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Critical Thinking in the Classroom

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Introduction

Critical thinking is the use of reason in reading and writing. It enables the reader to evaluate the material being read, to recognize argument patterns and to detect inappropriate reasoning. And it allows the writer to present his or her points in a logical and reasonable manner.

As such, critical thinking is not reserved for the domain of logic and philosophy classes alone. It is a skill which has application throughout all disciplines. Indeed, expertise in any discipline is impossible without knowledge and application of critical thinking.

The purpose of this essay is to introduce the instructor to critical thinking and to suggest means of applying it in the classroom. As such, it is not a teaching document; it does not pause and repeat nor stimulate learning with examples and

exercises. Rather, its purpose is to provide an overview of the field and to suggest a common terminology. A list of references is provided for those desiring more detailed study.

This essay will not attempt to persuade the reader of the merits of teaching critical thinking in the classroom. That is assumed. Rather, it focuses on what critical reasoning is and how to apply it. This essay proceeds in three major sections. First, the three major types of reasoning are described. Second, errors of reasoning in these three major types of reasoning are described. Finally, third, methods of application to the classroom are suggested.

Some notes are necessary about the approach taken. First, the methods of creating and criticizing arguments are presented as 'tools' for a student (or anyone) to use to achieve a desired outcome. Second, and related to this, it is taken that the use of a tool is flagged with 'indicator words'. That is, there are certain characteristic ways of telling the reader that you are trying to achieve a particular outcome. Hence, words themselves are regarded as tools for the expressions of an idea.

Types of Reasoning

(i) Deductive Reasoning

Deductive reasoning is the oldest and most venerable of the types of reasoning. Examples of deductive reasoning include mathematics, categorial reasoning, set theory, and computer programming. Deductive reasoning is by its very nature abstract; for this reason, students find it the most difficult to master.

A deductive argument is formed from one or more premises and a conclusion. The conclusion is the opinion the author is attempting to prove is true. The premises are the reasons given in order to persuade the reader that the conclusion is true.

The premises and the conclusion of an argument are identified by indicator words. There are two types of indicator words: premise indicators, and conclusion indicators. Premise indicators always precede premises, while conclusions always precede conclusions. In general, the structure of deductive arguments is as follows:

(Using a premise indicator):

____ *because* ___ .
Since ___, ____ .

(Using a conclusion indicator):

___ *therefore* ___.

Notice the use of not only the indicator words ('because', 'since' and 'therefore') but also the use of punctuation and conjunctions to indicate the structure of the argument. Good writing follows a clear argument structure, and hence, good writing uses grammatical elements to show clear argument structure.

In the absence of an indicator word (some people are sloppy writers), the reader is reminded that the conclusionis an opinion. Hence, the conclusion is usually 'hedged' in some way. By that, what is meant is that the conclusion is not stated directly, but rather, is qualified with expressions like, 'I think

that" or 'It must be that', or the like. Compare, for example, the difference between "The sky is blue" and "The sky must be blue". The latter is clearly hedged, hence, it must be an opinion and therefore probably the conclusion of an argument.

Not all arguments are deductive arguments. Deductive arguments may be recognized by their characteristic forms. The form of an argument can be recognized by identifying keywords. Because deductive arguments constitute a particular sort of reasoning, they entail the use of a particular set of words. In particular, there are three types of key words to watch for.

1. Mathematical keywords: plus, minus, equals
2. Categorical keywords: is, all, some, no, every, any, only
3. Propositional keywords: both...and, either, ... or, if .. then, unless

These keywords are not used only to recognize deductive arguments. Knowledge of the role of these keywords also enables the writer to write clear, structured sentences. This will be discussed in more detail in section three.

(ii) Inductive Reasoning

The purpose of an inductive argument is to produce generalizations from matters of fact or experience. It is not as old as deductive argumentation, nor is it as well respected. Nonetheless, without inductive argumentation it would not be possible to live in the world at all.

