Thinking skills in the context of Formal Logic, Informal Logic and Critical Thinking[19]

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Abstract

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The aim of this essay is to explore the concept of thinking skills in three different contexts, i.e. Formal Logic, Informal Logic and Critical Thinking. The essay traces some contemporary historical connections between these approaches and illustrates differences and overlap between them by referring to the content pages of textbooks which are representative of the different approaches. In evaluating the historical developments sketched in the essay, the conclusion is reached that the open and pragmatic way in which Critical Thinking handles the topic of thinking skills has advantages for inter-disciplinary contact and cooperation. However, this pragmatic approach also has a possible downside: the concept of thinking skills can become so vague as to be of no use.

1. Introduction

In this essay I shall explore the concept of thinking skills in three different contexts, i.e. Formal Logic (FL), Informal Logic (IL) and Critical Thinking (CT)[20]. In doing so, I shall highlight the historical connections

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19 This essay is a re-worked version of a paper presented at the Annual Conference of the PSSA, Durban, July 1994. I am indebted to referees who have made useful suggestions to improve the essay.

20 Formal Logic is abbreviated as FL, Informal Logic as IL and Critical Thinking as CT.

between these disciplines by way of a narrative.

I could begin my story with the ancient Greeks, or at the Beginning of Everything (*en arché en ho logos*, John says in John 1:1).[21] However, I shall commence my story at the beginning of the 20th century. In the final paragraph of the essay I shall give a short evaluation of the historical developments which I have narrated.

Before starting off with the narrative, a few remarks on the term *thinking skills* seem in order here. For the purposes of my story I shall take this term to mean the following: thinking skills are acquired cognitive operations in the execution of which a person can attain high levels of proficiency. Which cognitive operations are relevant in the present context will become clear in the course of this essay. (However, I do not claim to give a complete list.) The cognitive operations in question are associated with logic, and have been regarded by many philosophers as the 'core skills' of the Western tradition of rationality which was initiated by the ancient Greek philosophers.[22]

2. Formal Logic

In the first decade of the 20th century a more or less successful marriage was established between mathematics and logic in Whitehead and Russell's *Principia Mathematica*. At that stage it became possible to give complete definitions of the logical meaning of certain so-called logical operators' (e.g. *and*, *or*, *if .. then*) and to generate conclusive proof of validity for a certain class of deductively valid inferences from a set of axioms and rules. The semantics and syntax of the artificial language which mathematical logic uses to construct valid forms of inference is completely transparent and is not connected in any way to empirical content or psychological processes. For this reason mathematical logic has been acclaimed as an autonomous science which has at long last

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[21] This interesting option has already been tried out by Hegel (1971:31).

[22] Whether the equation of rationality with 'logicality' is a fundamental mistake, as Toulmin (1972:44) thinks it is, cannot be discussed within the limits of this essay.

emancipated Logic from Epistemology and Psychology.[23]

The truth table method or alternatively the proof-theoretic method of mathematical logic can be used to test arguments in natural languages (e.g. Afrikaans and English) for validity. In order to do this, arguments in a natural language have to be translated into the artificial language of mathematical logic. The following argument can serve as illustration:

- Argument in natural language:

  If it rains it is wet

  It rains

  Therefore it is wet

- Argument translated into artificial language:

  $R \supset W$

  R

  $\therefore W$

Because mathematical logic is an extremely powerful instrument for the study of forms of deductive inference, it has been regarded by many people as the 'last word' on logic. This view has had important implications for the teaching of thinking skills in logic courses and for the contents of textbooks on logic. Because mathematical logic is an instrument for the study of deductive inference, textbooks have tended to emphasize deductive inference and the skills associated with it.

In the context of *mathematical logic* 'thinking skills' imply the following:

i) The manipulation of symbols in accordance with a set of rules. These rules consist of a number of argument forms and statements of logical equivalence. When applied to a given argument, these rules sanction steps of deductive reasoning proceeding from the premises to the conclusion of the argument. Such a completed sequence of deductive reasoning steps validates the argument.

[23] See for instance Scholz (1961:71-2).

ii) The translation (or rather transformation) of sentences in natural language into 'well-formed formulas', i.e. sentences which conform to the rules of the syntax of the artificial language.

