Logical Thinking

by

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Ablutions
Fire escape
Seminar topics
- thinking elements
- knowledge and facts
- logic and reasoning
- divergent and convergent thinking
- question types
- sorting and categorisation
- argument maps
Break between each session
End time - 16:30
Chatham House rule
Do
- ask questions
- challenge
- participate

In seeking wisdom, the first step is silence, the second is listening, the third remembering, the fourth practicing, the fifth – teaching others.

— Solomon ibn Gabirol
Do You Understand Your Thinking Biases?

http://weknowmemes.com/2011/10/the-educational-system-comic/
Thinking Elements

- All thinking is defined by the eight elements of thought shown in the adjacent diagram.

- Thinking
  - generates purpose
  - raises questions
  - uses information
  - utilises concepts
  - makes inferences
  - makes assumptions
  - generates implications
  - embodies a point of view

Knowledge and Facts

Knowledge

- ‘... acquaintance with facts, truths, or principles, from study or investigation’.
- ‘... perception of fact and truth and being cognisant or aware of fact or circumstance’.
- ‘... body of truths or facts accumulated by human beings in the course of time’.

Facts

- ‘... has really happened or is the case’.
- ‘... truth known by actual experience or observation’.
- ‘... something said to be true or supposed to have happened’.

*The Macquarie dictionary 2005, 4th edn, Macquarie University, Sydney, NSW.*
Truth

- Analytic truths are statements whose denial leads to a contradiction.
  - Analytic truths have a law-like generality with no exceptions.
  - Truth is arrived at simply by analysing the subject term in the statement.
    - Example. The assertion that ‘all mothers are female’ is an analytic truth because all mothers can be defined as a female parent. To deny the statement that ‘all mothers are female’ results in the absurd assertion that not all female parents are female.

- Synthetic truths are statements that are true but can be denied without creating a contradiction.
  - A synthetic truth contains two or more unrelated concepts.
  - Truth is arrived at using experience and beliefs.
    - Example. The statement ‘... most human mothers are over twelve years old’ is a synthetic truth because it contains two unrelated concepts – the concept of being over twelve years old and the notion of being a human mother. We know the statement is true, based on experience and not simply by understanding the meanings of the words.

Beliefs

- Beliefs are something that we hold to be true.
- For an individual, beliefs are facts that are derived from either analytic or synthetic truths, or from some other source such as an authoritative (or not so authoritative) reference or person.
- Our dictionary definition of knowledge says it consists of facts and truths.
- Does a mistaken belief result in a fact?
- Can knowledge be based on mistaken, but justified, beliefs?

Knowledge as Justified True Belief

Equation 1.

– proposition $P$ is true, and
– person $S$ believes that $P$ is true, and
– $S$ has adequate justification for believing that $P$ is true.

But the justification for the belief could be wrong!

Equation 2.

– $P$ is true
– $S$ believes that $P$ is true, and
– What $P$ is about is causally connected in an appropriate way to $S$’s belief that $P$ is true.

But it does not account for situations where we know something but the ‘knowing’ is not caused by the thing. For example, we can know that 13 is a prime number.

Logic

- Logic is the philosophical study of **valid** reasoning. It is the underpinning of all reasoned argument.

- Logic is used, or should be used, in all intellectual activities and analysis.

- Logic is usually expressed in the form of arguments. For example
  1. proposition P is true
  2. person S believes that P is true, and
  3. What P is about is causally connected in an appropriate way to S’s belief that P is true.

- Arguments are evaluated on the basis of evidence, assumptions and inference.

http://star.psy.ohio-state.edu/coglab/Miracle.html
Evidence

- Evidence in its broadest sense includes everything that is used to determine or demonstrate the truth of an assertion.
- Evidence consists of facts and data.
- Evidence may lead to a direct proof or a derived proof.
- **Key Questions:**
  - What evidence do I need?
  - Is the evidence relevant?
  - Do I have sufficient evidence?
  - Do I have opposing and supporting evidence?
  - How do I know the evidence is accurate?

Inference

- Inferences are derived interpretations or conclusions.
- Inferences should logically follow from the evidence.
- **Key Questions:**
  - What conclusions am I coming to?
  - Is my inference logical?
  - Are there other conclusions I should consider?
  - Does the interpretation make sense?
  - Does the solution necessarily follow from the data?
  - Is there an alternative plausible conclusion?

Assumptions versus Inferences

**Assumptions**
- Assumptions often operate at the subconscious level of thought.
- Assumptions often are taken for granted beliefs.
- Surfacing assumptions can reveal bias, stereotyping, prejudices, and other irrational forms of thinking.
- Justifiable assumptions lead to reasonable inferences.

**Inferences**
- Inferences operate at the conscious level of thought.
- Inferences are a step of thought leading to a conclusion that something is true, based on something else being true, or appearing to be true.
- Inferences can be justified or unjustified.
- All inferences are based on stated or unstated assumptions.

