Master Thesis – Critical Thinking

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Critical Thinking

• What is critical thinking?

• Why is critical thinking important?
Critical Analysis versus Description

- Describe
- Analyse critically
- Need some background to understand

The Three sphinxes of Bikini Atoll
What is Critical Thinking

• Definitions

Critical thinking calls for a persistent effort to examine any belief or supposed form of knowledge in the light of the evidence that supports or refutes it and the further conclusions to which it tends.

• (Glaser 1941)
In other words

• Persistence- Considering and issue more than once
• Evidence- Evaluating the evidence put forward to support a viewpoint
• Implications- Considering where the belief or viewpoint leads- what conclusions follow; are these rational
• Outcome- Should this belief be reconsidered?
What is Critical Thinking

• It is not:
  – Being negative
  – Simply agreeing with the majority
  – Thinking that you are always right
  – Drawing conclusions too quickly
  – Simply agreeing with the lecturer
  – Placing weight on insignificant details
  – Refusing to ask questions
Why is Critical Thinking Difficult

• Critical thinking requires mental effort
• Routine problems can be solved without critical thinking, e.g. $2+2 = ?$

• Questions:
  It takes 5 machines 5 minutes to make 5 widgets. How long would it take 100 machines to make 100 widgets?

All roses are flowers, some flowers fade quickly, therefore some roses fade quickly. Does it logically follow?
Problem Solving: Scientific and Engineering Method

Scientific Method

1. Ask a Question
2. Do Background Research
3. Construct a Hypothesis
4. Test with an Experiment
5. Procedure Working?
   - No: Troubleshoot procedure. Carefully check all steps and set-up.
   - Yes: Analyze Data and Draw Conclusions
     - Results Align with Hypothesis: Communicate Results
     - Results Align Partially or Not at All with Hypothesis: Go back to Construct a Hypothesis

Engineering Method

1. Define the Problem
2. Do Background Research
3. Specify Requirements
4. Brainstorm, Evaluate, and Choose Solution
5. Develop and Prototype Solution
6. Test Solution
   - Solution Meets Requirements: Communicate Results
   - Solution Meets Requirements Partially or Not at All: Brainstorm, Evaluate, and Choose Solution

From http://www.cdn.sciencebuddies.org/
For a civil engineer, there's no such thing as a "little mistake."
Critical Thinking - Line of reasoning
Cottrell (2013)

- Logical progression
- False premises
- Flawed reasoning
- Assume causal connection
- Draw general conclusion based on few examples
- Inappropriate comparisons
Case Study 1

• People noticed that young children were diagnosed with autism around the same time as the measles vaccine was administered
• Should we stop vaccinating children?
Case Study 2 -
Do babies come from storks?

From www.lgsquirrel.files.wordpress.com
Identify and Evaluate the Evidence - Cottrell 2013

**Identify** - statistics, examples, case histories, experiments, surveys, case studies etc.

**Evaluate** -
- Valid criteria
- Date of research
- Source
- Bias
- Statistics
- Generalisation
- Emotive language
Apply Critical Analytic thinking

(Cottrell 2013 p196)

Activity 1

• In pairs- read the text.
• Highlight the main points
• Critically analyse the text using the chart on p196 (not conclusion)

Activity 2

• Hand notes to other pair to write a brief critical analysis of the article
• Other pair reads out summary of notes (time allowing)
Case Study 3

- 1 in 10 people develop stomach ulcers during their life
- PH in stomach is 1.5 to 3.5 (very acid)
- As everyone knows, bacteria cannot survive in such an acidic environment and therefore the following may cause this:
  - stress
  - hereditary factors
  - diet
  - alcohol
Case Study 4 - Does the evidence support the conclusion? (Cottrell 2013, p194)

- A biology master student analysed the stomach content of 301 toads and found insects in all of them
- 51% of those insects were agricultural pests including beetles
- The student concluded that the toad can be effectively used as a biological control of beetles
Case Study 5

- Hubble discovered in 1929 through telescope observations that the universe expands
- Newton’s law says that masses attract each other
- The expansion of the universe should therefore slow down
- Brian Schmidt (ANU) discovered in 1994 that the universe expansion is accelerating
What is critical thinking?
How have your ideas changed?

https://au.pinterest.com/kimmywoo2/critical-thinking/
Procedures of Critical Thinking - 1

- Identifying key definitions
- Identifying ambiguity
- Identifying variables
- Formulating questions
- Defining issue or problem
- Determining credibility

- Distinguishing fact from opinion
- Identifying assumptions
- Identifying values
- Noting missing evidence
- Identifying relationships
  - Comparing & contrasting
  - Cause and effect
- Summarizing information
- Using analogies
Procedures of Critical Thinking – 2

- Predicting trends from data
- Predicting outcomes based upon evidence
- Translating between verbal and symbolic
- Identifying conclusions

- Identifying errors in reasoning such as:
  - Logical fallacies
  - Errors in statistical reasoning
  - Alternative conclusions that satisfy evidence
Thank you