The new mathematical logic did not completely displace the traditional formal logic, which has derived from Aristotle and has been developed and refined during the Middle Ages and in modern times. This so-called syllogistic or categorical logic is based on the relations between classes of objects.

- The following argument is a typical example of a syllogism:

  All M are P

  S is M

  Therefore S is P

- An instance of this pattern is the following argument:

  All human beings are mortal

  Socrates is a human being

  Therefore Socrates is mortal

This argument is an expression, in syllogistic form, of a conventional formulation such as 'Socrates, being human, is mortal'.

A certain class of arguments in conventional argumentative discourse which does not already exhibit a syllogistic form can be expressed in such a form. By applying the rules which govern the valid forms of the syllogism, it can be ascertained whether a specific argument form is valid or not. There are eleven valid forms of the syllogism.

In the context of *syllogistic logic* the following are important thinking skills:

i) The application of the rules of valid syllogistic reasoning by straightforward inspection procedures which enables one to make a definitive decision on whether a specific syllogism is valid or invalid.

ii) The translation of nonstandard forms of argument into syllogistic form.

At this stage a glance at the content pages of two logic textbooks which have been widely used could be useful. One dates from the late 20s and the other from the middle 60s. Excluded from the content summaries below are headings concerning terms, their intention and extension, categorical propositions, and other subjects belonging to the propadeutic of formal logic.

R. Latta & A. Macbeath: ***The Elements of Logic*** **(1929-1956)**	**S.F. Barker:** ***The Elements of Logic*** **(1965-1985)**
The Categorical Syllogism	The Logic of Categorical Inferences
The Figures and Moods of the Syllogism ...	The Logic of Truth Functions
Conditional Reasonings	Monadic Quantification
Syllogism and Deduction	General Quantification
The Validity of the Syllogism	Fallacies
The Problem of Induction	Inductive Reasoning
Observation, Enumeration and Analogy	Applying Logical Principles [Enthymemes, reasoning by analogy, rhetoric]
The Inductive Methods	
The Method of Hypothesis	
Fallacies	

As can be seen from the content headings of Barker's book the new and powerful mathematical logic does not displace the traditional syllogistic logic, although predicate logic is capable of handling the class of

arguments treated by syllogistic logic.[24] The main reason for this state of affairs is not the power of tradition (although it certainly does have an effect) but certain limitations of mathematical logic (to which I will return shortly).

In both books mentioned above deductive reasoning receives priority (and also gets the larger part of the print). Inductive reasoning is treated as a necessary complement to deductive reasoning because of the important role it plays in scientific research. Inductive reasoning plays second fiddle to the logic of deductive reasoning because, unlike the latter, which limits itself to determinate *forms* of arguments and (in the case of mathematical logic) employs a set of rules which is demonstrably complete, inductive logic is not an 'exact' and 'systematic' discipline. Indeterminate background information and methods of data acquisition affect inductive reasoning. Those are the main reasons why inductive reasoning is often introduced in textbooks under the heading 'The problem of induction'.

The following main topics are traditionally treated under this heading: induction by enumeration, induction by elimination (Mill's methods) and argument by analogy. The context in which these types of inductive reasoning are usually treated is 'scientific inquiry' (Welton & Monahan, 1962:337-413; Latta & Macbeath, 1956:299-347). Textbooks on logic traditionally contain shorter or longer sections on 'informal fallacies' because arguments in natural language may be incorrect not because they have an invalid form but because of (e.g.) irrelevance or semantic inconsistency.

In the context of inductive reasoning the following 'thinking skills' are of some importance: the application of certain criteria in order to determine how strong the support is which the premis(es) give to the conclusion of a specific argument, and determining the relevance of the premises in relation to the conclusion of an argument.

Identification and criticism of fallacies by using criteria such as relevance

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[24] This is also the case with Welton and Monahan's *Intermediate Logic* (1938[4]-1962). A more recent textbook which also contains a section on syllogistic logic is Rafalko's *Logic for an Overcast Tuesday* (1990).

and semantic inconsistency may also count as 'thinking skills' in the context of nondeductive logic.

