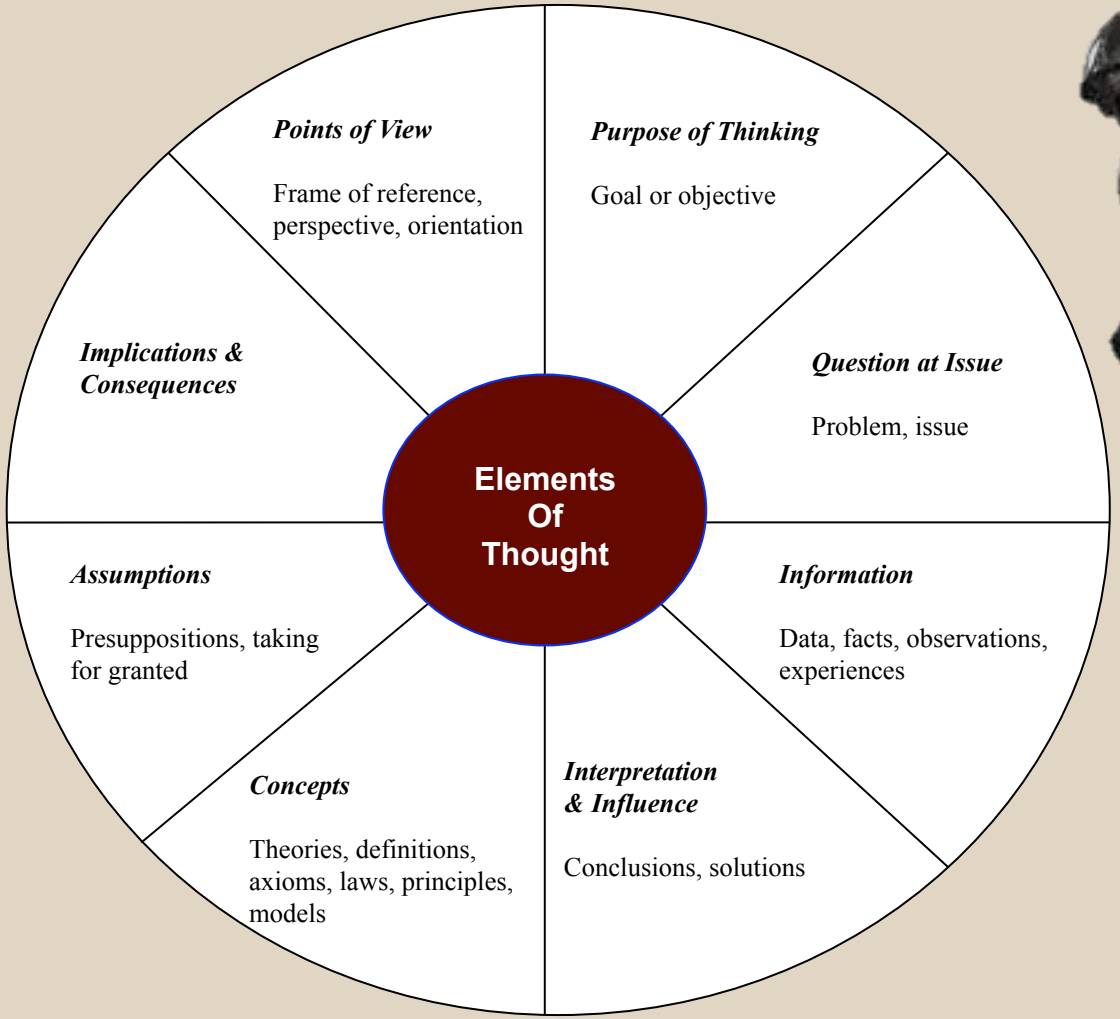
Elements of Thought

Adapted from Paul & Elder, 2001



Checklist for Reasoning

Paul and Elder (2001)

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- All reasoning
  - has a **PURPOSE**
  - is an attempt to **FIGURE** something out, to settle some **QUESTION**, solve some **PROBLEM**
  - is based on **ASSUMPTIONS**
  - is done from some **POINT OF VIEW**
  - is based on **DATA, INFORMATION & EVIDENCE**
  - is expressed through, and shaped by **CONCEPTS & IDEAS**
  - contains **INFERENCES** or **INTERPRETATIONS** by which we draw **CONCLUSIONS** and give meaning to data
  - has **IMPLICATIONS** and **CONSEQUENCES**

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Developmental Framework for Critical Thinking

