Logical Reasoning as a Curriculum Area in Schools

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Philosophers have a *penchant* for the non-existent. Kant considered the main pre-occupations of speculative thought to be God, freedom, and immortality - which gives us about two and a half out of three in favour of the factitious. In this discussion of a kind of applied philosophy one might be forgiven for seeing a similar perversity: logic does not appear on the timetable, certainly not in the educational institutions covered by this volume.[1] In reply one might, however, try to exploit a theological parallel: logic, reasoning, is nowhere because it is everywhere. This paper attempts to show that the truth is, as usual, somewhere in between, but that the true situation is hardly comforting - we hope its readers may be moved to alter it.

An initial problem is to specify the topic. Human beings have always had to reason, to move non-capriciously from one set of ideas, thoughts, or beliefs to another. The fact that a sequence of reasoned thought is not capricious (indeed the usual colloquial term is a *chain* of reasoning) means that reasoners evaluate reasoning, whether or not they enunciate the standards explicitly. In this way, one might say that reasoning is indeed everywhere (to add *logical* is only to say that it comes up to standard on one important dimension as well), though one should not forget that this is compatible with many people in many areas reasoning badly or not reasoning at all. Certainly, in this way, logical reasoning does occur in much of the school curriculum: in manipulating equations; in explaining historical or geographical facts; in justifying the actions of fictional characters; in defending or attacking a point of view; and much, much more.

We owe the self-conscious, reflective, explicit study of reasoning, the formulation of standards appropriate to it, to the ancient Greek philosophers, pre-eminently Aristotle, though Indian and Chinese thinkers also took up these issues. One of Aristotle's fundamental achievements was to recognize an appropriate level of abstract patterning in different arguments or sequences of reasoning. Just as prosodists abstract from the actual words of a poem to focus on the length of syllables and their patternings, so Aristotle created the science of *formal* logic by seeing many different arguments as exhibiting the same pattern: for example, *All A are B*, *all B are C*, *so all A are C*.[2] The study of such patterns revealed a distinctive kind of reasoning in which truth would be transmitted from one's starting point (one's *premises*) to one's conclusion. With such patterns of *deductive* argument, one has a guarantee that *if* the premises are true then the conclusion will also be true, though, of course, one has thereby no guarantee that the premises actually are true. To appreciate this relationship one must distinguish the question of the argument's formal structure from that of the truth or falsity of its constituent premises and conclusion. A common stipulation among philosophers is to reserve the terms *valid*, *invalid* for the structures and the terms *true*, *false* for the statements that compose the premises and conclusion of an argument. If one wishes, one can go on to stipulate that a valid deductive argument with true premises is *sound* (as is done in Copi's influential text, 1978: 43). The point then is that a bad or *unsound* deductive argument can go wrong in two crucially different ways: it may be an invalid argument or it may have at least one false statement somewhere among its premises.

A great deal of our everyday reasoning is not deductive, and much of its power seems to lie in its content rather than its form. Some of our deductive reasoning is not obviously a matter of formal structure.[3] But science is not in general dismayed by such limitations, though it continues to be argued that in the case of logic they do undermine much of its possible pedagogical value (cf. Scriven, 1976, 1980). Logic was certainly overawed by the extent of Aristotle's contribution; it is hardly an exaggeration to say that he not only invented but completed the main portion of logic he created, the study of syllogisms. While the Stoics explored elsewhere and while there was much elaboration during the mediaeval period (when formal logic was a prominent part of the tertiary curriculum) it was not until the nineteenth century that logic broke out of the Aristotelian strait-jacket. Frege revolutionized logic with a new theory of the underlying logical structures. Where, for instance, traditionally *all men are mortal* had been seen as two terms, *men* and *mortal*, linked by the universal affirmative copula *all ... are ...*, Frege suggested an analysis that could be written *for all x, if x is a man then x is mortal*. While we cannot show it here, Frege's approach allows for a tremendous increase in the range of sentences that can be analysed and whose logical relationships can be elucidated. Pedagogically it may well seem indefensible to leave students unaware of the

powers of modern, Fregean logic while continuing to teach a version of Aristotelian syllogistic (as happens in UWI, Mona's *Use of English* course, cf. Geach, 1972: 44-61).