To summarize: when the standard content of textbooks on logic is taken into consideration, it may be said that the most important thinking skills taught in *mathematical logic* are skills of deductive reasoning. In mathematical logic such skills consist of the manipulation of argument forms and statements of logical equivalence in order to produce proofs of validity. Associated with this kind of deductive reasoning is the translation of statements in natural language into formulae of the artificial language of mathematical logic. In *syllogistic logic* the most important thinking skills consist of the application of the rules of valid syllogistic reasoning to ascertain whether a specific syllogism conforms to the rules (i.e. is valid), and in the transformation of nonstandard forms of argument into syllogistic form. As to *inductive reasoning*, the most important thinking skills consist of the application of criteria such as those which determine measure of support, relevance and semantic consistency. *Basic skills* which are a prerequisite for the execution of the complex operations mentioned above, are also taught in standard logic textbooks: these are (*inter alia*) identification of arguments in natural language discourse and analysis of arguments into their basic constituents of premises and conclusions.

3. Informal Logic/Logic of natural language

The limitations of formal logic (syllogistic logic and mathematical logic) which become apparent when it is called upon to handle argumentation in natural language in a comprehensive way, has motivated lecturers, theorists and textbook authors to seek an alternative approach.[25] Since the

[25] Kahane (1971:vii) formulates the need for an alternative approach vividly: "In a class a few years back, while I was going over the (to me) fascinating intricacies of the predicate logic quantifier rules, a student asked in disgust how anything he'd learned all semester long had any bearing whatever on President Johnson's decision to escalate again in Vietnam. I mumbled something about bad logic on Johnson's part, and then stated that Introduction to Logic was not that kind of course. His reply was to ask what courses did take up such matters, and I had to admit that as far as I knew none did. He wanted what most students today want, a course relevant to everyday reasoning, a course relevant to arguments they hear

late 60s there is an Informal Logic 'movement' which articulates an important shift in logicians' conception of 'thinking skills' and the teaching of such skills to students. This shift can be characterized as a shift away from 'synthetic' arguments which only fill in the variables of formal logic, and towards authentic argumentative discourse in everyday life (e.g. in politics, religion, court cases, advertisements, popular scientific writing, etc.). One example of a 'synthetic' argument which is used in a logic exercise may suffice in the present context:

> Grandmothers don't go in for surfing. Surfers go in for sunbathing. So sunbathers sometimes aren't grandmothers (Barker, 1985:76).

The limitations of formal logic and the thinking skills associated with it become apparent when one tries to construct a logic of 'everyday' argumentative discourse:

* In 'everyday' argumentative discourse most of the arguments we use do not exhibit valid forms, nor are they meant to. More often than not, when they are valid, their validity does not depend on the logical form they exhibit but on the semantics of the words and phrases of the natural language in which they are formulated. 'Everyday' argumentative discourse which is not formally valid can only be made valid by a transformation of the original discourse, which involves a greater or lesser degree of distortion.

* Translation of natural language into the artificial language of mathematical logic is not without problems, and it always remains problematical whether the author of a specific argument would concur with the interpretation given of his/her statements in the artificial language.

* On the level of deductive reasoning formal logic has some important limitations. Syllogistic logic is limited to categorical propositions. In the case of mathematical logic failure to construct a proof of validity cannot be considered sufficient grounds to conclude that the argument in question is *invalid.* The proof-theoretic method is thus

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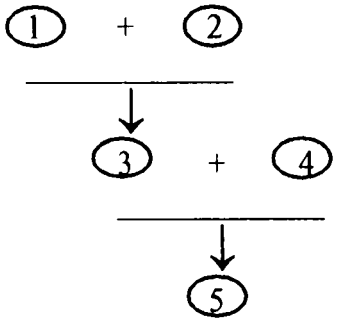
and read about race, pollution, poverty, sex, atomic warfare, the population explosion, and all the other problems faced by the human race in the second half of the twentieth century".

