Critical Thinking--Student Guide

(The following is intended for students for educational purposes.)

Introduction

Critical thinking involves *reflection* on our beliefs, in order to *increase our awareness of them*, and the *evaluation* of these beliefs, in order to *assess our evidence for them*.

Truth and values should be grounded in one's own experience, in one's own ability to think and choose, but this must be accomplished in natural, social and historical context. Human knowledge properly speaking involves a relationship between the individual and the world and between the individual and other individuals within social and historical context. Thus, truth and values should be grounded in one's own concrete experience, yet we must also check our own experiences of the world against each other and against the experiences lived through by others, both past and present.

When *reading* critically, the reader should make a genuine attempt to understand the author's position, yet the reader should also attempt to listen to his or her own response to the material being read. Do you agree or disagree with the author's claims? If you do agree or disagree, why? This is a good place to begin if you wish to *write* critically about what you have read. Start by stating whether you agree or disagree, and then proceed to state the *reasons why* you do so. To begin, you may wish to simply imagine that you are trying to convince a friend of your claim: just state as calmly and as clearly as you can your *reasons* for your agreement or disagreement. Knowing the principles of logic, both inductive and deductive, will help you develop your intuitive reasons into more formal and precise arguments. Thus knowing the principles of logic will help you both state your own position and evaluate the works of others more rationally.

Before moving on to discuss the logical principles of sound reasoning a few additional points should be mentioned that may help you evaluate a position.

First of all, try your best to recognize the position's assumptions and consequences. What is the author's starting point, and what does this starting point assume? Moreover, what are the consequences of holding this position? For example, if someone argues for the death penalty, does this position *assume* that some people are inherently malevolent and cannot change? Or does the death penalty have, as evidence indicates, an unfair *consequence* for certain racial or ethnic groups? *Knowing* a positions assumptions and consequences will help you begin to evaluate this position.

Secondly, what bias does the author hold, either explicitly or implicitly?
Is the author a conservative trying to make a case against liberalism? Or is the author a liberal trying to make a case against the conservative position? Or perhaps the author's position lies somewhere in between. Knowing where someone is coming from may help evaluate the position being asserted, for it helps gain greater insight into the positions assumptions and consequences.

Obviously, it is always best to read more than one author or position when researching an issue. It is always best to read the range of positions and how they criticize one another.

The reader is then in a better position to choose the best explanation or to formulate one that is better. Academic sources tend to be the best because within academia positions are usually carefully reviewed and criticized. They tend to be reviewed and evaluated by peers within the field. There are no unbiased positions, but academic sources move toward being unbiased because they are scrutinized and cross-checked more than other sources, certainly more than the typical popular source.

Thirdly, does the author use a neutral language that attempts to carefully and accurately describe what has occurred or a language that contains emotional and evocative expressions? The "spinning" or manipulation of the emotional content of language can be a powerful tool of persuasion, for calling someone a "freedom fighter" rather than a "terrorist," or vice versa, can easily predispose an audience to one interpretation rather than another. While there is some debate about this, and while most believe there is no completely objective language, many philosophers believe that we can use language more neutrally in our attempt to describe our publicly perceived world more accurately. After all, describing the throwing of someone from a ten-story building as "providing the freedom to fly" makes far less sense and is far less accurate than describing it as "an act of killing."

Fourthly, does the position (the explanation or theory) accurately describe and explain the facts or human experiences as they typically appear? While philosophers have moved away from the notion that things of a certain type (for example, all dogs) share an *identical essence*, most accept the idea that the individuals of a certain type are similar enough to construct meaningful class concepts about them, to construct concepts that more or less capture their similarity. We now know, for example, that no two human beings are identical (biologically, genetically, or psychologically), but we also know that human beings are similar enough for us to make reasonable generalizations about the basic conditions of a healthy life, the genetic probability of contracting, or not contracting, a certain disease, and about human behavior in certain typical circumstances. There may not be a single human essence that exactly and precisely determines human behavior forever, yet humans are similar enough to be able to make reasonable generalizations about the typical range of human reactions to various circumstances, both natural and social.

Moreover, if this is so, if the world and things within it, including humans, are stable enough to make reasonable generalizations about them, then these generalizations can be tested against future experiences and refined or changed if necessary. There is a relatively stable world around us, and it is generally experienced as public or accessible to others and not just as a product of one's own cognition or wishes. While it is true that we experience this world through the filtering avenues of the human body and our culture, including our language, this does not mean that we can make the world anything we wish. There is something outside our bodily and culturally adaptive systems that helps measure and limit them, a relatively stable world whose materials and events can be described with greater or lesser accuracy. It is to the determination of this accuracy that we should now turn.

