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ABSTRACT

The results of studies that examined the logical reasoning of secondary students in Jamaica are analyzed. A logical reasoning test was administered to 205 Jamaican students in grades 7, 9, and 11. Also analyzed were data collected using the same instrument on three other groups of Jamaican students in grades 7, 8, 9, and 10. As expected, test performance was not very good. Students did show some improvement in logical reasoning from grade to grade. No significant sex differences were found in overall reasoning ability. Nor were correlations found between reasoning ability and academic achievement. However, clear differences were found between educational strata within the school, e.g., science was found to encourage a critical spirit. The Jamaican students scored much lower than a group of U.S. students taking the same test. Reasons for the noticeable differences in level of performance may be due to a number of factors, including lack of resources in Jamaican schools and the inadequate knowledge and skills of many teachers, especially at the elementary level. Some important facts that teachers need to be taught about logical reasoning are suggested. (RM)

CONDITIONAL REASONING IN JAMAICA

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CONDITIONAL REASONING IN JAMAICA

This paper reports the initial stages of a project to study logical reasoning in Jamaica and some other English-speaking Caribbean islands. So far the attempt to establish bench-marks for such reasoning competence in Jamaica has involved a study of 205 children by Nolan, which is the core of the findings reported here. Brandon has subsequently collected data using the same instrument on three other groups of Jamaican school children.[1] Work is afoot to extend the data base both in terms of groups of respondents and also in terms of different reasoning tests. Some work has also been done to study less formal aspects of critical reasoning among teachers in Jamaican schools. It is hoped that at some point these two research programmes will come together in the production of materials for improving the competencies both of teachers and of their pupils.

I

It may help in understanding the results and discussion to have a brief sketch of the Jamaican school system. Very roughly, the possible educational careers of Jamaican children fall into one of two forms: permanent primary-type schooling in what are known as All-Age schools, or a sequence of primary schooling followed by some kind of secondary schooling. Approximately 47% of grade 7 (age 12) pupils are in All-Age schools (figures in this paragraph are taken from UNESCO, 1983). Pupils who move on from primary schooling (either in Primary schools or in the primary segment of All-Age schools) go either to academically oriented High schools (17% of grade 7 enrolments in 1980/81), New Secondary

schools (31%), or mostly at grade 8 or 9, to a small number of Technical High schools (3.5% of grade 9 enrolment in 1980/81). The picture is further complicated by the existence of a few Comprehensive High schools (taking 2%) in which High school and New Secondary school curricula are offered under one umbrella. Transition from primary schooling to these forms of secondary schooling depends either on geographical location, in the case of the New Secondary schools, or on the passing of a variety of examinations, most importantly the Common Entrance Examination for entry to High school. This examination is taken in grade 6 by around 40,000 children, only about 24% of whom are able to enter a High school. In addition to this fairly diverse government sponsored school system, there are several private schools, at both the primary and secondary levels.

Jamaican society is of considerable complexity, its very unequal class structure reinforced by a racial or colour stratification. Numerically the vast majority is black, negro, and poor (per capita national disposable income in 1981 was J$2,146, which at the then exchange rate amounts to US$1,206).[2] But economic and social power is shared between a sizeable, brown, creole community (now with a large influx of blacks, what Miller (1976) called the emerging middle class) and small groups of Chinese, Lebanese, and whites. Since we have not yet tried to look at the impact of these social variables on logical reasoning, we shall not pursue these matters now (interesting discussions can be found in Brathwaite, 1974; and Stone, 1980), except to note the linguistic state of Jamaica. The official language is English, but it would be more honest and pedagogically more fruitful (cf. Craig, 1980) to acknowledge that English is a second language for almost every native Jamaican, their first language being some variety or varieties of Jamaican creole. The

lexicon of this creole is predominantly English, but its syntax, even in those varieties that appear close to standard English, is very different. Unfortunately, many people continue to think that creole is a degenerate form of English, so they do not take a realistic approach to the teaching of the official language, in either its spoken or written forms. The use, or misuse, of a language known properly neither to teacher nor to taught, is but one more of the many disadvantages under which the Jamaican school system labours.

II

The main data to be reported come from a study undertaken by Nolan in September, 1983, using a slightly modified form of the Cornell Conditional Reasoning Test, Form X (Ennis, Gardiner, Guzzetta, Morrow, Paulus, Ringel, 1964). This test is fully described in Ennis and Paulus (1965) and summarized in Nolan (1984). It consists of 72 questions testing 12 different patterns of inference involving conditional statements and employing three different kinds of content. Each question gives the respondent some information, for instance, "Suppose you know that if all birds fly then all birds have wings", and then asks "Would it be true that if all birds have wings then all birds fly?" The respondent is given a choice of three answers: Yes, No, and Maybe. A "Yes" or a "No" is appropriate when the argument is valid; "Maybe" when, as in this example, the argument is invalid.

The 12 patterns of inference tested are listed in Table 1 with the mnemonics we have used. There are six questions, or items, testing each principle. Four of these items use "concrete familiar" content,

Table 1

Logical Principles and Basic Pattern of Inference

	Mnemonic	Pattern of Inference	Logical Status
1.	OMODTOLL	p only if q, not q, therefore, not p.	Valid
2.	OMODPON	p only if q, p, therefore, q.	Valid
3.	MODPON	if p then q, p, therefore, q.	Valid
4.	MODTOLL	if p then q, not q, therefore, not p.	Valid
5.	FULLTRAN	if p then q, if q then r, therefore, if p then r.	Valid
6.	PARTTRAN	if p then q, p, if q then r, therefore, r.	Valid
7.	CONTRA	if p then q, therefore, if not q then not p.	Valid
8.	BICOND	p if and only if q, not p, therefore, not q.	Valid
9.	DENYANT	if p then q, not p, therefore, not q.	Invalid
10.	CONVERSE	if p then q, therefore, if q then p.	Invalid
11.	AFFCON	if p then q, q, therefore, p.	Invalid
12.	OAFFCON	if p then q, p, r only if q, therefore, r.	Invalid

where the component claims are not implausible but are not known to be true or false (for instance, "The bicycle in the garage is Bob's"). One item employs schematic letters (e.g., "There is an X") and its content will be called symbolic. The one remaining item uses suggestive material: some of the claims made are known to be false or preposterous and this falsity cuts across the correct judgment of validity (so the correct answer to the question, "Would it be true that whales can't fly?", is "Maybe" in an item in which one component sentence is "Whales are birds"). Suggestive content is intended to test the crucial ability to distinguish questions of the truth or falsity of the premises or conclusion of an argument from the question whether the argument itself is valid or invalid.