Frege's main interest was in the foundations of mathematics; modern logic, in its ramifications, has become part of that discipline, but there has remained an undercurrent of thought that its fundamental concern should be, as with Aristotle, for the conditions of good reasoning in any area (Dummett, 1973: 432-435). Certainly the books that introduce logic to English-speaking philosophy students, as opposed to mathematicians, claim applicability to everyday argumentation, albeit with various simplifications, while often taking care to display topics that have so far not yielded to a formal approach (Hodges, 1977; Jeffrey, 1967, whose very title makes this point). But it must be admitted that the examples these books use are as artificial as ever, applicability remaining an article of faith, perhaps evidenced by the performance of such students elsewhere (see Massey, 1981, for arguments for a positive evaluation, and Tomko, 1981, Gibbs, 1985, and Miller, 1986, for discussion of the empirical evaluation of attempts to improve critical thinking). Formal logic, in the English-speaking world at any rate, is then studied by mathematicians and computer scientists, as a branch of mathematics and thus as divorced from any actuality, and by most philosophers, as a study of very simple argument structures, too simple to appear often in controversy. And virtually all this study is restricted to the tertiary sector of education.

The explicit study of actual everyday reasoning is not, however, entirely absent. In England there has been a tradition of books addressed to the intelligent layman, with titles such as *Straight and Crooked Thinking* (Thouless, 1953, 1st edition 1930), or *Thinking to Some Purpose* (Stebbing, 1939), which have tried to bring logical theory closer to real life. A recent example of "logical coaching" claims "such an exercise may be beneficial even though neither the coach nor the coached have or acquire any familiarity with the calculi of Logic" (Flew, 1975: 21). In North America there has been more recently a coming together of philosophers, rhetoricians, and others in a movement to encourage the study of "informal logic" or critical thinking, not only at tertiary institutions but also within secondary schools (and even earlier in at least Lipman's interesting movement, *Philosophy for Children*, v. Lipman and Sharp, 1980, and Ross, 1988, for what little is going on in England). There is considerable diversity of theory and approach within this broad grouping, but in general one can discern a shared belief that the philosophical study of logic and language can contribute significantly to students' ability to use and evaluate arguments or reasoning throughout the curriculum. A notable feature of its work is that actual arguments, often of some length, are examined rather than the traditional artificialities of the logic books, though assumed reading levels are often fairly low (but see Scriven, 1976, or the recent British venture in this field, Fisher, 1988, for more involved argumentation). Another common feature is a focus upon inadequacies rather than on patterns of valid or acceptable argument (for instance, Johnson and Blair, 1977; for a historical survey of work on fallacies, see Hamblin, 1970).

The informal logic movement provides an existence proof for what is otherwise demonstrable: that there are ideas, theories, procedures in logic and the philosophy of language that can illuminate the use and evaluation of reasoning and argument which has traditionally been left to educated common sense. As has been noted elsewhere (Brandon, 1985), educators in general, and the Caribbean Examinations Council in particular, frequently espouse aims of improving students' reasoning ability - "one of the aims of the Secondary School curriculum is to produce students who can think clearly, reason and follow a logical argument" (CXC, 1979) and CXC syllabi for Integrated Science, Chemistry, English, Mathematics, and other subjects refer to the importance of problem solving,[4] testing hypotheses, logical inference, critical appraisal, and so on: all matters in which logic, indeed often deductive logic of an elementary sort, is crucial. Elsewhere students will be expected to use distinctions such as that between fact and opinion which form part of our common sense tool kit but which clearly presuppose philosophical conclusions (see Weddle, 1985, for a discussion that reveals the ambiguities concealed in the fact/opinion contrast as it is taught in schools: he offers eight different distinctions that might be involved). As we noted earlier, logical reasoning is pervasive in the curriculum, but it is left implicit. It is part of the so-called "hidden" curriculum, to be caught from rather than taught by teachers and textbooks.