Principles of Logical Reasoning

(This section briefly discusses the main principles of logical reasoning. Please consult a standard introductory logic text for many more details and qualifications. Introduction to Logic by Irving Copi and Carl Cohen and A Concise Introduction to Logic by Patrick Hurley are among the best. Both texts have been thoroughly consulted and used in the preparation of what appears here and in the sections that follow below. The American Heritage Dictionary has been consulted for basic definitions.)

Critical thinking helps us distinguish between knowledge and mere belief (or opinion or fantasy). Knowledge claims must be supported by evidence, and the evidence must exist in the proper relationship to the knowledge claim. This relationship is called an inference, and the study of these inferences is called logic. Logic generally speaking is the science of correct thinking or, more specifically, the study of what makes inferences correct or incorrect. Logic deals with the movement or inference from one or more statements to other statements according to rules, and it is these rules determine how certain statements support those that follow from them, as we shall see below.

Knowledge is belief supported by evidence and it is connected to this evidence by rules of inference.

Evidence, support or justification.

↓ ← Rules of inference.

Knowledge claim.

Philosophers generally recognize two forms of human knowledge, perceptual and conceptual. Each has an immediate and mediated relationship between its knowledge claim and its evidence.

Perceptual Knowledge and Inference

Immediate: Perception provides direct evidence.

Example: Evidence: We look and see.

↓ (Properly speaking this is not an inference, a movement from one statement to another. It is support that is directly observed.)

Knowledge claim: The classroom chalkboard is black.

Mediated: Generalizations move beyond what is directly perceived. The generalization from observations of sense particulars is called induction, and sometimes induction by enumeration.

Example: Evidence: The observed majority of the school's chalkboards are black.

↓

Knowledge claim: Therefore all of the school's chalkboards are black.

Reliability of inductive generalizations:
In agreement with a rule of common sense, the reliability of inductive generalizations increases with the number of observations made. Observing 60% of the schools chalkboards provides greater evidence for the above claim than observing 25% of them. This type of generalization from sense experience is probably the most commonly practiced form of human knowledge. We could not make our way in the world without it, and even the simple movement of the adult hand toward a drinking glass presupposes that this has been done before.

Argument by Analogy:
Analogy is the recognition of similarities between two or more things. Induction, in fact, is based on this simple act of recognition.

Analogical *arguments* claim that if two or more things are similar in one way, then they will be similar in other ways as well.

Reliability of Analogical Arguments:
As with induction by enumeration, the reliability of an analogical inference increases with the number of observations that support it.

Moreover, the analogy must be relevant. For example, if we wish to compare automobile fuel efficiency, we should compare the similarity of automobile engines not the color of their surface paint.

Some misuses of inductive generalization:
Generalizations are *hasty* if they are based on too few observations.
Generalizations that are applied to individuals in a group without regard for their individuality are called *stereotypes*.

General objections to perceptual knowledge:
Perception is unreliable

1.) because of the possibility of perceptual error—for example, something that is large may appear tiny when perceived from a great distance
2.) because of the possibility of perceptual illusion—for example, a straight stick half immersed in water appears bent
3.) because people perceive through distorting beliefs and interests

Objections answered:

1.) We can reduce the possibility of error by
    a.) bringing in other senses (by checking what we hear with what we see, and what we see with what we touch, and so on)
    b.) repeating observations
    c.) observing from optimal distances
    d.) bringing in other observers
    e.) establishing coherence with previous studies
    f.) demonstrating usefulness

2.) The only way we can establish that one perception is erroneous or an illusion is from the point of view of one that we accept. Therefore it is incorrect to doubt all perception based on a particular error or illusion.
3.) We can try to universalize our beliefs and interests by taking up the perspectives of others, and by cross-checking observations with other observations and the observations experienced by others. Human knowledge is the outcome of this collaborative process, which at its best should involve equals in non-coercive or non-threatening debate.

Scientific Theory

Scientific theories rely heavily on inductive generalizations, yet to say they rely solely on induction is a misrepresentation. Scientific theories attempt to explain and not just describe the facts by generalizing from them. For example, we know from experience that fire is hot, but science, as well as philosophy, seeks to understand and explain why it is hot. The structure of this explanation typically takes the form of a categorical syllogism, with at least one universal proposition, that deduces the conclusion as the facts to be explained. (See *Conceptual Knowledge and Inference* below for details.)

For example:
All molecules moving fast produce heat.
Fire has molecules that move fast.
Therefore fire is hot.