> unable to conclusively invalidate an argument; it is only able to definitely validate one. This is the main reason why syllogistic logic has not been completely displaced by mathematical logic: the method of the former consists in the application of a few rules in a mechanical manner and it can both validate and invalidate syllogistic arguments. Although the truth table method is a mechanical procedure which can validate or invalidate an argument conclusively, it is too cumbersome to use when an argument form has five or more variables. The proof-theoretic method is for all practical purposes non-mechanical: everybody who has attempted a construction of a complicated argument knows that one proceeds by trial and error and that a great deal of ingenuity is often called for.

While the formal logic approach focuses on valid forms of reasoning, the informal logic approach studies the structure of arguments in documented 'everyday' discourse. Monroe Beardsley's *Practical Logic* (1950) set the standard for this type of analysis by using arrow diagrams to make the structure of arguments in natural language explicit. The function of arrow diagrams is to make the connections between the premises and the conclusion of an argument explicit. For example:



The encircled numbers stand for statements in a specific passage of argumentative discourse, and the arrows indicate the relation of support between premises and conclusion. In the example above statements 1 and 2 together support statement 3, which is an *intermediate* conclusion. Statements 3 and 4 together function as premises which support statement 5, the final conclusion.

In the context of *informal logic* the following are important thinking skills:

i) Identifying discourse in natural language as argumentative, and isolating the argument from the discourse which does not belong to it (e.g. asides, incidental information, etc.).

ii) Clarifying the meaning of the discourse (if necessary), i.e. making decisions about vague or obscure language and ambiguous terms with due consideration of the context of the argument.

iii) Structuring the argument in the standard form and representing the structure by way of a diagram which makes clear how the premises are connected to each other and to the conclusion.

iv) Supplying tacit premises and conclusions.

v) Employing some technique or other to make the structure of extended arguments explicit.

The informal logic approach does not only want to make the structure of arguments in natural language explicit, but also wants to evaluate arguments. In FL the range of evaluation criteria is (strictly speaking) limited to validity and invalidity. The form of an argument is either valid or invalid with no degrees in between. In IL it has become standard practice to extend evaluation to the premises of arguments with questions concerning acceptability and relevance. Acceptability depends on a variety of criteria, e.g. observation, background knowledge and expertise. Evaluative criteria used in connection with the support rendered by premises to conclusions of arguments are strong/weak, plausible, cogent etc. In this particular context thinking skills consist of the following:

vi) The application of criteria such as relevance and expertise regarding premises, and strength of support regarding the relation between the premises and the conclusions of arguments.

Because the majority of arguments in natural language are not deductive arguments, IL gives priority to inductive reasoning, and also most of the print. This point can be illustrated by a summary of the contents pages of two IL textbooks which may be regarded as representative of the IL approach:

I.M. Copi: ***Informal Logic*** **(1986)**	**S.N. Thomas:** ***Practical Reasoning in Natural Language*** **(1986, Third Edition)**
Introduction [Argument structure, diagrams]	Basic Analysis of Reasoning [Argument structure, diagrams]
Some Uses of Language	Basic Evaluation of Reasoning
Fallacies	Clarifying Obscure Reasoning
Definition	Practical Decision Making
Analogy	Traditional Topics [Fallacies]
Causal Connections [Mill's methods]	Analyzing Media Editorials
Science and Hypothesis	Analyzing Philosophical Reasoning

Even superficial comparison of the formal logic approach with the informal logic approach by way of the contents of the textbooks summarized above is enough to highlight the implications of the shift towards reasoning in natural language. The main topics of the latter concern language and the structure of short and extended arguments.

However, it is also clear from such a comparison that there is overlap to a certain extent. The formal approach has more often than not supplemented the study of logical form with expositions on inductive reasoning and fallacies. The importance of the latter has generally increased in IL textbooks. Moreover, IL is not as 'informal' as the name suggests. The notion of validity in IL tends to be intuitive and imprecise to the extent that it is dissociated from the forms of arguments and made to depend on the meaning or semantic content of all the words and phrases that appear in the premises and conclusion of an argument.[26] Validity (or invalidity) in this sense is determined by asking the question: "Supposing the reason(s) were true, is there any way in which the conclusion could be false?" (Thomas, 1986:134). It is clear that the inability to answer 'yes'

[26] See Thomas (1986:12).

to this question does not conclusively validate an argument (for the inability might be due to lack of imagination on the part of the person trying to answer the question). Because of this limitation of the semantic notion of validity, and because some arguments in natural language do exhibit valid logical forms, most IL textbooks do treat basic forms of valid reasoning and some of the thinking skills associated with the formal approach.