Following Ennis and Paulus, the sufficient condition for mastery of a logical principle is to get at least five of the six items correct; a necessary condition is to get four of the items correct. This amounts to saying that persons who only get three or less items correct have failed to master the principle in question, while those who get four items correct are on the borderline between mastery and lack of mastery.

The only change made to the test was the provision of separate answer sheets, so that question books could be re-used. We have no reason to think that this change has materially affected the results. It was decided not to "Jamaicanize" the test, but in fact there would have been very little to alter. The concrete familiar material should be familiar to Jamaican children in virtually every instance.

Nolan administered the test to 205 pupils drawn from grades 7, 9, and 11 of Rusea's Comprehensive School in Lucea. Lucea is a small,

very attractive sea-side town, the capital of the parish of Hanover. It has recently acquired some small manufacturing industry, but we suspect that the majority of the pupils come from more traditional farming or fishing backgrounds. Despite its scenic beauty and its position between Montego Bay and Negril, Lucea is still virtually untouched by the tourist trade. Rusea's school is a newly established comprehensive school, created by the yoking together of an old-established high school with the local new secondary school. It is the only secondary school in Lucea, and the only place with high school facilities in the parish. Nolan took two forms from grades 7 and 9 - the top forms, 7^1 and 9^1, which contain pupils who had passed the Common Entrance Examination, and an average stream, 7^5 and 9^5, which contains pupils who did not pass that examination and would be typical of the higher forms of a normal new secondary school. In grade 11, students are grouped by specialization. Nolan took the top groups in the Science, Arts, and Vocational areas. The first two of these contain pupils who had passed the Common Entrance; the Vocational group again represents the normal new secondary school pupil.

The other three Jamaican groups for which data are available are (i) 61 boys from two good grade 10 forms at Wolmer's Boys School, a high school in Kingston, the capital of Jamaica; (ii) 85 children from the top stream of grades 7, 8, and 9 of the All-Age school in Chapleton, a rural township and (iii) 40 pupils from grades 7 and 9 of Hillel Secondary school, a private and very well-endowed school in Kingston. (Some figures will be based on a total sample of 420: the 391 Jamaicans mentioned already plus 29 students tested in Trinidad, 20 of whom are at schools for the hearing-impaired.) Table 2 lists

Table 2

Basic Data on Groups Tested

Group	n	Mean Age (in months)	SD	Mean Total Score	SD
Rusea's					
Form 7[1]	31	148	6.6	35.7	10.5
Male	11	150	5.3	34.2	9.9
Female	20	147	7.1	36.5	10.9
Form 7[5]	30	151	4.0	30.8	8.5
Male	8	153	3.7	30.4	7.9
Female	22	150	4.0	31.0	8.9
Form 9[1]	31	168	9.1	47.3	10.6
Male	13	168	9.1	46.3	13.1
Female	18	169	9.2	48.1	8.7
Form 9[5]	33	175	6.7	30.1	9.0
Male	16	176	6.9	27.8	8.0
Female	17	174	6.6	32.3	9.5
Form 11S[1]	23	198	10.0	55.7	11.4
Male	10	204	7.6	55.1	12.4
Female	13	193	8.9	56.1	11.0
Form 11A[1]	32	197	9.2	48.1	10.5
Male	13	195	9.6	49.4	12.1
Female	19	199	8.9	47.2	9.4
Form 11V[1]	25	199	4.1	38.1	8.9
Male	12	199	4.1	41.7	8.5
Female	13	199	4.3	34.7	8.0
Wolmer's Boys					
Form 10[1]	28	180	7.5	52.7	10.1
Form 10[5]	33	180	6.4	49.8	10.9

Table 2 (cont.)

Group	n	Mean Age (in months)	SD	Mean Total Score	SD
Chapleton All-Age					
Form 7[1]	31	156	5.8	31.2	6.6
Male	9	156	9.2	32.2	6.1
Female	22	155	3.9	30.8	6.9
Form 8[1a]	23	165	5.3	27.1	9.9
Form 9[1]	31	176	5.3	28.4	6.6
Male	11	176	4.6	27.5	7.3
Female	20	176	5.8	28.9	6.4
Hillel					
Form 7	19	150	8.4	46.6	11.3
Male	9	150	7.8	40.2	11.3
Female	10	151	9.2	52.4	8.1
Form 9	21	171	6.4	56.9	8.6
Male	5	172	6.7	58.8	9.9
Female	16	171	6.5	56.2	8.4

[a] Only one male pupil took the test in this form so a breakdown by sex has been omitted.

basic data on the different groups, including average total scores on the test. Total scores are derived by taking the number of correct responses, subtracting half the incorrect responses (not counting questions not attempted), and then adding 27. This yields a possible range from -9 to 99.

III

As was expected on the basis of the U.S. data, performance on the logical principles is not very good. Table 3 gives the percentage meeting the criterion for mastery and the percentage failing to meet that criterion for each of the 12 principles by grade at Rusea's. (See Appendix A for difficulty and discrimination scores for each of the items used to test these principles.)