Or, more generally:
All As are Bs.
X is A.
Therefore X is B.

Here the facts (the conclusion) are derived from and explained by the premises of the argument and are thought to be an instance of what is expressed in the universal proposition. For the facts to be relevant, they must be deducible from the premises. (The fact that Joe was late for work is deducible from the claim that his car broke down. Yet it is not deducible, at least not in any obvious way, from the fact that his car is red.) This form of deductive-nomological explanation or argument is referred to as the Covering Law Model and in general appears as follows:

General statement
Statement of current conditions
Conclusion

The general statement, with the statement of current conditions, is thought to explain the derived conclusion.

Here *refutation* relies on both deduction and observation. If we claim that "All As are Bs," then we are predicting that "All future As will be Bs." Yet if we observe that some

A is not B, then we disprove the general claim that "*All* As are Bs." One counter example here disproves the claim of *all*.

Since theories are in the form of generalizations, they make predictions about what will take place and what will be observed in the future. If the predictions aren't confirmed by observation, then the theory is falsified.

The Inductive-Statistical argument:
Since some scientists and philosophers have been dissatisfied with the universal, law-like claims of the above method, a less general and more probabilistic form of argument has been proposed, which has the following form.

A high or significant percentage of As are Bs.
X is A.
Therefore X is B.

For example:
A significant percentage of individuals who smoke cigarettes get cancer.
George smokes cigarettes.
Therefore, George will get cancer.

Criteria for evaluating theories:
1.) A theory, scientific or otherwise, must be *comprehensible*, that is, it must make sense of the world around us, or, in logical terms, the facts and states of affairs of the world must be deducible from the theory. 2.) A theory must be *comprehensive*, that is, it must explain all that it needs to explain, and the theory that covers the greatest range of facts is thought to have the greatest explanatory or predictive power. 3.) A theory must be *consistent* with the body of human knowledge that has already been confirmed and well established. 4.) A theory (particularly a scientific theory) must be empirically *testable*. And finally 5.), a theory must tend toward *simplicity*, that is, it must not contain unnecessary hypothesis.

Conceptual Knowledge and Inference

A categorical proposition is a statement in which the subject and predicate terms relate classes to one another. There are four types of categorical propositions: universal affirmative (All S is P), universal negative (No S is P), particular affirmative (Some S is P), and particular negative (Some S is Not-P). Logical arguments are composed of categorical propositions and place class concepts in various relationships to one another. In fact, logic deals with how classes are placed in relationships to one another within arguments, how class concepts overlap or are included within or excluded from one another. This will become clear if we observe some actual cases.

Immediate inference: Some conceptual relationships can be immediately inferred from others.

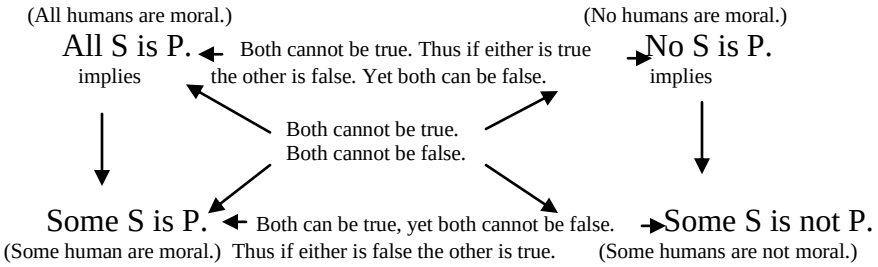
Example: Evidence or premise: All humans are mortal.

↓

Conclusion: Some humans are mortal.

If we know that all beings in the *entire* class of humans are also in the broader class of mortals, then we know by immediate inference that some *subset* of the class of human beings is also in the class of mortals.

The **Square of Opposition** conveniently summarizes a number of important immediate inferences. Let us use as an example the ethical or moral nature of human beings.



Mediated inference:

Categorical syllogism: a categorical syllogism is composed of three categorical propositions, with just three terms, each occurring twice. Validity is established when the conclusion's subject and predicate terms are logically connected by a third term, which appears once in each premise. This third or middle term is italicized in the below example.

Example: Premises: All *men* are mortal.
Socrates is a *man*.
Conclusion: Therefore, Socrates is mortal.

If we know, as the 1st premise states, that the entire class of humans is included in a broader class, beings that expire, and if we also know, as the 2nd premise states, that Socrates is in the class of humans, then we know with certainty that he is in the class of mortals.