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**Diagram:**
- Evidence (situation) → Conscious level of thought → Inferences (conclusions)
- Assumptions

Unconscious level of thought
Deductive Reasoning

- Deductive reasoning involves using given true premises to reach a conclusion that is also true.
- Deductive reasoning arrives at a specific conclusion from a general principle.
- Deductive reasoning links premises with conclusions.
- If the rules and logic of deduction are followed, this procedure guarantees an accurate conclusion.

Example:
1. If an angle is >90° then it is an obtuse angle. (theory)
2. Angle A is an obtuse angle. (hypothesis)
3. A=120° (observation)
4. A is an obtuse angle (confirmation)

http://www.socialresearchmethods.net/kb/dedind.php
Inductive reasoning constructs or evaluates propositions that are abstractions of observations of individual instances of members of the same class. Inductive reasoning is also known as hypothesis construction because any conclusions made are based on educated predictions. Inductive reasoning allows for the possibility that the conclusion is false, even when all of the premises are true. The answer is probably true.

Example:
1. Joe is a human. (observation)
2. Most humans are right-handed. (pattern)
3. Joe is right-handed. (hypothesis)
4. The probability that Joe is right-handed is 75%. (theory)
Abductive reasoning is similar to inductive reasoning, but differs in that observations are always incomplete.

Abductive reasoning begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set.

The abductive process can be creative, intuitive, and sometimes even revolutionary.

The answer or solution is likely to be true based on the available observations.

Example:
1. A medical diagnosis is an application of abductive reasoning: given a set of symptoms, what is the diagnosis that would best explain most of them?

http://www.socialresearchmethods.net/kb/dedind.php
Divergent versus Convergent Thinking

Divergent Thinking

Idea

Question

Idea

Idea

Convergent Thinking

Facts

Answer

Facts

Facts
Divergent and Convergent Thinking Sequence

- Where possible begin with divergent thinking.
  - The more ideas the better.
  - Don’t evaluate ideas yet.
  - Strange ideas are ok.

- Focus on winnowing out the impractical, and clustering ideas that are similar (the start of convergent thinking).
  - Collect facts for each idea.
  - Build one idea upon the other.

- Select ideas that promising (convergent thinking).
  - Promising ideas are supported by facts.
  - Promising ideas are intuitively practical.

Question Types

● **Factual**
  - Soliciting reasonably simple, straightforward answers based on obvious facts or awareness.
  - These are usually at the lowest level of cognitive or affective processes and answers are frequently either right or wrong.

● **Convergent**
  - Answers to these types of questions are usually within a very finite range of acceptable accuracy.
  - These may be at several different levels of cognition - comprehension, application, analysis, or ones where the answerer makes inferences or conjectures based on personal awareness, or on material read, presented or known.

● **Divergent**
  - These questions explore different avenues and create many different variations and alternative answers or scenarios.
  - Correctness may be based on logical projections, may be contextual, or arrived at through basic knowledge, conjecture, inference, projection, creation, intuition, or imagination.
  - These types of questions require analysis, synthesise, or evaluation of a knowledge base, and then project or predict different outcomes.
• **Evaluative**
  
  – These types of questions usually require sophisticated levels of cognitive and/or emotional judgment.
  
  – In attempting to answer evaluative questions, analysts may be combining multiple logical and/or affective thinking processes, or comparative frameworks.
  
  – Often an answer is analysed at multiple levels and from different perspectives before arriving at newly synthesised information or conclusions.

• **Combinations**
  
  – These are questions that blend any combination of factual, convergent, divergent and evaluative questions,

http://www4.uwsp.edu/Education/lwilson/learning/quest2.htm
The Six Knows

- All questions are one or more of the “Six Knows”.
- The Six Knows combined with the previous question types determine the thinking tool that is most appropriate for the task.
- For example:
  - Chronologies and timelines are the appropriate tool to answer a “Know When” question.
  - Sorting and categorisation tools are useful to answer “Know What” questions.

Arguably, the first step of analysis is to sort and categorise data.
Even the simplest problems can benefit from sorting and categorisation.
Categories can be discrete or hierarchical.
Categories are not always obvious.
Sorting and categorisation is subject to cultural and personal bias.
Put the following into a category, or categories, and justify your answer.

Argument Mapping

- An argument map is a visual representation of the structure of your logic using a visual tree.

- Argument mapping helps groups achieve a shared understanding of wicked problems.

- It uses a notation called IBIS (Issue Based Information System) to map the relationship between questions, ideas, and arguments.
Exercise – Flesh Out ‘How?’ and ‘Budget’

- How do we implement system X?
- Must implement priority 1 features described in scoping doc.
- Must be completed by year end.
- Co-develop
- Hire consultants
- Take longer
- Do it ourselves

- How?
‘The real questions refuse to be placated… They are the questions asked most frequently and answered most inadequately, the ones that reveal their true natures slowly, reluctantly, most often against your will.’

Ingrid Bengis, Author