As can be seen from Table 3, there is consistent improvement in most of the principles from grade to grade, but the pattern is complex. There is, for instance, a sizeable improvement in OMODTOLL but only modest gains in BICOND which are very similar principles from a logical point of view. Throughout the grades principles vary considerably in difficulty, and the invalid arguments are much more difficult to spot for all respondents.

While the percentage of mastery differs considerably, all the groups tested reveal very similar relative orderings of the principles. This can be seen from Table 4 which gives the percentage mastery and lack of mastery for the principles for most of the other groups tested. As we shall see later, a similar range of achievement levels can be found in the Rusea's data once one distinguishes between the academic or

Table 3

Percentage Mastery and Lack of Mastery of Logical Principles, by Grade, at Rusea's

Principle	Percentage Mastery Grade 7	Percentage Mastery Grade 9	Percentage Mastery Grade 11	Percentage Lack of Mastery Grade 7	Percentage Lack of Mastery Grade 9	Percentage Lack of Mastery Grade 11
1. OMODTOLL	20	37	62	57	41	17
2. OMODPON	28	30	42	54	41	29
3. MODPON	28	45	34	61	34	32
4. MODTOLL	8	22	27	77	58	52
5. FULLTRAN	15	33	33	70	50	45
6. PARTTRAN	20	22	38	69	59	49
7. CONTRA	6	23	27	79	62	55
8. BICOND	15	20	27	69	67	44
9. DENYANT	3	3	6	90	94	80
10. CONVERSE	2	6	6	97	91	80
11. AFFCON	2	2	7	87	94	81
12. OAFFCON	2	5	9	92	94	85
n =	61	64	80			

Note. Percentages have been rounded to nearest digit. The two percentages for each grade do not usually sum to 100 since neither includes respondents on the borderline between mastery and non-mastery.

Table 4

Percentage Mastery and Lack of Mastery

of Logical Principles, Other Jamaican Groups

Principle	Percentage Mastery Group				Percentage Lack of Mastery Group			
	Chapleton	Hillel 7	Hillel 9	Wolmer's	Chapleton	Hillel 7	Hillel 9	Wolmer's
1. OMODTOLL	7	47	86	67	73	16	-	13
2. OMODPON	16	58	81	51	73	16	5	21
3. MODPON	12	37	86	51	67	37	-	36
4. MODTOLL	5	26	71	33	88	53	19	36
5. FULLTRAN	4	42	67	49	89	42	14	28
6. PARTTRAN	7	42	71	46	87	37	14	33
7. CONTRA	5	47	43	33	91	37	33	47
8. BICOND	1	42	67	21	92	37	14	36
9. DENYANT	-	-	5	5	89	100	86	80
10. CONVERSE	4	-	5	7	84	100	95	85
11. AFFCON	-	-	5	5	95	100	86	75
12. OAFFCON	4	-	-	-	85	100	95	92
n =	85	19	21	61	85	19	21	61

Common Entrance stream and the non-academic new secondary type stream. But since our first aim was to get a picture of a typical grade level performance, we shall continue to look at the Rusea's results by grade in the next few paragraphs.

Hoping to replicate the U.S. study as closely as we were able, we looked at the correlation between total score on the test and age, sex, and academic achievement. Taking age first, overall at Rusea's, r (204) = .33, p = .001. This, though significant, is not a particularly high correlation, reflecting the considerable range of scores in the different groups. It is quite considerably lower than that reported by Ennis and Paulus (1965, p.IV-28) for a subset of their sample, r (63) = .58. Within each grade, correlations are smaller but negative: for grade 7, r (60) = -.197, not significant; for grade 9, r (63) = -.286, p = .011; and for grade 11, r (79) = -.267, p = .008. None of these grade correlations is very impressive, though they are stronger than in the U.S. study. They may reflect delayed entry to school or the various possibilities for repeating years or examinations that exist in Jamaica.

As in the U.S. study, no significant correlation emerged between total score and sex. As can be seen from Table 2, boys and girls scored virtually the same in all groups. The overall correlation at Rusea's was r (204) = -.011, which given the coding, male =1, female = 2, indicates a slight male advantage; but that is in fact more the exception than the rule. In most groups the girls scored slightly higher than the boys, though in only one case have we stumbled upon a statistically significant difference: in Hillel, grade 7, r (18) = .552, p = .007. The very general equality between the sexes is perhaps a

little surprising in Jamaica since it is well known that girls continually out-perform boys throughout the educational system.

While overall no sex difference in reasoning ability emerges, there is one phenomenon of some interest that might warrant further investigation. The whole sample of 420 has been divided into four ranks (the top rank with a total score of 51 and above; the second rank from 41 up to 51; the third rank from 31 up to 41; and the bottom rank below 31). If one then groups together the valid patterns of argument there are absolutely no sex differences of any interest, and there is a smooth transition from an average score of 37.9 (SD = 5.055) for the top rank (out of a possible 48) to an average of 15.9 (SD = 4.755) for the bottom. These two very roughly formed groups number 120 and 127, respectively. But when one looks at the group of invalid principles (likewise now scored out of 48), not only are there no significant differences between the ranks but in fact the first and second rank girls, and the second rank boys, get worse scores than the bottom two ranks. The figures are given in Table 5. They testify very powerfully to our respondents' utter inability to recognize invalid patterns of argument, and perhaps to the over-confidence of the brighter students. While the differences between boys and girls in the top rank are barely significant (F (1, 118) = 5.76, p <.05, for what little it may be worth), they may point to an interesting, if subtle, difference in the socialization of academically superior boys and girls.