Of course, the place of the middle term can vary, determining what is called the syllogism's *figure*. Moreover, since there are four types of categorical propositions (stated above), the type of the proposition and its place in the syllogism may vary as well. This means that there are over 200 hundred forms that the categorical syllogism can take, and most are invalid. For example, the following argument is invalid, since the information in the conclusion is not entailed in the premises, and any argument of this form will be invalid.

All roses are flowers.
All daisies are flowers.
Therefore all daisies are roses.

Or generally: All S is P.
All T is P.
Therefore all T is S.

(Note: See Copi and Cohen, Introduction to Logic for the Venn diagram technique for evaluating categorical syllogisms.)

Thus, when evaluating any categorical syllogism, be sure to note 1.) whether or not the conclusion follows logically from the premises, but also 2.) the truth or falsity of the premises (usually established by experience and empirical generalization). In the following argument the conclusion does follow logically from the premises, yet the first premise is clearly false, thus producing a false conclusion.

All birds are pink.
Tweety is a bird.
Therefore Tweety is pink.

For an argument to be *sound*, the argument must be valid *and* the premises must be true. In other words, if the argument is valid and the premises are true, then the conclusion must also be true.

Disjunctive Syllogism*:* This form of argument presupposes a "fixed universe" with "already established alternatives." For example, suppose I possess a combustion engine that has only two moving belts, belt P and belt Q. If I hear a squeaking belt, then I know that it must be either P or Q, and the following forms of argument apply.

Valid forms:

Either P or Q.	Either P or Q.
Not P.	Not Q.
Therefore Q.	Therefore P.

If we know that belt P is not squeaking, then we know that belt Q must be, and vice versa.

Invalid forms:

Either P or Q.	Either P or Q.
P.	Q.
Therefore not Q.	Therefore not P.

The latter forms are invalid because the confirmation of P does not deny the possibility of Q, or vice versa. Knowing that belt P is squeaking does not eliminate the possibility that Q also squeaks.

Hypothetical or Conditional Syllogism:

In the conditional proposition the consequence follows from the antecedent. For example, if it is raining outside, then the ground will be wet. The consequence, wet ground, follows from the antecedent condition, it is raining. An argument can be composed of only conditional propositions and has the following valid form.

If P, then Q.
If Q, then R.
Therefore if P, then R.

Example: If it is raining, then the ground will be wet.
If the ground is wet, then it will be slippery.
Therefore, if it is raining, then the ground will be slippery.

Mixed Conditional:

The mixed conditional syllogism is composed of one conditional proposition and one categorical proposition and has the following forms.

Valid forms:

If P, then Q.	If an animal is a raccoon, then it has a striped tail.
P	The animal is a raccoon.
Therefore Q.	Therefore, it has a striped tail.

If P, then Q.	If an animal is a raccoon, then it has a striped tail.
Not Q.	The animal does not have a striped tail.
Therefore Not P.	Therefore, the animal is not a raccoon.

Invalid forms:

If P, then Q.	If an animal is a raccoon, then it has a striped tail.
Q.	The animal has a striped tail.
Therefore P.	Therefore, it is a raccoon.

(This is invalid because animals other than raccoons have striped tails.)

If P, then Q.	If an animal is a raccoon, then it has a striped tail.
Not P.	The animal is not a raccoon.
Therefore, Not Q.	Therefore, it does not have a striped tail.

(This is invalid because animals other than raccoons have striped tails.

The Logic of Causality

Causal Connections

Definition of cause: “something that produces an effect”; the condition responsible for an action or result; something that makes something else happen or occur.
Definition of effect: “something that is produced by a cause”; the result of an action or condition; something that happens or occurs because of something else.

Causal Connections and Generality

Discussions of causality typically make a claim for the universality of specific cause and effect relationships or associations. For example: "In all cases bacteria A will cause illness B." These generalizations are produced inductively by generalizing from observations of sense particulars, in this case observations of the *association* of particulars. If we observe that A has always been associated with B, it is generalized that A will always be associated with B.

Induction by simple enumeration, as it is exemplified here, has been significantly strengthened by a number of methods put forth by J.S. Mill.

1.) The first method looks for *agreement* among cases.
For example, suppose we know that a number of diners got sick after their meal at a local restaurant, and that their orders from a numbered menu were recorded by the restaurant. We are able to note and conclude the following:

Person X ate food corresponding to the following menu numbers 1, 2, 3, 4, and got sick.
Person Y ate food corresponding to the following menu numbers 1, 5, 6, 7, and got sick.
Person Z ate food corresponding to the following menu numbers 1, 8, 9, 10, and got sick.
Thus the food corresponding to menu number 1 caused the sickness.

2.) The second method looks for *disagreement* among cases.