Types of inductive reasoning include statistical generalizations,

analogy, reasoning concerning cause and effect, and probability.

Like a deductive argument, an inductive argument is formed from one or more premises and a conclusion. And like a deductive argument, the purpose of an inductive argument is to persuade the reader that the conclusion is true, and the premises are given as reasons to believe that the conclusion is true. All that was said above of indicator words and hedging is also true of inductive arguments. Hence, the two can be distinguished only by their keywords.

Here are characteristic keywords of some inductive arguments:

1. Statistical keywords: most, many, five percent, usually, generally
2. Analogical keywords: is like, is similar to, like, as
3. Probabilistic keywords: the chances of, probably, likely
4. Causal keywords: causes, depends on, effect

Again, the use of these keywords tells the reader what sort of argument s being used. A reader can, for example, recognize an analogy much more clearly if the words 'like' or 'as' are used than if they are not.

(iii) Abductive Reasoning (Inference to the best explanation)

Abductive reasoning was recognized as such only in the late nineteenth century by Charles Sanders Peirce, though there are instances of it through antiquity. It is now the most common form of argument in the sciences, for it involves the postulation

of theories which explain some event or regularity.

The form of an inference to the best explanation differs from that of deductive or inductive argument, though (confusingly) the same indicator words are used. In an abduction, the conclusion is some event or regularity which needs to be explained, while the premises are the theories or sets of conditions which do the explaining. That said, the word 'why' is used much more frequently in explanations, hence, the word 'why' can be used to distinguish abductions form other forms of argument.

The most common form of an inference to the best explanation is:

The reason why ___ is because ___.

Note again that the conclusion should be some fact or regularity, while the premise is typically a theory. Very often the conclusion which is being explained is also the conclusion of an inductive argument. A writer will use induction to show that some generalization is true, and then use abduction to explain why it is true.

Abductive arguments do not have characteristic keywords (other than ‘explains’ and ‘why’). The only way to distinguish between an inductive or deductive argument and an abduction is to determine whether the conclusion is a fact (in which case it's an abduction) or an opinion (in which case it's a deductive or inductive argument). It is important to watch for hedging words while making this distinction.

Errors of Reasoning

(i) Deductive Errors

There are two ways a deductive argument can fail: (i) the premises may be false, or (ii) the conclusion may not follow from the premises. Students often attempt a third method of evaluation: arguing directly against the conclusion. While this is allowed, it amounts to ignoring the argument in favour of the conclusion, and hence, is never decisive.

Whether or not the premises are true, if the conclusion follows from the premises, then the argument is valid. To say that an argument is valid is to say that the premises are appropriately related to the conclusion. The premises need not be true. To see this, consider the following argument: "If Mulroney is a Marxist, then he likes Castro, and he is a Marxist, hence, he likes Castro." As it happens, the premises are false. But suppose they were true. Then we can see clearly that the conclusion would have to be true as well; the premises support the conclusion.

In order to show that a deductive argument is invalid, it is necessary only to show that there is some way the premises could be true while the conclusion could be false. If this is possible, then we can see that the premises do not make the conclusion true. Consider the following example: "If the mill is polluting the river, then we can see dead fish, and we can see dead fish, therefore, the mill is polluting the river." Even if the premises actually are true, we can see that they do not support the conclusion, for it could be that something else is killing the fish, and that the mill is not polluting the river at all.

There are two major forms of invalid argument:

Denying the Antecedent. Any argument of the form "If A then B, and not A, therefore B" is invalid.

Affirming the Consequent. Any argument of the form: "If A then B, and B, therefore A" is invalid. The example of the mill (above) affirms the consequent.

The second way of criticizing a deductive argument is to show that the premises are false. Students are particularly hesitant to do this, however, it is often (all too often) accomplished with ease. Consider a categorical premise of the form "All A are B", for example, "All things which swim in the sea are fish." This is easily shown to be false by observing that there can be some A which is not B, for example, a dolphin swims in the sea, but is not a fish.