Unfortunately we have not been able to obtain data on the general intelligence of the pupils tested. They were chosen so as to be fairly typical of students in secondary education in Jamaica, but we

Table 5

Average Scores on Invalid Principles,

by Achievement Ranks and Sex

Groups	n	Mean Score	SD
Top Rank	120	13.3	9.7
Male	65	15.3	8.9
Female	55	11.0	10.1
Second Rank	80	9.7	7.6
Male	40	10.4	8.2
Female	40	8.9	7.0
Third Rank	93	13.2	8.5
Male	39	12.2	8.1
Female	54	13.9	8.8
Bottom Rank	127	11.9	7.7
Male	49	11.5	8.9
Female	78	12.1	6.9

cannot demonstrate that they are. Instead of looking at the correlation between the logical reasoning scores and some other measures of intelligence, Nolan obtained school grades in English, Mathematics, and Biology for all the Rusea's students. Many different things can be tested in school examinations in those subjects, and we have found virtually no correlations of any size between scores on the conditional reasoning test and these grades. Since we have no doubt that the test tests some aspects of logical reasoning, we are inclined to conclude that such aspects of reasoning are peripheral to whatever the school is seeking in the subjects chosen.

While we are then unable to report correlations with the other measures of academic ability, we are in a position to report on the very clear differences between educational strata within the school. As noted above, Nolan took forms from the top academic stream and other forms corresponding to the more vocationally oriented new secondary school stratum. In Rusea's, the academic stream diverges in grade 11 into a Science and Arts group. Whatever aspect of the data one examines, this bifurcation between academic and vocational is extremely pronounced. Most of the improvements registered in Tables 2 and 3 are due to the academic stream. Thus, if one looks at mean total score, in the academic stratum it moves from 35.7 (SD = 10.5) in grade 7, through 47.3 (SD = 10.6) in grade 9, to 48.1 (SD = 10.5) in grade 11 Arts and 55.7 (SD = 11.4) in grade 11 Science. On the other hand, the non-academic groups virtually stand still, although they enter not far below the Common Entrance passes. In grade 7, mean total score is 30.8 (SD = 8.5), in grade 9 it is still 30.1 (SD = 9.0), and it ends up in grade 11 Vocational at 38.1 (SD = 8.9), scarcely above the grade 7 academic stream:

not much for five years of secondary schooling.

Tables 6 and 7 give a more detailed breakdown of these developments by giving percentage mastery and lack of mastery of the 12 logical principles by forms at Rusea's. The figures should be compared with the figures in Table 4, in which the groups are known not to be representative of their grade levels. The stagnation of the non-academic groups is visible also in the Chapleton figures in Table 2, and is the reason why all grades were combined for Chapleton in Table 4. In fact at Chapleton, the grade 7 had a slight edge over the others, possibly because it still contained a few pupils who could stand a chance at a second competition for entry to some sort of secondary schooling.

It is also notable that at Rusea's both the grade 11 academic forms seem, in some cases at least, to have regressed from the levels of performance exhibited by the academic grade 9 form. We do not have a clear explanation for this tendency. To some extent, grade 9 pupils may be close to peak academic commitment, before the distractions of adolescence affect them markedly. For these particular students, there is also the fact that the creation of the combined school was not an uncontroversial matter, so that the grade 11 pupils may well have had more distractions than normal. It may also be that motivation to succeed academically is pretty small in what is a comparatively underdeveloped community and parish. But it is worth noting on the other hand that the Science group produced the highest percentages for mastery of the invalid argument principles of any of the groups tested. Perhaps the teaching of science does encourage a critical spirit.

Besides the 12 patterns of argument, the test also examined the

Table 6

Percentage Mastery of Logical Principles

at Rusea's, by Forms

Principle	Stratum: Academic 7^1	9^1	11A	11S	Non-academic 7^5	9^5	11V
1. ONODTOLL	32	58	66	83	7	18	40
2. ONODPON	35	55	41	56	20	6	32
3. NODPON	29	61	28	43	27	30	32
4. NODTOLL	12	32	31	22	3	12	28
5. FULLTRAN	13	48	34	48	17	18	16
6. PARTTRAN	19	35	47	56	20	9	8
7. CONTRA	13	42	28	30	-	6	24
8. BICOND	19	32	37	30	10	9	12
9. DENYA.A	3	-	3	17	3	6	-
10. CONVERSE	3	6	9	8	-	6	-
11. AFFCON	3	3	3	22	-	-	-
12. OAFFCON	3	6	6	22	-	3	-

Table 7

Percentage Lack of Mastery of Logical

Principles at Rusea's, by Forms

Principle	Stratum: Academic 7^1	9^1	11A	11S	Non-academic 7^5	9^5	11V
1. OMODTOLL	46	19	12	4	70	60	36
2. OMODPON	52	13	22	17	57	67	48
3. MODPON	58	23	31	35	63	45	32
4. MODTOLL	65	32	44	52	89	82	64
5. FULTRAN	71	26	41	26	70	73	68
6. PARTRAN	71	42	47	22	67	76	76
7. CONTRA	81	45	47	52	77	79	68
8. BICOND	52	52	38	35	87	82	60
9. DENYANT	87	93	91	65	93	94	80
10. CONVERSE	94	94	78	65	100	88	96
11. AFFCON	84	87	81	61	90	100	100
12. CAFFCON	87	90	84	74	97	97	96
n =	31	31	32	23	30	33	25

ability to handle three different sorts of content. Expressing all scores out of 12, Table 8 gives the mean scores on the three types of content for each of the grades. While it cannot be said that any group can reliably handle the contrast between validity of argument and truth or falsity of the statements in the argument, by grade 9 students are handling suggestive content as well, or as badly, as concrete familiar content, a finding that can be confirmed by reference to the difficulty and discrimination scores for each item in Appendix A. On the other hand, in grade 7 suggestive content is significantly more difficult; compared with symbolic content, correlated t (60) = 3.07, p = .003. By contrast, in grade 9 the greatest gain has been made with symbolic content, which is now significantly easier than the other two; compared with suggestive content, correlated t (63) = 2.44, p = .018.

