

Turning Numbers into Knowledge

MASTERING THE ART OF PROBLEM SOLVING

Second Edition

JONATHAN G. KOOMEY, PH.D.



Analytics Press

PO Box 20313

Oakland, CA 94620-0313

<http://www.analyticspress.com>

<http://www.numbersintoknowledge.com>

THE POWER OF CRITICAL THINKING

Years ago, Dr. Norman Vincent Peale became famous for proclaiming the power of positive thinking. His claim was that each of us has control of how we feel about our lives, and, by using that control, we can create a better future for ourselves.

For assessing the analysis of others, *critical thinking* is at least as important as positive thinking. Critical thinking implies the ability to assess the true meaning of arguments and the skill to determine whether those arguments are credible and compelling. William Hughes, in his excellent book *Critical Thinking*, defines some of the key terms for understanding this important skill:

When we express an inference in words, we do so by means of statements. A *statement* is a sentence (i.e. a set of words) that is used to make a claim that is capable of being true or false.... An *argument* is a set of statements that claims that one or more of those statements, called the *premises*, support another of them, called the *conclusion*. Thus, every argument claims that its premises support its conclusion.³⁰

A *logically strong argument*, according to Hughes, is one “whose premises, if true, support its conclusion.” A *sound argument* is “a logically strong argument whose premises are true.” Critical thinking is the way to identify and create sound arguments, which is the main goal of all analysts.

Hughes describes the key steps a critical thinker uses to assess arguments and decide whether they are sound.³¹ I summarize his steps below:

- “*Identify the main conclusion*”: Rephrase the main conclusion in your own words, to be sure you understand it. Think about the context in which the argument is being made. Finally, if the argument is not stated clearly, interpret the argument in the way that is most charitable to your opponent’s views (Hughes calls this “the principle of charity”).

- “*Identify the premises*”: Rephrase the premises in your own words. List the unstated premises and assumptions. Discard distracting and irrelevant examples that are not really premises. Don’t forget that context is important, and that the principle of charity should guide your interpretations at this stage as well.
- *Identify the logical structure of the argument and determine how the premises support the conclusion*: Determine whether one premise depends on another one, or, alternatively, if premises are independent of each other. Determine whether the argument contains sub-arguments that support the ultimate conclusion. Hughes presents a way of describing the structure of arguments, known as a tree diagram, that can help with this step.
- *Ask whether you’d be justified in accepting the premises*: In most cases, a strict proof of the premises is impossible, so we must be satisfied with the less stringent standard of “acceptability.” Hughes suggests two criteria for evaluating acceptability:
 - If the statement is common knowledge, we should regard it as acceptable, unless the context requires a higher standard of proof.
 - If the statement is not common knowledge, we should ask for, or be prepared to offer, the evidence upon which it is based, and accept it only if the evidence meets the appropriate standard, for example, personal experience, appeal to a recognized authority, or strict proof.

14 16

Hughes also points out that “common knowledge” is often wrong, so use care when relying on any measure of acceptability less than a true proof.

Key questions to ask when determining acceptability include: Are the premises common knowledge? What is the context of the argument? Who is making the argument? Are they experts? Do they have a vested interest in the outcome? Are the premises backed up by credible research published in peer-reviewed journals? Are the premises based on consistent comparisons?

14

4

25

- *Ask whether the premises are relevant*: Many arguments are peppered with premises that are irrelevant to the conclusion but appear to support it. Usually the previous steps will make it obvious which premises don’t apply, but it’s worth asking the question again at this stage just to be sure.
- *Ask whether the premises “adequately” support the conclusions*: Certain statements lend some support to the conclusion but are not sufficiently compelling to make the argument adequate (appeals to authority often fall into this trap). Inadequacy is a key weak point of many arguments. This

14

step is mainly an exercise in common sense and in figuring out whether a particular argument accounts for all of the many possibilities.

- *Look for missing arguments*: Omitting a valid comparison is one commonly used way to make an argument seem stronger, so try to find these omissions in other people’s arguments. People often look for the best-case comparisons to support their own position and ignore comparisons that might weaken their case.
- Finally, “*Look for counter arguments*”: Try to find a sound argument that leads to a conclusion contradictory to the one reached by the argument being evaluated. If you find such a counter argument, you know that something’s wrong, because two sound arguments cannot contradict each other (unless one is not truly sound).

Careful critical thinking is at the root of all good analysis. When these steps become second nature, you will have mastered its essence. The many subtleties of assessing arguments will always keep you on your toes though. There’s no end to the ways that arguments can be flawed.

EXERCISE

In a newspaper, find a letter to the editor on a topic you care about. Identify the conclusion and the main premises. Assess each premise, determining whether each is acceptable, relevant, and adequate to support the conclusion. How easy was it to carry out Hughes’s process?

The fascinating impressiveness of rigorous mathematical analysis, with its atmosphere of precision and elegance, should not blind us to the defects of the premises that condition the whole process. There is perhaps no beguilement more insidious and dangerous than an elaborate and elegant mathematical process built upon unfortified premises.

— T. C. CHAMBERLAIN



Attribution-Noncommercial-No Derivative Works 3.0 United States

You are free:



to Share — to copy, distribute, display, and perform the work

Under the following conditions:



Attribution. You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).



Noncommercial. You may not use this work for commercial purposes.



No Derivative Works. You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work. The best way to do this is with a link to this web page.
- Any of the above conditions can be waived if you get permission from the copyright holder.
- Nothing in this license impairs or restricts the author's moral rights.

[Disclaimer](#)

Your fair use and other rights are in no way affected by the above.
This is a human-readable summary of the [Legal Code](#) (the full license).

All material in this file is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 United States License. For details see:

<http://creativecommons.org/licenses/by-nc-nd/3.0/us/>

To reference this work, please cite Koomey, Jonathan. 2008. *Turning Numbers into Knowledge: Mastering the Art of Problem Solving*. 2nd ed. Oakland, CA: Analytics Press. <<http://www.analyticspress.com>>