In general, premises are shown to be false by showing that their contradictories are true. Here are some common contradictions:

1. 'All A are B' contradicts 'Some A is not B'
2. 'No A are B' contradicts 'Some A is B'
3. 'If A then B' contradicts 'A and not B'
4. 'Either A or B' contradicts 'Not A and not B'
5. 'Both A and B' contradicts 'Not A'

An argument which is both valid and has true premises is called a sound argument. Sound arguments are also sometimes called cogent arguments.

(ii) Inductive Errors

All inductive arguments base their success on the similarity between the objects or events described in the premises and those described in the conclusion. This is most clear in the case of an analogy, and so we turn to the first error of inductive reasoning:

False Analogy. The two things being compared are not similar in a way which is relevant to the conclusion. For example, suppose someone argued, "An employee is like a nail. Just like a nail, an employee must be hit in the head in order to get him to work." This argument may be criticized by showing that employees are not like nails in that (i) incentives will not persuade a nail to work, but they will persuade employees to work, and (ii) a nail won't resent being hit, but an employee will.

Statistical generalizations are arguments which use some sort of sample to draw a conclusion about apopulation. For example, a pollster will collect a sample of opinions and draw conclusions about the population as a whole. In order for the sample to tell us anything useful about the population, the sample must be similar to the population. The two major inductive fallacies are cases where the sample may be dissimilar to the population:

Hasty Generalization. The sample is too small, and hence, we can't be sure that it is similar to the population.

Unrepresentative Sample. The sample can be shown to be in some way different from the population. For example, a survey taken in only one city is unrepresentative of the nation as a

whole.

Unrepresentative samples are very common. Phone-in or write-in polls are classic examples of unrepresentative samples. So are testimonials. Many instructors value student opinions and observations in class. No doubt this makes the students feel good, but such information should not form the basis of instruction, for the individual experiences of one person constitute an unrepresentative sample.

There is a variety of things which can go wrong in causal reasoning. In order to say that A causes B, a minimum of two things must be true:

1. Generally, if A happens, then B happens
2. Generally, if A does not happen, then B does not happen
In addition, many theorists argue that there should be a third condition:
3. There must be a law of nature connecting A and B

The most common causal fallacy occurs when only the first condition is true and yet a causal relation is assumed to hold:

Post Hoc Ergo Prompter Hoc (After this therefore because of this). This fallacy consists in assuming that because one thing follows the other, the one thing is caused by the other.

Good inductive arguments are called strong arguments. Bad inductive arguments are called weak inductive arguments.

(iii) Abductive Errors

There are two major ways an inference to the best explanation

can go wrong: either (i) the fact to be explained is not a fact at all, or (ii) the theory which does the explaining is inadequate. Let us consider these in turn.

The fact to be explained may be false because of:

Non-support. For example, Jenny may wonder why John knows so much about physics. This 'fact' is false because of non-support if John knows nothing about physics.

Subverted Support. The argument which supports the 'fact' is not a good argument. For example, if a generalization such as "Edmontonians are cheap" was formed on the basis of one person's experience, then it is supported by an unrepresentative sample. Pointing out that this putative fact is not well supported is to subvert support.

There are also two ways a theory can be inadequate:

Untestibility. Theories which cannot be tested are not good theories. Theories are tested by being used to make a prediction. If a theory cannot be used to make a prediction, then it is a poor theory. For example, if someone theorized that "Coffee keeps you awake because it has wakening properties" then this theory could be criticized because we cannot use it to predict what other things will keep us awake.

Better Alternative. If another theory can explain the same phenomenon and is a better theory, then the new theory can be used to criticize the old. There are two major criteria for the betterness of a theory: (1) the theory has a wider scope, that is, it applies to more things; and (2) the theory is simpler.