IV

However one looks at the Rusea's data, it is clear that the Jamaican students are not performing as well on the conditional reasoning test as the U.S. group. This is very striking if one looks at the overall performance by grade, but it remains true when one concentrates on the academic stream. Tables 3, 6 and 7 should be compared with Table 9, which records the percentage mastery and lack of mastery of the U.S. group on each of the principles.

A similar picture emerges if one compares the overall mean difficulty of the test. At Rusea's, in grade 7 this is 38.9; in grade 9, 43.2; and in grade 11, 51.2. In the U.S., grade 5 showed a mean difficulty score of 47.5; grade 7, 55.8; grade 9, 54.6; and grade 11, 61.5

Table 8

Mean Scores on the Three Types of Content,

by Grade at Rusea's

	Grades					
	7		9		11	
Type of Content	Mean	SD	Mean	SD	Mean	SD
Concrete Familiar	4.82	1.02	5.07	1.47	6.24	1.36
Symbolic	4.80	1.71	5.69	2.01	6.10	1.83
Suggestive	3.93	2.23	5.03	2.34	5.94	2.35

Note. All scores are out of 12.

Table 9

Percentage Mastery and Lack of Mastery of Logical Principles, by Grade, in U.S.

	Percentage Mastery				Percentage Lack of Mastery			
	Grade				Grade			
	5	7	9	11	5	7	9	11
Mean Age[a]	129	153	184	203	129	153	184	203
1. CMODTOLL	46	63	70	79	31	20	13	9
2. CMODPON	53	63	69	81	26	17	23	5
3. MODPON	51	56	66	62	30	26	21	22
4. MODTOLL	30	41	35	35	54	36	41	40
5. FULLTRAN	25	45	40	58	48	38	35	22
6. PARTTRAN	26	52	53	58	54	30	34	23
7. CONTRA	34	40	35	33	51	36	45	47
8. BICOND	23	40	46	40	51	37	33	36
9. DENYANT	3	6	5	12	92	80	90	73
10. CONVERSE	2	5	11	19	94	84	80	68
11. AFFCON	2	3	4	3	94	92	89	85
12. OAFFCON	4	4	1	0	86	91	93	95
n =	102	99	80	78				

Note. Data are taken from Ennis and Paulus (1965), p. V-16 and p. V-18.

a. In months.

(Ennis and Paulus, 1965, p.IV-30). Yet again, one can compare mean total scores for the grades. At Rusea's, in grade 7, mean total score is 33.3; in grade 9, 38.4; and in grade 11, 47.2. In the U.S., grade 5 gives 42.4; grade 7, 51.7; grade 9, 55.3; and grade 11, 56.6 (ibid., p.V-16). Both these sets of figures suggest that the U.S. respondents reach a fairly flat plateau by grade 7, although there are some improvements as Table 9 shows. The Rusea's students, on the other hand, are changing rather more rapidly (at least the ones in the academic stream) and considerably narrow the gap that originally separates them from very roughly comparable U.S. grades.

While there is a clear gap between the levels of achievement in the two countries, there are many respects in which the relative picture of logical competencies is very similar. Much could be gleaned from a close comparison of the data presented by Ennis and Paulus (1965) and that presented here; we shall only note a few points now. In both countries the relative difficulty of the 12 principles is similar. The two simple principles using "only if", OMODTOLL and OMODPON, are the simplest, followed by detachment and the two transitivity principles, MODPON, FULLTRAN, and PARTTRAN; the most difficult group of valid argument patterns is BICOND, MODTOLL, and CONTRA. All of these valid patterns are much easier than the four invalid arguments. In Jamaica it is noteworthy that it is only in grade 11 that the invalid principle items begin in general to discriminate positively (see Appendix A).

Again, in both countries we find that suggestive content starts off more difficult but soon becomes as easy as any other material. There are also many close similarities in the relative difficulty and discrimin-

ation of items within the different item-groups, which it would be tedious to enumerate now, but which give us strong reason to believe that our Jamaican students were responding in similar ways to the same problems.

More to the educational point, however, is to ask for an explanation of the very noticeable differences in level of performance. This is the more pertinent since we think the differences are symptomatic of a very important contrast. It is well known that schools in Jamaica lack many of the facilities, books, electronic gadgets, etc., etc., that are now taken for granted in developed countries. It is also well known that the general grasp of subject matter on the part of teachers in Jamaican schools is far from ideal - we have already adverted to the problem caused by an inadequate understanding of the intricacies of the language in which instruction is meant to proceed. These varied inadequacies contribute to the explanation of the generally low standard of Jamaican entrants in international examinations, the G.C.E. and C.X.C. examinations in particular. But while a lack of content is no doubt deplorable, it is also something that is usually easily remediable. But one of the educational paradoxes surrounding reasoning is that, while many people laud critical reasoning prowess and try to defend the most diverse curricula in terms of helping pupils to think better, in fact very little attention is ever paid explicitly to reasoning and to how to improve it. A grasp of logical relations is something that is most definitely "caught" rather than "taught" for the vast majority. Students' competence in such matters is, then, an indirect but, fairly important measure of the general intellectual quality of their schooling and social context. It is for this reason that we believe our results are of considerable importance for educational planning in Jamaica. They

suggest that the lack of facilities and the inadequate knowledge and skill of many teachers are damaging, not only in the obvious areas of facts and knowledge of theories or practice, but also in as much as they perpetuate an intellectually immature ambience. Many have complained of the deadening experiences of rote learning in the primary school (for a recent sociological survey in Chile, see Filp, Cardemil, Donoso, Torres, Diéguez, and Schiefelbein, 1981; for material directly relevant to reasoning, see Hansen and Pearson (1983)); what we see in the performance of our grade 7 students, and in the whole last phase of the All-Age school, is part of the intellectual cost of this educational neglect.