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	Observation	Interpretation	Judgment	Planning
Steps for Better Thinking	Foundation Knowledge → Identify The Problem	Explore Interpretations & Connections	Prioritize Alternatives	Envision Strategic Innovation
Performance Patterns	Confused Fact Finder	Biased Jumper	Perpetual Analyzer	Pragmatic Performer	Strategic Re-visioner
Interventions	Distinguish relevant & irrelevant Information Read conflicting opinions	Relate assumptions & biases Analyze pros & cons	Prioritize issues and information Justify assumptions	Articulate vision Reinterpret information
	Step 1	Step 2	Step 3	Step 4

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Steps for Better Thinking Performance Patterns, http://www.wolcottlynch.com

Chaffee (2014)

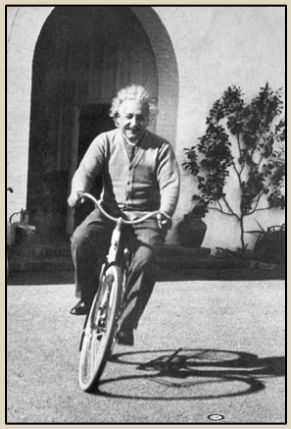
Developing Good Questions

Powerful Questions:

- Generate curiosity
- Stimulate reflective conversation
- Are thought-provoking
- Invite critical thinking and new possibilities
- Stay with students
- Touch a deep meaning
- Ask the un-askable
- Evoke more questions

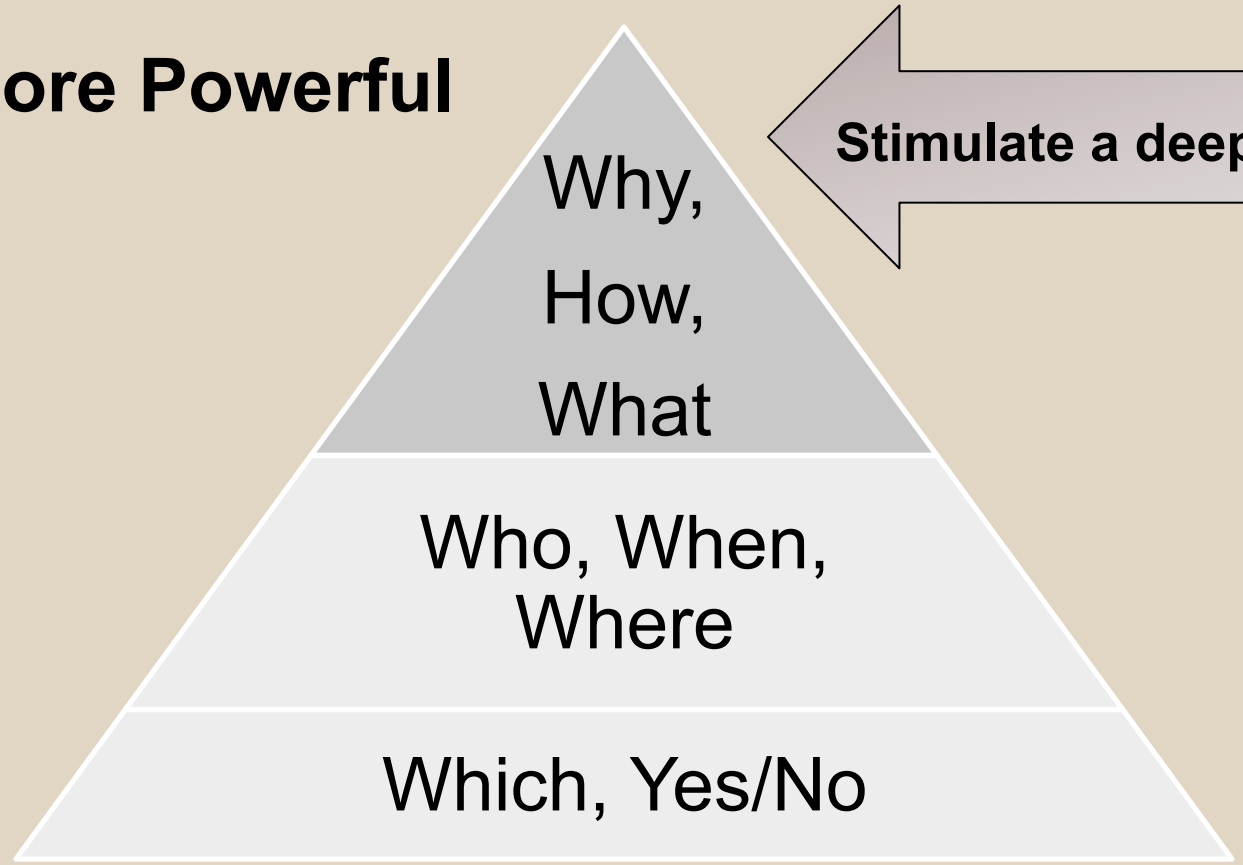
"If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes."