(iv) Informal Fallacies

There is also a range of error which can be committed in any type of argument. These are grouped under the heading of 'informal fallacies' ("fallacy" is a ten-dollar word for "error of reasoning") .

The first grouping is Fallacies of Relevance. These are fallacies because they change the subject in some way. The following are major fallacies of relevance:

Attacking the Person. Authors commit this fallacy when they argue that because their opponent is a certain type of person, then their opponent is wrong. Students often argue that this form of argument is legitimate. For example, they argue that if a person has an interest in the outcome of an argument (say, a developer argues that some land should be rezoned) that a valid criticism may be made. This assumption is wrong.

Appeal to Force. In this fallacy, the reader is advised that some bad consequence will occur if the conclusion is not believed.

Appeal to Pity. In this fallacy, the reader is appealed to for support because the writer is in some bad state. For example, if a politician tells you how hard he worked on a piece of legislation, he is appealing to pity.

Prejudicial Language. A writer commits this fallacy when some moral value is attached to believing or not believing a conclusion. For example, "Clear thinkers agree that murder is bad" is a fallacy because it implies that people who disagree are not clear thinkers.

Appeal to Popularity. This fallacy is committed when it is argued that because most people believe a conclusion, then the conclusion is true. History is replete with examples where the majority was wrong.

The second grouping is Fallacies of Distraction. These are fallacies because while the premises in question appear to be true at first glance, closer examination shows them to be false.

False Dilemma. In this fallacy, the reader is presented with two options, and since one is unacceptable, we are forced to choose the second. The fallacy occurs when more than two options actually exist.

Argument from Ignorance. This fallacy is by far and away a student favourite. In this fallacy it is argued that because some proposition has not been proven to be true, it is therefore false.

Slippery Slope. The writer argues that if some proposition is believed, a chain of consequences will follow, leading to some unacceptable conclusion. The fallacy occurs when there is no reason to believe the consequences will actually occur.

Complex Question. This fallacy occurs when two separate points are presented as a single point. This fallacy is committed a lot on surveys, where a reader may be asked, for example, "Do you support reducing the deficit and cutting social programs?"

Begging the Question. Very often, this is the only way students know how to argue. Instead of offering support for a conclusion, the arguer instead restates the conclusion in a slightly different

manner. Obviously, when the conclusion is simply restated, no support has been given for the conclusion.

The third grouping concerns Fallacies of Authority. Students tend to be very trusting of authority, even when the authority is inappropriate.

Unqualified Authority. This occurs when an authority is quoted outside his or her field of expertise. Celebrity endorsements fall within this category.

Disagreement. Even when an authority is an expert in the field, it may be that experts in the field disagree on the point in question. In such a case, an appeal to an authority is fallacious, since it is possible to quote an equally qualified authority who holds the opposite view.

Unnamed Authority. This fallacy is committed when an authority is implied but not named. This fallacy may be detected by the use of phrases such as "experts agree..." or "it is said that...". This is a fallacy because there is no way to know that the authority is an expert.

The fallacies listed in this section constitute only a partial list; they were chosen because they are committed the most frequently and because they are most often believed by students.

Applications in the Classroom

Critical reasoning has many more applications in the classroom than merely the correcting of faulty arguments. Critical

thinking concerns the nature of argumentation itself, and all branches of knowledge involve some form of argument. This section will describe a number of applications of critical reasoning in the classroom.

(i) Writing

Knowledge of logical structures improves a student's writing in a direct and dramatic fashion. When logical structures are understood, the construction of a sentence is understood as an application of a particular logical structure. The following is a brief example of this process.

Simple sentences using categorical form. The structure of a categorical proposition, 'All A are B', mirrors the structure of a simple sentence. The 'A' in question is the subject of the sentence, while the 'B' is the predicate. This is useful because it helps correct problems with noun-verb agreement. Clearly identifying the subject and the predicate reminds the student that they work as a pair.