Implicitness, the "hidden" curriculum, is fairly efficient for some things: the nuanced practices of the structures of oppression within which we live; the grammar of our mother tongue; the vast areas of the unthinkable. But it is not much good for passing on truth or understanding. It is not normally our preferred mode of teaching when we have a branch of explicit knowledge or, less tendentiously, study. In a remark addressed to the philosophical inheritors of the explicit study of logic, Gilbert Ryle noted that "anachronistically we have all assumed that Plato just knew from the start the differences between good and bad *pro* and *contra* arguments. We have not wondered how he or anyone else learned to look for these differences or to satisfy other people that they were there" (1966: 206-7). We would make the same point with respect to teachers whose baseline remains the unschooled prejudices from which, and often against which, Plato and his successors had to struggle. One reason for allowing ourselves the luxury of the earlier historical discussion was to suggest that while the western philosophical

tradition may have problems passing itself off as a branch of knowledge in its entirety the same cannot be said for the discipline of logic, nor, we think, for certain aspects of the philosophy of language (an area that it is increasingly difficult to distinguish from linguistics - though of course some might wish to see that as a criticism of the pretensions of linguistics). The suggestion is, then, that there is something superior to common sense to be had in these areas which appear so important to the devisers of curricula.

We have noted already the importance of the promotion of logical matters for several CXC syllabi. For a time, the mathematics board actually had an optional unit entitled *Reasoning and Logic* which covered parts of formal deductive logic in the usual abstracted way. Various reasons, not least the inability of teachers to teach it successfully, led to its demise.[5] There are of course considerable analogies between matters dealt with in elementary formal logic and the set theory that is an essential element of CXC mathematics, but the latter is hardly ever taught with these possible applications in mind. In Jamaica, this area of overlap has been used as the basis for a unit in the Secondary School Certificate examination (arising out of Diploma in Education work by Sidrak) but it would appear not to have been widely used in schools. But apart from these two restricted cases, it would seem that all the other logical matters have remained firmly "hidden".[6]

Hidden and generally unnoticed. Several students in the Mona Faculty of Education have, however, attempted to teach units focussing on various logical matters. While they thereby notice their existence, the problem remains since such student teachers cannot usually advance beyond their own common sense in structuring their teaching of these topics. Thus most of the studies devoted to problem solving in mathematics or social studies, to evaluating advertizing, to exploring "inferential comprehension skills", and so on, remain at the common sense level. One student might recognize that the examples she offered for decision as fact or value might raise too many issues, another might record the fact that she was initially marking the wrong answer right in teaching set theory (that is, that she, like most people, thought a particular fallacious argument structure to be valid) but these insights come after the event; they have not contributed to formulating and structuring the material taught. They constitute in fact the detailed case, which cannot be presented here, for the general re-orientation of practice that is being canvassed.

The scene is not, however, completely barren. Sirbratthie has completed two projects involving explicit logical teaching. For the first one (Sirbratthie, 1986), a unit was constructed to teach some elementary formal and informal logic (notions of deductive validity, the testing of invalidity by means of counter-examples, etc.). The other involved teaching a more extensive range of topics owing much to Ennis' (1979) conception and test of critical thinking, which in practice involves a focus on kinds of fallacy (Sirbratthie, in preparation). The earlier study, which found significant, if modest increases in performance on a deductive reasoning test (correlated t (27) = -3.68, p = 0.001) was in fact based on material Brandon had been employing with Mona Certificate of Education students (Brandon, 1983). Both Brandon and Sirbratthie were, however, affected by a lack of time in the use of this material so that, for instance, in Sirbratthie's project no significant change was observed on items involving invalid argument forms. Sirbratthie's second project seems to have overcome this problem - she devoted 24 hours over one term to its teaching with grade 10 students in a girls' high school - and she has found very considerable improvements on critical thinking tests that focus on invalid reasoning.