-Albert Einstein



Powerful Questions

More Powerful



Stimulate a deeper level of thinking

Less Powerful

Example From Group Project Reflection Exercise

- Are you satisfied with how our group is working together?
- *When* have you been most satisfied with how our group works together?
- *What* is it about working with our group that you find most satisfying?
- *Why* might it be that our group has had its ups and downs?

Question Activity

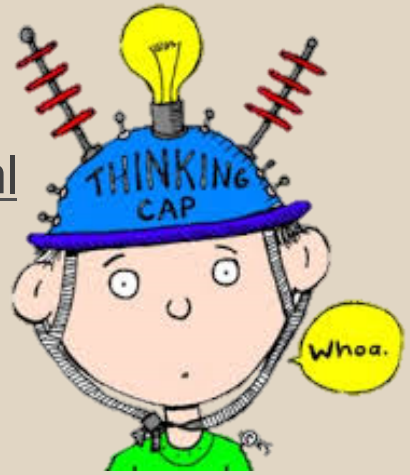
- Think of a concept you teach in your class and develop questions at each level in the pyramid that you can pose to students.
- How did the questions change the level of thinking required to answer it?
- Share with a colleague.

Incorporating Critical Thinking

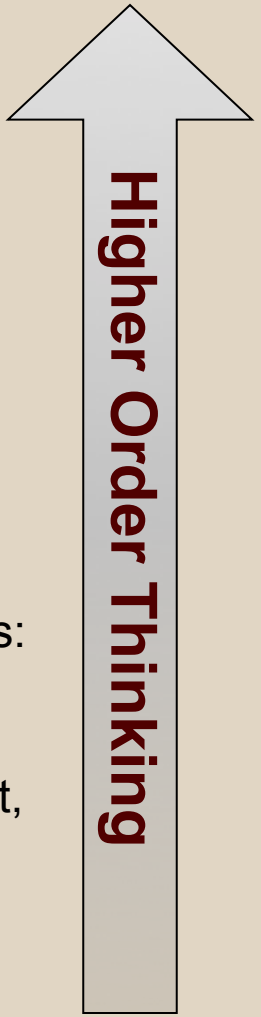
- Gather baseline data
- Refine coursework over several semesters (a sequence of courses not just one)
- Pay particular attention to weaknesses in the ability of your students to identify the problem, relevant information, and uncertainties
- Introduce students to your chosen model
- Recognize need for students to give up old ways of thinking and adopt new ways of thinking
- Consider implementation across the curriculum

References

- Chaffee, J. (2000). *Thinking Critically*. (6th ed.). Stamford, CT: Cengage Learning
- Paul, R., & Elder, L. (2014). *The Miniature Guide for Critical Thinking Concepts & Tools (7th edition).* Dillon Beach, CA: Foundation for Critical Thinking. http://www.criticalthinking.org/store/products/the-miniature-guide-to-critical-thinking-concepts-amp-tools-7th-edition/156
- Vogt, E. E., Brown, J. & Isaacs, D. (2003). *The art of powerful questions: Catalyzing insight, innovation, and action*. Whole Systems Associates: Mill Valley, CA.
- WolcottLynch Educator Resources: http://www.wolcottlynch.com/EducatorResources.html



Bloom's Revised Taxonomy



Creating—Generating new ideas, products, or ways of viewing things. Outcome verbs: design, construct, plan, produce, invent.

Evaluating—Justifying a decision or course of action. Outcome verbs: Hypothesize, critique, experiment, judge, conclude.

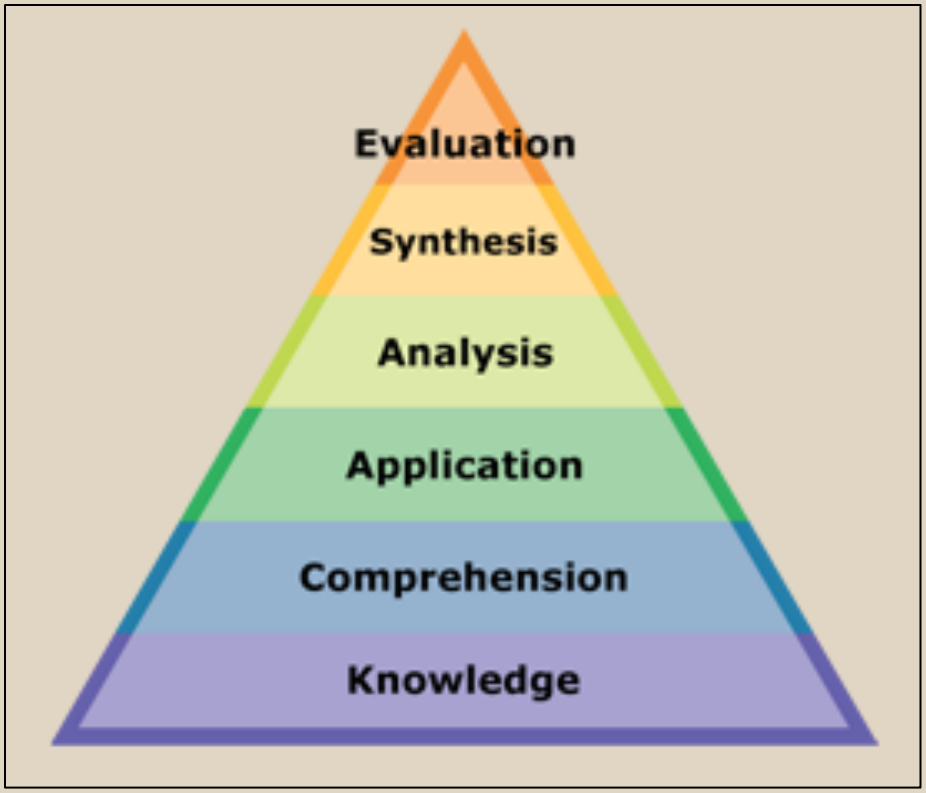
Analyzing—Breaking information into parts to explore understandings and relationships. Outcome verbs: Compare, organize, deconstruct, interrogate, diagram, correlate.

