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MEDIATING MATHEMATICS:
RULES AND OTHER THINGS IN CARIBBEAN CLASSROOMS

Patricia George

School of Education, University of Leeds

This paper seeks to explore the association, if any, amongst mediational means, cultural capital, and students' approaches to mathematics in a Caribbean setting. On a macro-level, student outcomes in mathematics by school type (a crude indicator of social class) suggest that there is a link between these outcomes and social class (itself an indicator of cultural capital). Micro-level analysis via the lens of an algebra question showed some variation in how students made use of rules in attempting the question, and this along the lines of school type. It is posited that the way rules are used as mediational means in mathematics is structured in part by students' cultural capital, and that this, cultural capital, provides an explanatory model in this context for the observed differences in mathematical achievement.

INTRODUCTION

Rules mediate the doing of mathematics in that they transform and ideally facilitate problem solving activities. The mediating role of rules in mathematics was brought to the fore during student group interviews conducted as part of data collection for an ongoing PhD study. In attempting an algebra question given during these interviews, rules were seen to structure students' approaches to working the question, and to both facilitate and constrain the ways in which students went about providing a 'solution'. A more in depth analysis of the exercise seemed to suggest that there may be more going on with how different student groups made use of rules, and in particular that students were perhaps drawing on things or resources available to them outside the context of mathematics per se and these things were mediating (structuring) the ways in which they approached working the question. These *other things* may be considered a part of students' cultural capital, and as such led to the idea of cultural capital influencing the ways in which students make use of mediational means. This paper will focus on students' use of rules in their approach to the algebra question.

The literature provided some conceptions of mediation and cultural capital. For mediation in relation to a task, this has been conceived as an actor's achieving coordination with something that structures her/his behaviour in doing the task; this *something* is not necessarily a part of the task domain (Hutchins, 1997, p38). According to Bourdieu (1997, p47), the notion of cultural capital was conceived as 'a theoretical hypothesis' to explain differences in the observed academic achievement of children from different social classes by relating success in academia to the gains children in these social classes can obtain in educational markets due to how cultural capital is distributed amongst classes. In bringing out his conception of cultural capital, Bourdieu reclaimed the word 'capital', seeking to delimit the usual economic sense of its use, seeing capital as 'accumulated labor' (ibid, p46). If one then starts from the idea of 'capital' as some *thing* (resource) that can be used in educational exchanges (in this case), and 'culture' as '…the deep structures of knowing, understanding, acting and being in the world' (Ladson-Billings, 1997, p700), then cultural capital may be conceived as some *thing* continuously being built up in a person which influences how s/he knows how to *be* and becomes available to her/him for exchange or use in educational settings. Thus, in influencing students' use of mediational means, cultural capital may be seen as the *something* students coordinate with in structuring their actions in educational settings.

CONTEXT AND METHODS

The study in which the data were collected looked into what views of mathematics Caribbean students hold, what factors may be involved in forming these views, and how these views/factors may impact their approach to learning and performance in mathematics. The focus of the study arose out of continued reports within the Caribbean of students' underachieving in mathematics. Whilst various theories were posited, very little by way of systematic research-based evidence was provided to support these, and hence it was felt that such a study within the region was timely. Most of the data were collected in Antigua & Barbuda (A&B) and the main participants were students in one 4^{th} form class (Year 10) of 11 of the 13 main secondary schools there. Data were collected in four main waves, carried out in approximate order of documentary evidence, student questionnaire, observations in some classrooms (choice informed by documentary evidence), and group student interviews (student choice informed by initial analysis of questionnaire data).