We have stressed that normally teachers and pupils deal with the evaluation of reasoning on a basis of unreflective common sense, and we have suggested that this is not particularly reliable. A certain amount of work has been done within the Faculty to establish some estimates of unreflective performance. The main investigations here again derive from the work of Robert Ennis, one of whose tests - of conditional reasoning ability - was used in the initial study of students in three grades of a comprehensive high school in Jamaica (Nolan, 1984; some of the data are more readily accessible in Nolan and Brandon, 1986; for Ennis' own research see Ennis and Paulus, 1965). Ennis' tests contain six questions for each distinct logical principle; mastery of the principle requires at least five right answers, while persons with only four right answers are regarded as on the borderline (for a suggestion that this may be too lax a criterion for mastery of a logical rule, and other comments on the underlying rationale of the tests, see Brandon, 1987). Table 1 contains typical findings for mastery of a few principles at Nolan's school and in Ennis' original U.S. sample. The main point now is the generally mediocre peformance everywhere, and the appallingly bad performance on invalid arguments; but it is also worth stressing the increasing gap between streams in the Jamaican school (which one would expect to find elsewhere, though Ennis did not report stream or track differences - Nolan's grade 7 result is the average for two streams since at that point there was no significant difference between pupils who had passed the Common Entrance Examination and those who had not) and noting the fact that some of the Jamaican sample end up fairly close to the U.S. level (see also Table 2 for other Jamaican groups that come closer) though their progress there is probably delayed by several years (a similar delay has been found in other cognitive tasks: Mitchelmore, 1980, 1982; Webb and Brissett, 1986).

TABLE 1: Percentage mastery and borderline mastery of certain logical principles in the U.S. and Jamaica

	USA				Jamaica					
	Grade				Grade					
	5		11		7		11S		11V	
	M	B	M	B	M	B	M	B	M	B
MODPON	51	19	62	16	28	11	43	22	32	36
MODTOLL	30	16	35	25	8	15	22	26	28	4
OMODPON	53	21	81	14	28	18	56	27	32	20
CONVERSE	2	4	19	13	2	1	8	27	0	4
AFFCON	2	4	3	12	2	11	22	17	0	0
Mean Age	129		203		149		198		199	
N	102		78		61		23		25	

Note: The principles are as follows: MODPON - *if p then q, p, so q*; MODTOLL - *if p then q, not q, so not p*; OMODPON - *p only if q, p, so q*; CONVERSE - *if p then q, so if q then p*; and AFFCON - *if p then q, q, so p*. CONVERSE and AFFCON exhibit invalid patterns of inference. M stands above percentage mastery, B above percentage borderline mastery of each principle. 11S and 11V are the science and vocational groups respectively in Nolan's Jamaican sample. Mean age is in months. U.S. data from Ennis and Paulus (1965), Jamaican from Nolan and Brandon (1986).

Subsequently, variants of these tests have been used on other students and on non-graduate teachers who apply to the UWI. The items for one logical principle (MODPON - *if p then q, p, so q*;) have been kept constant in these tests; Table 2 gives results on this principle for various groups. The main point now is that secondary school students and teachers are performing at about the same level, as one might expect from the fact that neither group ever studies these issues explicitly.

TABLE 2: Percentage Mastery and Borderline on One Logical Principle (MODPON)

	Mastery	Borderline	N
Teachers/trainees			
1985 Entrants	53	25	452
1989 Entrants (male)	63	18	117
1989 Entrants (female)	69	18	507
St Lucia trainees	70	14	100
Students (in Jamaica)			
Private Kingston High School Grade 9	86	14	21
Kingston High School Grade 10	62	26	34
Kingston High School Boys, Grade 10	51	13	61
Urban New Secondary Grade 10 (boys)	31	13	67
Urban New Secondary Grade 10 (girls)	25	21	81
Rural All-Age Secondary Segment	12	21	85

Note: Unpublished data

The data in that table also suggest, what has been found consistently in these investigations, that there are no significant differences between the sexes on logical reasoning ability (in Nolan's investigation, for instance, the correlation between sex and score on conditional reasoning was r (203) = -0.011, p = 0.4378, while Ennis had also found an insignificant correlation in his sample; similarly among the 1987 UWI Mona B.Ed. applicants the T test for sex differences on the logical reasoning test gave t (222) = 0.718, p = 0.473, for all applicants in 1989 on a slightly different test t (149.4 - using separate variance estimate, n_1 = 115 and n_2 = 507) = 1.591, p = 0.114, and on yet another test taken by teacher trainees in St Lucia t (95) = 1.43, p = 0.157).