The most we can say on the basis of the Rusea's data is that the Jamaican school system can still deliver the goods for that very small percentage of secondary pupils it channels into the academic stratum. As we have noted, these forms end up very close to U.S. levels of performance, after they have had four or five years of "beating book" in secondary school to combat whatever primary school may have done to them (the local phrase reveals perhaps a very great deal of the real social meaning of schooling in Jamaica). Since we are putting most of the blame on the Jamaican primary schools, it might be worth adding that the extraordinarily high scores found at Hillel may be due, in considerable measure, to the fact that most of the pupils have gone through Hillel's own very efficient, U.S.-style, primary school. To go to either institution, pupils need to come from backgrounds wealthy enough to provide a great deal of other intellectual stimulation, but we think that the kind of teaching in primary school counts for much as well. Jamaican parents are often prepared to pay a lot of money in the same belief.

One important aspect of educational failure in Jamaica relates to language, as we noted earlier. For the pupils who did fairly well on the test, language appears not to have made much of a difference. Everything they do in school, all the books they read are in English, so one would not perhaps expect much difference here. What we are at present unable to say is what effect the language of the test has on the academically weaker students. It is planned to translate a simpler and shorter reasoning test into Jamaican creole and to try to estimate if there are any significant differences in performance on the two versions of the test, but that is a task for the future. It is also a task which is not warmly welcomed by many teachers.

One obvious implication of the results is then to reinforce the many calls for all-round improvement in the quality of Jamaican schooling, especially at the primary and non-academic levels (though one should not be too sanguine about the academic either). But in terms of more detailed implications for the teaching of reasoning it is unfortunately still too early to offer much more than hunches. Our explorations in the data have raised one serious question regarding the conceptual framework Ennis and Paulus used. One way of putting the issue is to say that the scoring system, and indeed the whole test, allows one to discover whether someone can obey a rule, whether the person knows what counts as obedience to the rule. They also allow one to judge that someone does not know what counts as obedience to that rule. But if grasping a rule of logic is much like grasping a concept, one might want to insist also that we be able to judge that someone knows when the rule is broken or misapplied. Does it really show much of a grasp of modus ponens (MODPON) if one thinks it equally good as affirming the consequent (AFFCON)?

Another way of putting our point might be to say that it may be premature for empirical investigations of logical reasoning to think continually in terms of logical rules. For persons who have studied logic, the rules often function as "target forms", to borrow Kielkopf's recent label (1984, p.21). They are a codification with which one compares actual arguments; evaluating an argument is not thinking it through according to some set of logical rules but it is rather a matter of holding it up against a formal skeleton. No doubt there are some rules for doing that, but those rules, the ones logicians follow in evaluating arguments, need have nothing much to do with the paradigms of logical reasoning by appeal to which judgments are made. Ordinary people, on the other hand, do not usually have the logician's codifications to hand, and so there is very little reason to expect that their own judgments of what follows or does not follow will neatly mirror the laws of logic. Nor perhaps, though here one is in danger of entering a trackless waste of argument, for thinking of what they do as the following of any rules, at least rules that look anything like the laws of logic.

Perhaps we may illustrate the kind of point we are making on the basis of some very tentative work we have been doing with the reasoning data. In one exploratory factor analysis of the results on the 12 principles for the top rank students, the first factor extracted (by oblique rotation, otherwise using the SPSS default options) seems to involve a very general kind of conversion and inversion and their associated detachment rules. Roughly the "rule" seems to sanction moves from <u>if p then q</u> to <u>if not q then not p</u> (it loads highly on CONTRA) or to <u>if q then p</u> (it loads highly on low scores on CONVERSE) or to <u>if not p then not q</u> (a move that is not tested for) and with the addition of <u>q</u>

the conclusion p (it loads highly on low scores for AFFCON) or with the addition of not p, the conclusion not q (it loads highly on low scores on DENYANT). The factor also loads highly on BICOND but not on either form of modus tollens. Ordinary, valid, detachment (found in MODPON, FULLTRAN, and PARTTRAN) crops up in the second factor. We do not wish to place any weight upon this particular result, but it illustrates the kind of "rule" that may well be operative, and it suggests why some students may do very well on the valid principles while failing utterly on the invalid ones (cf. Hillel grade 9 in Table 4). It is probable that the tactics needed to pick out invalidity are very different from the inferential procedures used to arrive at conclusions.

The distorting effect of logician's targets can also be illustrated by a contrast between the results on OMODTOLL and OMODPON, both in Jamaica and the U.S., and Ennis' recent reflections on the complexity of only (1981, p.367). The empirical data reveal that at least some uses of only if are considerably easier than their logical analogues with if (which hardly fits well with the common claim that in ordinary people's usage if incorporates only if) whereas Ennis reports that the word only makes life more difficult for him. We agree with him. But we suspect there is a widespread tendency among students of logic not to think in terms of only: when faced with a premise like p only if q, one translates it first into if p then q before evaluating the argument, because the targets are not usually stated in terms of only if. Ordinary people who do not use the targets may find only if easier because it is, or feels, more restrictive, it seems to leave fewer possibilities open. They certainly seem not to use the translation strategy: the same exploratory factor analysis leaves OMODTOLL and OMODPON out in the cold.