Another application of categorical form involves the use of subordinate clauses. The subject-predicate form clearly illustrates to the student the idea that subordinate clauses modify the subject (or predicate) they are attached to. Showing the student a sentence of the form:

"All men are mortal"

clarifies the form of:

"All men who are kings are mortal."

Complex sentences using logical operators. Complex sentences are formed out of simple sentences using logical operators. Consider, for example, how a complex sentence may be constructed from the simple sentences "All men are mortal" and "Socrates is a man".

If all men are mortal then Socrates is a man.
Either all men are mortal or Socrates is a man.
All men are mortal and Socrates is a man.

Even more complex sentences or paragraphs using indicator words. Using simple and complex sentences as described above, the structure of paragraphs can be detailed to students. We identify the premises and conclusion of an argument as a set of sentences. Then these sentences are assembled into a paragraph using indicator words.

If all men are mortal then Socrates is a man, and all men are mortal, therefore Socrates is a man.

All men are mortal, and Socrates is a man. Therefore, Socrates is mortal.

More complex paragraphs are constructed from more complex arguments. Consider the following:

All men are mortal and Socrates is a man. Thus, Socrates is mortal. All things which are mortal eventually die. Therefore, Socrates will eventually die.

(ii) Abstraction

Knowledge in many disciplines is abstract knowledge. This is

most clearly the case in mathematics, where notation such as "x+y=z" is abstract, but it is also true in many other cases. For example, in geography, students may be taught that a river meanders in a particular way. This is abstract because we are not talking about any particular river. Or in music, students are taught to read sheet music. This is abstract because sheet music is not generally written for a particular music.

Critical thinking forces a student to reason abstractly because sentences and arguments are thought of as abstract structures. The long paragraph just above should be recognized by the student as an instance of:

All A are B and S is A. Thus, S is M. All M are D. Therefore, S is D.

The benefits of abstract thought should be clear. Lessons learned in one domain are more easily applied in another domain when abstract features of the two domains are identified.

How might this be applied in a classroom? In essence, it involves imparting to the student not merely knowledge of particular matters of fact, but also the abstract form of whatever knowledge is being taught. For example, the proposition that "Rome fell because of a lack of morality" is an instance of the more general "Civilizations fall because of immorality". Students may be shown this, and also shown that the same pattern occurs in "Sodom and Gomorrah fell because of immorality" and "This civilization will fall because of immorality".

(iii) Reading

Students often misunderstand what they are reading. Often this is because they do not know what to look for in a piece of writing. This is understandable; there are many ways to go wrong when reading even a short paragraph.

For example, students often misunderstand a particular sentence. One common mistake occurs, for example, when a student interprets "Not all men are mortal" as meaning "No men are mortal". Knowing that the contradictory of "All A are B" is "Some A are not B" would allow the student to understand that "Not all men are mortal" means "Some men are not mortal".

Students often believe that information contained in a subordinate clause is the main point of a sentence. Making the structure of categorical propositions clear corrects this error.

Students frequently miss the main point of a paragraph as a whole. Pointing to indicator words makes conclusions clear, and the conclusion is a main point of a paragraph. If a student learns to look for conclusions, misunderstandings of this sort can be reduced.

Students should be reminded on a regular basis how to extract information from a text. From time to time, it is useful to identify a key paragraph in a piece of writing and to provide an analysis of it, showing the student how to identify what each sentence says and showing the student how to identify the author's main point. Consider, for example, the following paragraph:

A country, after all, is not something you build as the pharaohs built the pyramids, and then leave standing there to defy eternity. A country is something that is built every day out of certain basic shared values. And so it is in the hands of every Canadian to determine how well and wisely we shall build the country in the future. (Pierre Trudeau, Memoirs, p. 366)

The use of the indicator word "so" clearly shows that the last sentence is the conclusion. There are no logical operators in the last sentence, hence, it is a simple sentence of the form "Every Canadian should determine...". The student should also note the use of an analogy in the first sentence. And notice the reasoning, in very abstract form: "A country cannot be left unattended, therefore, all people must attend to the country'.