4. Critical thinking

Critical Thinking is a term which came into circulation in the USA in the 40s. Sometimes the names Informal Logic and Critical Thinking are used interchangeably for an academic discipline. In my view, however, there are important differences which militate against this usage. In the first place it is a historical fact that there are two 'movements' which exist separately and independently of each other. The Critical Thinking 'movement' originated in the early 70s. While IL tends to define itself as an academic discipline and as an enlargement of the scope of logic, CT defined itself from the start as an instrument of educational reform on all levels of education: leaders in the Critical Thinking movement "have argued that effective and meaningful education requires that curricular, pedagogical and assessment strategies at all levels of education be coordinated so as to foster in students those cognitive skills and habits associated with critical thinking" (Facione, 1991:1).

The term *thinking skills* came into vogue through the Critical Thinking movement. *Thinking skills* as a generic concept encompasses *reasoning skills* (which are the main concern of FL and IL) as a sub-species. *Thinking skills* is a concept which is wide (and vague) enough to allow inputs from educationists, cognitive psychologists, rhetoricians and communication scientists into the Critical Thinking movement, which has acquired an interdisciplinary character. It is interesting to note that CT has created scope for interaction between Logic and Rhetoric, which have been sworn enemies for centuries.

The Critical Thinking movement has the aim to address three major problems of the so-called post-modern era (roughly the post-70 industrialized world), i.e. mass education, the information explosion, and the restructuring of the economy.

Mass education in universities and colleges[27] tends to reproduce a style of teaching and learning which can be found in most schools, i.e. the communication of 'facts' to students, and rote learning and reproduction by the students. One of the major aims of the critical thinking movement is to abolish this style of teaching and learning on all levels of education by infusing critical thinking skills into the curriculum, into teaching and learning methods, and into assessment.

'Teaching facts', rote learning and reproduction cannot handle the information explosion: what people who are exposed to it need are thinking skills to cope with it. Educating people in the required skills is another major aim of the critical thinking movement.

The restructuring of the economy, necessitated in industrialized countries by the pressures of global competition and computer-driven production processes, tends to erase distinctions between 'workers' and 'management'. 'Workers' and 'staff' are suddenly in need of a wide range of skills, e.g. decision-making skills, communication skills, planning skills, problem-solving skills, etc. All of these skills are based on or contain a component of thinking skills. Educating people to cope with the demands of a post-industrial economy is the third major aim of the Critical Thinking movement.

Notwithstanding the differences between CT and IL mentioned above, there is much overlap between them. As I have already mentioned, CT encompasses the reasoning skills mentioned above in the discussion of IL, and shares with IL its focus on everyday argumentative discourse. CT, however, moves beyond the topics usually associated with IL in that an explicit distinction is made between a 'cognitive skills' dimension and a 'dispositional' dimension to thinking. The latter dimension ties in with CT's educational objectives which are (amongst others) to produce 'good critical thinkers' as opposed to 'weak critical thinkers':

> Modeling that critical spirit, awakening and nurturing those attitudes in students, exciting those inclinations and attempting to determine objectively

[27] In 1992 the number of students enrolled in colleges and universities in the USA for the first time equalled the number of pupils attending primary and secondary schools.

> if they have become genuinely integrated with the high quality execution of CT skills are ... important instructional goals and legitimate targets for educational assessment (Facione, 1991:20).

The dispositions or attitudes in question here are (inter alia) open-mindedness regarding divergent views, flexibility in considering alternatives and opinions, reasonableness in selecting and applying criteria, and persistence when faced with difficulties (Facione, 1991:25).

Skills associated with reasoning count as 'core CT skills', but in this context they are viewed as 'micro skills'. Micro skills function within 'macro skills' like listening to or presenting a speech, writing an essay or reading an extended discourse, or even a book. CT tends to emphasize the constructive use of skills more than IL does. In both FL and IL a tendency exists to use rules and criteria for good reasoning primarily for the evaluation of discourse; CT tends to place a greater amount of emphasis on the use of skills to *generate* various types of discourse.