Applying—Using information in another familiar situation. Outcome verbs: Implement, carry out, use, execute, solve.

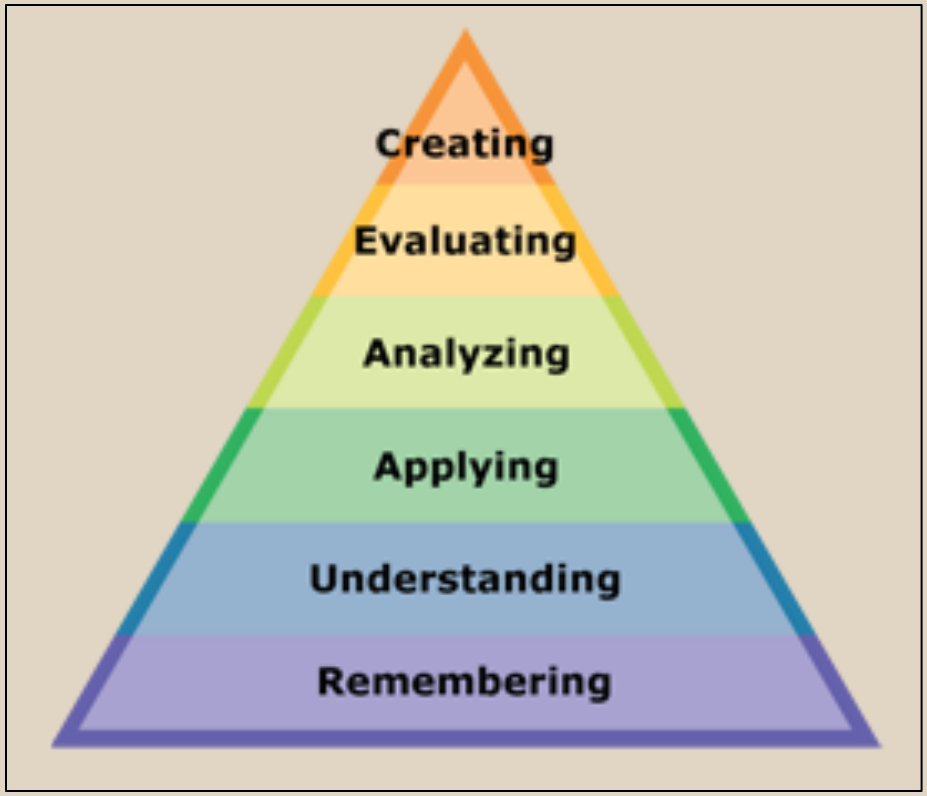
Understanding—Explaining ideas or concepts. Outcome verbs: Interpret, summarize, paraphrase, classify, explain.

Remembering—Recalling information. Outcome verbs: Recognize, list, describe, retrieve, name, find.

Bloom's Taxonomy



Bloom's Original



Anderson's Revised

Skills Assessed by the Critical thinking Assessment Test (CAT)

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Evaluating Information and Other Points of View

- Separate factual information from inferences
- Interpret numerical relationships in graphs
- Understand the limitations of correlational data
- Evaluate evidence and identify inappropriate conclusions

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Creative Thinking

- Identify alternative interpretations of data for observations
- Identify new information that might support or contradict a hypothesis
- Explain how new information can change a problem

CAT

Learning and Problem Solving

- Separate relevant from irrelevant information
- Integrate information to solve problems
- Learn and apply new information
- Use mathematical skills to solve real-world problems

Communication

- Communicate ideas effectively