(iv) Critical Evaluation

This is the clearest application of critical thinking in the classroom. Essentially, it involves questioning the truth of premises and the validity of arguments, in other words, not taking the written (and spoken) word as Gospel. Students (and especially those coming straight from high school, where everything is Gospel) find this difficult to do.

A criticism of a point of view is, like everything else in academia, a form of argument. The conclusion is always that some argument has committed a logical error. The premises are the reasons for believing that the error occurred. The form of all critical evaluations is as follows:

The argument does such-and-such, and
Such-and-such is a fallacy,

Thus, the argument is a fallacy.

(Very often the second premise is left implicit.)

Students need to be shown that all sources, including their textbooks and their instructors (not to mention the media and their friends) can commit errors of reasoning. The best means to show them this is to critically evaluate any materials used for instruction. My own experience is that this can be very confusing for a student (one student commented, "I've never seen an instructor criticize the text before).

It is important, therefore, to state the criticism and the reason for the criticism clearly. It is also important to state the intent of posing such criticisms, specifically, that the student should not accept everything as being true, and that the student is expected to perform a similar sort of evaluation on any material. It is especially useful to encourage students to criticize the instructor, and to occasionally concede some points. Even when there is a response to be made, much more progress is made when a good criticism is acknowledged as such.

Finally, students should be required to stand the test of good reasoning. Comments in papers or in class which commit logical errors should be identified as errors in reasoning. This requires some tact. The approach should not be that the student is wrong, but rather, that the student's reasoning is flawed.

Suggested Readings

Barker, Stephen F. The Elements of Logic. McGraw-Hill, 1989.

Bergmann, Merrie, Moor, Fames, and Nelson, Jack. The Logic Book. Random House, 1980.

Cedarblom, Jerry, and Paulsen, David. Critical Reasoning. Third Edition. Wadsworth, 1991.

Copi, Irving M. and Cohen, Carl. Introduction to Logic. Second Edition. Macmillan, 1990.

Davis, Wayne. An Introduction to Logic. Prentice-Hall, 1986.

Huff, Darrell. How to Lie With Statistics. Norton, 1954.

Kelly, David. The Art of Reasoning. W.W. Norton, 1988.

Mayfield, Marlys. Thinking For Yourself. Wadsworth, 1987.

Pospesel, Howard. Introduction to Logic: Propositional Logic. Second Edition. Prentice-Hall, 1984.

Purtill, Richard. Logic for Philosophers. Harper and Row, 1971.

Quine, W.V.O. Methods of Logic. Fourth Edition. Harvard University Press, 1982.

Salmon, Merrilee. Introduction to Logic and Critical Thinking. Harcourt Brace Jovanovich, 1984.

Salmon, Wesley. Logic. Third Edition. Prentice-Hall, 1984.

Skyrms, Brian. Choice and Chance: An Introduction to Inductive Logic. University of Michigan, 1966.

Thomason, Richmond. Symbolic Logic: An Introduction. Collier-Macmillan, 1970.

Yanal, Robert. Basic Logic. West Publishing, 1988.

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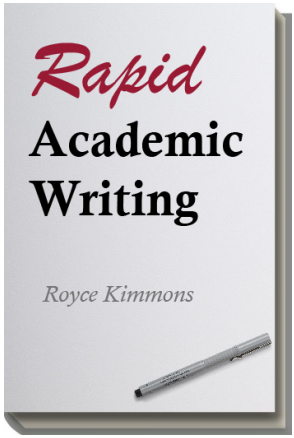

Kimmons, R. (2018). *Rapid Academic Writing*. EdTech Books. Retrieved from https://edtechbooks.org/rapidwriting