Person M ate food corresponding to the following menu numbers 1, 2, 3, 4, and got sick.
Person N ate food corresponding to the following menu numbers 2, 3, 4, and did not get sick.
Therefore food corresponding to menu number 1 caused the sickness.

3.) Mill mentions the obvious point that these methods can be *used together*.

4.) An additional point worth mentioning is that of *consistent variation*. If one thing consistently varies with another, then, Mill says, we may conclude that they are causally related.

For example, suppose a student has to take three tests throughout the semester for a psychology class. Suppose also that the student studies 5 hours for the first test, 10 hours for the second test, and 15 hours for the third test, and that the student scores the letter grade of C for the first, B for the second, and A for the third. We may reasonably conclude that studying is causally related to grade scores, with higher scores correlated with the greater number of hours of studied.

Probability

General Definition
Most simply stated, probability expresses the likelihood that something will occur.

Classical Theory
Classical probability can be expressed as the ratio of favorable results to the total number of possible results. For example, the probability of selecting the ace of spades from a deck of playing cards can be expressed as the ratio of 1/52. This is sometimes referred to as *a priori* statistics because observation is not needed establish the ratio.

Relative Frequency
Unlike classical theory, relative frequency theory is based on the observation of the frequency of actual events. Here the probable is that which occurs most frequently, and it is calculated by the number of times something is actually observed in the members of a certain class of events, persons or things. The typical example of this type of probability is actuary tables. For example, we can determine the probability of a 50 year old male living to 60 years old by observing the members of the class of males who are 50 that live until they are 60. Since observing everyone in this class would be difficult, a sample class is set at 1000, and the probability is calculated by relative frequency of those within this group that live until they are 60. Thus, if 950 of these 1000 men live until 60, the probability of a 50 year old male living until he is 60 is 950/1000 or .950.

Statistical Reasoning
Since we are frequently bombarded with statistics such as "The majority of Americans believe X" and "20% of males do Y," it is important for us to be able to evaluate them.

Statistical studies frequently view a portion or sample of a population, and generalize from them. If 20% of the sample population does Y, then it is believed that 20% of the entire population does Y.

Yet samples can be biased in a number of ways. Samples are biased if they do not represent all subgroups within the larger set being sampled. (This, of course, presupposes that we have knowledge of the whole and its subgroups.) Samples can be biased if they are not large enough, and generally speaking the larger the sample the more likely the sample will agree with the entire population. Furthermore, samples can be biased by the attitudes/interests of either the participants in the survey or those conducting it. Participants may exaggerate their response depending on the reasons for which the survey is being conducted. In a survey about future school expenditures, the mother or father of 10 children is likely to emphasize the need for better schools, especially if she or he knows the local government is thinking of reducing its financial support for them. In addition, those conducting the survey may be tempted to phrase the survey questions to favor the results they wish to achieve. For example, most people would certainly answer no to the question "Do you want increased taxes?" Yet many may answer yes to the following question: "Would you accept increased taxes if these taxes provided increased and improved medical care?"

The Statistical Mean
The statistical mean is calculated in three ways, by the mean (or the average, calculated by the sum of individual scores over the number of participants: 3, 5, 7, 9=24, 24/4=6), the median (calculated by determining which score has half the scores above it and half below it: 2, 3, 8, 12, 14, displays 8 as the median), and the mode (calculated by determining the score that occurs most frequently: 2, 3, 3, 3, 6, 9, 12, displaying 3 as the mode).

Certain characteristics, such as the height of college students, may well display a mean, median and mode that are virtually the same. The distribution of students who are from 5 feet to 6 feet tall would form a near perfect bell curve, with most of the students around 5' 4" to 5' 8" and fewer students gradually tapering off at each extreme.

Statistical calculations can be extremely valuable. In health care, for example, it can be extremely useful to know the typical or average response to certain dosages of medicine.

Yet, there are a few points that we should be aware of here. When calculating averages, the range, or the difference between the lowest and the highest scores, is frequently more important than the average. The average 24 hour temperature in the desert southwest may be 70 degrees, yet this could well mean a temperature of 30 degrees at night and 110 degrees during the day. In Miami we may record the same average temperature of 70 degrees yet within a much narrower range of extremes, say between 60 and 80 degrees. In addition, an average can be deceiving if we are looking at something like the distribution of salaries, for the average salary can be skewed upward by the extremely small percentage of people who earn millions of dollars a year. And finally, statistical averages should not be interpreted as revealing rigid essences or as denying all individuality. They are meant to be provisional and general guidelines, guidelines that must continuously be checked with observation.

Prepared by Douglas Low, 2004.