One of the most pervasive components that definitely seems to make for complexity is negation. But, as Ennis says, the evidence is mixed. One way in which the extra complexity of negation appears in the test is in the form of the questions asked each time. Usually the form is "Then would this be true? p". In some cases, however, the form is "Then would this be true? Not p". (We have marked such items with a "?" in Appendix A.) The most striking case where this appears to make a difference is in PARTTRAN, where in Jamaica and the U.S. item 62 is markedly less difficult than the others. In Jamaica, the one negative question in OMODTOLL also seems consistently harder, as also for grade 7 and 9 in BICOND, but these cases are not found in the U.S. data, nor do negative questions seem noteworthy in the case of the other principles.

There is another set of items in which a possible effect of gratuitous negation is confounded with a possible effect of presenting the premises in a non-standard order (these items are the fourth in each item group in Appendix A). Here the antecedent of one conditional premise is a negated proposition and the premises are presented out of standard logic book order, if that is possible (so that, for example, the form of item 14 is not p, if not p then q, therefore q). In both Jamaica and the U.S. these items were often more difficult or at least anomalous in discriminating power. Thus in both countries, OMODTOLL, OMODPON, MODTOLL, and BICOND showed this result; in Jamaica, MODPON (not so clearly), and in the U.S., PARTTRAN also. Neither group showed any difference here on FULLTRAN or CONTRA. It is not so obvious with the invalid principles but there are signs of an effect in both groups on CONVERSE and AFFCON. If we can carry over Roberge's (1970) finding that reversing the order of premises in a two premise argument makes no

difference (and after all, non-standard order is non-standard only for the readers of logic books), these results presumably reflect another effect of a lot of negations in an argument.

Such a finding would suggest the importance of stressing abstract logical form, so that students recognize that as far as validity goes there is absolutely no difference between if p then q, p, therefore q and if (not p or r) then not q, not p or r, therefore not q. But obviously the major pedagogical recommendation coming out of the results is the general one to find ways of making students appreciate when an argument is invalid. Constructing counter-examples is an imaginative exercise, often easiest with rather fanciful claims, so it is perhaps not surprising that it is not the sort of thing that sober and rigid schooling encourages. But the evidence is overwhelming that it is the sort of skill that is most lacking, not only in school children but in the population at large. And it is arguable that it is a serious lack: not realizing that a conclusion validly follows from some premises may prevent one exploiting one's information to the full, but it isn't yet to fall from truth into error (we have not yet analyzed the kinds of error students make on the reasoning test so this claim is somewhat tentative). But thinking that one's information does entail a conclusion that in fact does not follow puts one seriously at risk of such a fall from grace. Of course one can construct catastrophic scenarios for the case of not realizing the genuine consequences of a valid argument pattern, but we suspect that on balance it is more damaging to over-invest in apparently safe conclusions than to refuse some real pearls.

We have suggested that certain points are indicated for the

promotion of the teaching of logical reasoning. But it is worth noting part of the probable reason for the educational paradox referred to above. While teachers believe in the importance of reasoning, they are in fact on a level with their pupils when it comes to dealing with arguments in general. Very few teachers have ever studied reasoning formally, so they have no more direct access to the logician's targets than their pupils. In addition, once one remembers the tremendous difficulties of translation between the aseptic formalism of logic and the complexities of ordinary language, even the trained logician has to acknowledge a margin of possible error in his evaluations and descriptions of actual arguments. For both these reasons, then, reasoning, either formal or comparatively informal, is not a subject at which school teachers can claim expertise and so one finds not only the neglect already mentioned, but often a violent antagonism to actually trying to tackle questions of argument directly. For these reasons, one should be wary of expecting too much from such expressions of commitment and willingness as one may find for reasoning and critical thinking in the classroom.

V

By way of conclusion, we shall briefly indicate some of the lines of research we hope to pursue. As already mentioned, it is hoped to examine the effects, if any, of English versus Jamaican creole on logical reasoning competence. It is also hoped to take up some of the many loose ends in the study of actual reasoning, some few of which we have briefly mentioned already: the effects of negation; the effects of order of premises; the relation of inversion to denying the antecedent (cf. Fillenbaum, 1978); the relation of a conditional to what

Mackie called its "contrary conditional" (1973, p.109: if p then q and if p then not q); etc. And it is also hoped to get similar base-line data on Jamaican students' abilities with other kinds of inference: class-logic, and some other sentential operators.

This work is being conducted on students (school or Teachers' College, for the most part) because it is much easier to get them to take often tiresome tests. As already indicated, we would not expect their teachers to perform very differently, and work is in progress to check on this hunch, although not with purely formal material. So far, we have tried using one of the Illinois Thinking Project's informal reasoning tests (Ennis and Weir, 1983) on the teachers who have enrolled at U.W.I., Mona, in the current academic year. Preliminary results are not very impressive, reflecting minimal skills in picking out and criticizing bad reasoning.

Since we still believe that an appropriate introduction to formal matters can contribute much to a person's battery of argument evaluation strategies, it is hoped that the suggestions coming out of the formal reasoning tests will play a part in our future attempts to find ways of upgrading the general critical reasoning competence of Caribbean teachers.

FOOTNOTES

[1] The authors wish to thank the pupils, teachers, and principals through whose co-operation the data has been assembled, and in particular Professor R. H. Ennis for his interest and generosity in making available the test we have used and various other material from the Illinois Thinking Project. We hope that this partial replication of his early work will be of some use to the Project. We should also like to thank Graham Webb, Ian Isaacs, and the staff of the U.W.I., Mona, computer centre for varied assistance in the analysis of the findings. None of these persons is in any way responsible for what we have made of them or for any of the other comments we have made in the paper.

[2] Figures here come from Government of Jamaica (1982). We have used 1981 figures since the official exchange rate was then stable; the decline since that time makes the sense of comparative figures even more problematic than is usual. For the extreme inequality of Jamaican society, see McLure (1980), rediscovering for the early 1970s the much earlier findings of Ahiram (1964).