As noted earlier, the sorts of logical principle tested in these investigations are merely the building blocks of serious discussion. While the universally poor performance might seem deplorable, we might try to take comfort from the supposition that people seem to cope with the more complex tasks; the poor performance might then be an artefact of the testing context.[7] It is notoriously difficult to test the claim that people do cope with real life reasoning tasks adequately; some might see the electoral behaviour of many societies as a standing indictment of their educational systems, while others might applaud the same actions. While recognizing these and other problems (see Ennis, 1984), Ennnis and Weir have developed a test of critical thinking ability that at least simulates a real life situation. This test has been used on various groups of teachers studying at UWI, Mona, as well as on one of Sirbratthie's groups of high school students. Table 3 reports the results for some of these as well as for two U.S. groups given by Ennis. From this we can see that, for whatever reasons, the performance of teachers and students in Jamaica is markedly worse than the U.S. groups. While at the level of simple logical reasoning we have a universal problem, here we have apparently a much more urgent local one.

TABLE 3: Results on the Ennis-Weir Critical-Thinking Essay Test: U.S. and Jamaican Samples

	Mean	Standard Deviation	N
US undergraduates	22.0	4.3	27
US Gifted Grade 8	16.7	5.8	28
UWI Cert Ed	8.8	5.3	33
UWI Dip Ed	9.9	7.2	19
Kingston High School Grade 10 girls	9.5	6.7	91

Note: U.S. data from Ennis and Weir (1983); UWI unpublished; Kingston High School from Sirbratthie (in preparation).

We do not believe that this unwillingness or inability adequately to criticize bad argument can be removed simply by an exercise in curriculum development; but we would argue that such change in schooling, and in the preparation of teachers, can contribute something to the promotion of cognitive responsibility. One might suggest as a task for sociological research and theorizing an explanation of such obstacles to desired levels of critical thinking as exist within the school system and beyond. (Researchers have already documented, for instance, the comparatively extreme authoritarianism that has characterized teacher training in Jamaica: Howells, 1978.) But one may doubt that such understanding will reveal a simple way to eradicate them.

Not that the curriculum changes envisaged would be easy in any case. At the moment, teachers do not study reasoning any more than they study how to breathe. One consistent finding when teachers have attempted to go beyond this unreflective level has been the time and effort they have had to expend to meet the challenge. Teachers coming to be upgraded in the teaching of *X* may well recognize a lack in the content area of *X* but they are not usually predisposed to see that they also need to learn how to think better. We can, however, add that those who have faced this threat to their self-esteem seem uniformly to have responded to it positively.

As noted earlier, there is considerable debate over the best ways of teaching for improved logical reasoning or critical thinking. We would certainly not wish to endorse the abstracted formal logic of CXC's *Reasoning and Logic*, though undoubtedly that would be an easier way to package the topic. As we saw, the role of any formalization has been seriously questioned, though of course there is a question of degree here - no one wishes to dispense entirely with abbreviations or the odd diagram. But even at a simple level such devices can prove difficult: while few people get confused by replacing names with a variable (*if X is a man,...*) the idea of replacing whole sentences with a variable is much more difficult to grasp, as Table 4 suggests.

TABLE 4: Difficulty and Discrimination Indices for Symbolic Items among Two Samples

	Saint Lucia Trainees		Jamaica Grade 10	
	Difficulty	Discrimination	Difficulty	Discrimination
Name variable	.91	.13	.87	.41
Sentence variable	.53	.13	.48	.35

Note: The argument principle is MODPON, in one case phrased as *if there is an X, there is*

a Y, etc. in the other *if p then q*, etc. The difficulty index is as usual really a facility index - 91% of the trainees got the name variable question right. Unpublished data.