As a post-modern phenomenon CT is eclectic and 'fuzzy' in its composition, as is clear from the subjects in the contents of two textbooks which may be regarded as representative of the genre:

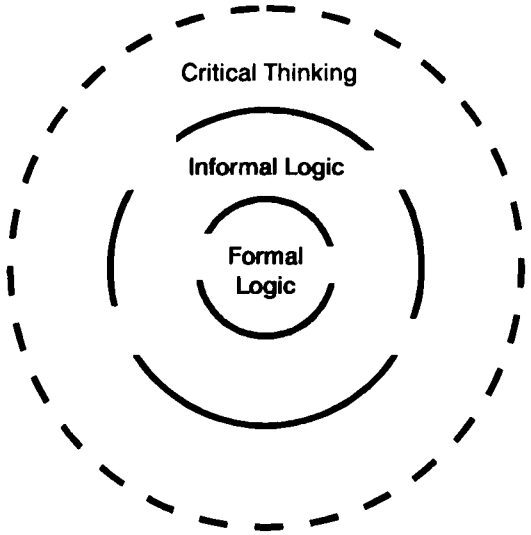
Some of the chapter headings in the table op p. 441 are italicized to highlight construction (as opposed to evaluation) and the assimilation of topics from various disciplines (communication science, cognitive psychology, rhetoric, and epistemology).

In summary: it is clear from the content lists below that the range of thinking skills treated in IL textbooks (basically reasoning skills) form an important part of the skills treated in CT textbooks. Because CT is a 'fuzzy' enterprise, there are no 'standard' CT thinking skills. Skills which conceivably fall within the ambit of 'thinking' (but not 'reasoning') are (*inter alia*) picking out false implications in advertisements, questioning exaggerated claims and resisting psychological appeals in advertisements, questioning 'bias' or slant in TV and audio news reporting, observation skills, problem solving skills, organizing skills, reporting skills, etc. It is interesting to note that skills associated with evaluating argument forms have been relegated to a few pages in the two books used for illustrative purposes below, and also in Diestler's *Becoming a Critical Thinker* (1994).

V.E. Barry & J. Rudinow: ***Invitation to Critical Thinking*** **(1990)**	**J. Chaffee:** ***Thinking Critically*** **(1988)**
Blocks to Critical Thinking	Thinking
Communication: Language and Advertising; Television and the News	Thinking Critically
The Anatomy of Arguments	*Solving Problems*
Casting Arguments	*Perceiving*
Missing Premises	*Believing and Knowing*
Criticizing Arguments [various kinds of fallacies]	Language
The Extended Argument	Forming Concepts
Writing the Argumentative Essay	*Mapmaking and Composing*
Solving Problems	*Relating and Organizing*
	Reporting, Inferring, Judging
	Constructing Arguments
	Reasoning Critically [Generalization, causal reasoning, fallacies]

5. Conclusion: Evaluation

The historical developments which I have sketched in broad strokes above can be graphically illustrated by an image of concentric circles:



This image conveys some aspects of the relations between the contexts in which 'thinking skills' have been elaborated by philosophers and logicians in the 20th century, but it can also be misleading to the extent that it suggests that FL and the skills associated with it forms the core of IL and CT. This is not the case with regard to CT because valid forms of reasoning tend to receive scant attention in CT textbooks. Concentric circles also give the impression that demarcations between the different disciplines are clear cut. This is not the case especially with regard to IL and CT: therefore their 'boundaries' have been drawn with broken lines. CT is an eclectic affair (it is a moot question whether it is a 'discipline' in the conventional sense) which incorporates bits and pieces from FL, IL and disciplines such as communication science, cognitive psychology and rhetoric. The 'fuzziness' in the composition of CT has certain advantages because, unlike FL, it can pragmatically annex 'thinking skills' from other

disciplines as the need arises. A 'fuzzy', pragmatic approach to thinking skills encourages interdisciplinary contact and cooperation. However, a negative side to the 'fuzziness' of CT is too much openness in the vein of 'anything goes', which can lead to loss of precision in the concept of thinking skills. A concept which comes to mean disparate things loses its ability to mean anything specific.

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