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Appendix A

Item and Item-Group Difficulty and Discrimination Indices by Grade

Principle Item	Difficulty Grade 7	Difficulty Grade 9	Difficulty Grade 11	Discrimination Grade 7	Discrimination Grade 9	Discrimination Grade 11
1. OMODTOLL						
12	66	77	89	20	47	25
21	77	77	94	25	31	17
42?	33	47	67	46	46	75
'25	47	31	52	46	56	24
15*	51	70	81	46	53	33
36!	46	67	80	39	57	45
mean (SD)	53 (16)	61 (18)	77 (15)	37 (12)	48 (10)	37 (21)
2. OMODPON						
10	69	67	85	38	39	16
17	57	52	57	20	14	45
20?	51	59	77	33	46	58
'33	33	25	27	-20	-9	18
38*	75	81	85	19	36	29
28!	46	69	76	82	73	41
mean (SD)	55 (15)	59 (19)	68 (22)	29 (33)	33 (28)	35 (16)
3. MODPON						
07	49	67	66	51	25	37
40	56	62	65	51	52	33
27?	52	64	69	69	42	62
'14	61	72	57	2	20	24
19*	61	80	80	57	23	25
31!	41	48	50	40	67	32
mean (SD)	53 (7)	66 (10)	65 (10)	45 (23)	38 (19)	35 (14)

Appendix A (cont.)

Principle	Difficulty Grade			Discrimination Grade		
Item	7	9	11	7	9	11
4. MODTOLL						
08	62	59	75	8	58	50
35	46	39	41	15	35	-11
29?	39	45	69	33	67	62
'16	29	34	36	4	56	35
22*	51	55	51	34	30	32
39!	33	56	64	40	57	24
mean (SD)	43 (12)	48 (10)	56 (16)	23 (15)	50 (15)	32 (25)
5. FULLTRAN						
45	36	45	52	16	35	7
55	72	73	80	0	52	16
66	34	61	60	52	62	19
'52	62	56	62	51	63	37
49*	38	48	41	-2	51	49
73!	29	50	59	65	51	54
mean (SD)	45 (17)	56 (10)	59 (13)	30 (29)	52 (10)	30 (19)
6. PARTTRAN						
43?	36	34	45	76	51	57
51?	39	59	60	46	68	62
62	61	67	72	63	47	20
'72?	38	41	54	34	18	28
67*?	43	47	58	52	62	33
76!?	59	59	64	21	25	49
mean (SD)	46 (11)	51 (13)	59 (9)	48 (20)	45 (20)	42 (17)

Appendix A (cont.)

Principle / Item	Difficulty Grade 7	Difficulty Grade 9	Difficulty Grade 11	Discrimination Grade 7	Discrimination Grade 9	Discrimination Grade 11
7. CONTRA						
46	38	44	56	58	51	36
69	33	47	54	52	73	36
74	36	42	54	10	52	19
'56	28	41	54	41	34	28
61*	44	53	49	58	57	36
50!	34	45	47	40	62	53
mean (SD)	35 (5)	45 (4)	52 (3)	43 (18)	55 (13)	36 (11)
8. EICOND						
47	54	56	62	75	46	45
54	47	52	52	39	36	15
63?	34	47	66	70	73	53
'58	13	11	35	23	22	36
78*	44	51	61	70	52	7
60!	49	61	71	70	57	41
mean (SD)	40 (15)	46 (18)	58 (13)	58 (21)	48 (18)	33 (18)
9. DENYANT						
09?	31	36	39	-14	7	-2
13?	34	25	36	-44	0	6
26?	29	31	35	-7	0	0
'18?	31	26	32	-33	-15	-7
34*?	16	16	20	-19	-5	-7
23!?	5	8	14	0	-10	14
mean (SD)	25 (11)	24 (10)	29 (10)	-20 (16)	-4 (8)	0 (8)

Appendix A (cont.)

Principle	Difficulty Grade			Discrimination Grade		
Item	7	9	11	7	9	11
10. CONVERSE						
44	16	37	29	-19	-14	27
57	25	20	41	-7	-4	40
77	16	17	32	5	-4	31
'70	18	9	24	-13	-21	0
59*	15	20	30	-7	12	14
64!	18	12	29	5	-4	35
mean (SD)	18 (3)	19 (10)	30 (6)	-6 (10)	-6 (11)	25 (15)
11. AFFCON						
11	21	22	32	-31	12	27
24	39	27	41	-42	7	10
32	34	22	49	4	12	32
'37?	25	16	22	-25	-4	0
30*	16	22	31	5	12	23
41!	11	9	19	-13	-5	22
mean (SD)	25 (11)	20 (6)	32 (11)	-17 (19)	6 (8)	19 (12)
12. OAFFCON						
48	29	20	34	-38	-15	19
53	23	14	37	-7	-4	0
71	31	23	27	0	7	-20
'68	33	28	35	-14	7	-24
65*	26	23	21	-26	0	0
75!	21	17	21	17	-20	-7
mean (SD)	27 (5)	21 (5)	29 (7)	-11 (19)	-4 (11)	-6 (15)

Appendix A (cont.)

Note. Difficulty indices are the percentages giving a correct answer to the item; the higher the index, the easier the item. Discrimination indices are arrived at by subtracting the percentage giving correct answers in the bottom 27% of the group (ranked by total score) from the percentage giving correct answers in the top 27%.

Items are listed in each item-group (principle) in an order determined by the detailed design of the test. In many cases, one item has a form of question different from the others in the item-group: items with a negative question are indicated thus: 42?. In each item-group one item has a conditional with a negated antecedent, and where possible, a non-standard order of premises; such items are indicated thus: '25. In each item-group, there is one item using symbolic content and one item using suggestive content; these are indicated 15* and 36! respectively.

All figures have been rounded to the nearest integer.