Our main point, however, is that whatever may be the best mix for conveying the ideas to pupils the teachers themselves must have a coherent grasp of the subject (cf. Nissen's contribution to this volume) and that this cannot be had without some exposure to the formal discipline and its techniques, *pace* Flew's comment quoted earlier.

Given the important role of examination boards and text books in structuring what is taught, an important stopgap measure might be to employ people with a logical training to work in collaboration with examination boards and publishers to try to get matters straight at least at that level. (Similar advisors might be useful for attempts to infuse other issues into the curriculum.) For instance, one of the main CXC English textbook series, *Language for Living*, written by Cecil Gray, includes many exercises that invite students to discuss arguments, express justified opinions, use a distinction between facts and opinions, and write essays supporting positions with evidence and reasons. Close examination of the text shows that Gray has taken such reasoning skills quite for granted since he gives no guidance on what he thinks distinguishes facts from opinions or a good reason from a bad one. It would seem that at the least our proposal faces the same difficulty we have already met in a perhaps extreme form: getting the experts to recognize their lack of expertise in a fundamental and taken for granted area. But if logical issues were clearly enunciated in curriculum objectives (as opposed to their ritual invocation among the aims) it might help to prevent teachers from asking children to deduce a universal generalization from observations of the behaviour of two proteins (cf. Brandon, 1981) or the reasons for the actions of a fictional personage from the narrative.

It also needs to be remembered that logical incoherence may be essential for some parts of the curriculum (one thinks of much of the school's dealings with values). A logic advisor may turn out to be more a wrecker than a collaborator. But in many areas, it is uncontentious that improved reasoning ability is desirable; we have indicated the need for it in at least the Jamaican school context; we have suggested some possible courses of action. The ball is now in the curriculum developers' court.

Footnotes

1. This may be a slight exaggeration, as noted later with reference to a CXC mathematics optional unit and an SSC unit in Jamaica. See footnote 6 for provision at the UWI. Back to text.

2. Aristotle's own way of rendering this pattern was slightly different (*the B belongs to every A*). The analogy with prosody soon breaks down: if something breaks the rules for being a dactylic hexameter it may still be excellent poetry, and if something else is a hexameter it might be appallingly bad verse, but if an argument exhibits a valid pattern it has one important virtue, however absurd it may otherwise be, and if its only plausible structural analyses are all invalid then it lacks that virtue, whatever else may be said for it. Back to text.

3. For example, an inference such as *Today is Monday, so tomorrow here it will be Tuesday*. One might try to supply unstated additional premises to make such inferences purely formal, but there is in fact a general problem of demarcating form and content in an absolute way (for discussion see Whiteley, 1951; Quine, 1970, esp. ch. 5; Peacocke, 1976). Back to text.

4. Cf. Isaacs' paper in this volume. Back to text.

5. See Brandon, 1985, for further discussion and criticisms of this unit. Back to text.

6. Nor have they properly surfaced at the tertiary level (up to the 88-89 academic year). Some formal logic appears in the mathematics courses at UWI, and more recently in computer science, and a little Aristotelian logic occurs in the Mona *Use of English* syllabus. Logic is notably not offered within the unit of Philosophy. Back to text.

7. One might notice here a study by Williams-Weekes (Williams, 1986) that involved the thorough teaching of elementary formal logic in conjunction with 'A' level mathematics to a small rural Jamaican group; performance in logic bore no significant relationship to performance in the mathematics questions. This is hardly surprising when one looks at the techniques required for the mathematics problems. Hamilton (1981) also reports a lack of relationship between "abstract" reasoning scores and A-level performance in a variety of subjects. At a much lower academic level, however, Douglas-Smith (1987) did find reasonable correlations between logical performance and

achievement on a test of "scientific" reasoning. We come here upon the general question of transferability. Instead of continuing to try to make the esoteric procedures of school specialities more widely applicable one might concede their uselessness and urge their (partial) replacement by subjects more clearly of general applicability, such as logic (v. Gibson, 1986, for this argument directed against school mathematics in particular; see Brandon, 1985, for some of the difficulties that might be involved in this otherwise laudable proposal). Back to text.

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