RESULTS AND DISCUSSION

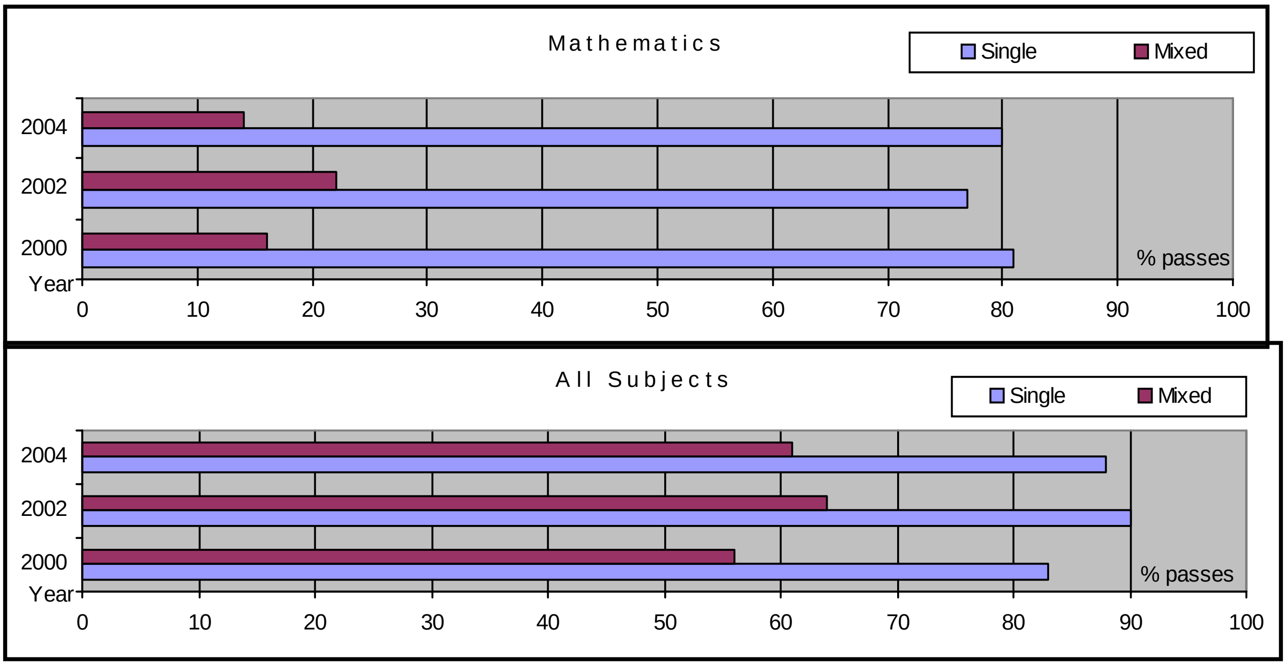
Schools in A&B can be divided into types based on whether they are private (4) or government-owned (9), single-sex (4) or mixed (9). The 11 participating schools consisted of the 4 single-sex schools (2 private and 2 government) and 7 of the 9 mixed schools (all government). For this paper, the categorization of schools as single-sex or mixed will be used as it seemed from data collected that schools in these categories were similar enough in terms of the type of student attending to allow such categorization. The following table obtained from questionnaire data provides some sense as it relates to the sample students' background in these school types:

Figure 1: Table of Sample Students' Background (numbers of respondents in brackets; only main categories given here)

Factor	*Variable*	*Mixed (177)*	*Single-sex (109)*
Adult at home	*Father & Mother*	*41%*	*66%*
	Mother	*49% (175)*	*30% (108)*
'Class' by parent occupation	*Upper*	*5%*	*30%*
	Intermediate	*32%*	*48%*
	Lower	*61% (132)*	*22% (91)*

Data from documentary analysis [1] revealed the following in terms of the previous outcomes in mathematics and across all subjects in these school types:

Figure 2: Graph of CXC CSEC [2] Exam Results by School Type, 2000-2004



There are three important points to note here: (1) between school types, there are differences in these previous outcomes for mathematics and across all subjects, but the differences as relates to mathematics are more marked; (2) within school types, whilst the outcomes for mathematics and all subjects are relatively similar for single-sex schools, there are marked differences between these for the mixed schools; and (3) the relative consistency of points (1) and (2) for the given years. In particular, it seems from these outcome data that the 'problem' of students underachieving in mathematics may be more of a problem in mixed schools than in single-sex schools. However, the 'answer' is not as much one of the gender make-up of the schools as it is one of the student types/background that attend these school types (refer to Figure 1) and what cultural capital is available to these students to exchange in school for mathematical (and educational) profit.

The Algebra Question

The following question was asked in interviews in 10 of the 11 participating schools:

> How would you do this? (In most cases, pointing to the question written on a sheet of paper): 3a + 4b – 7a + 2b. I am not interested in the answer, I just want to know how you would do it.

This was the only mathematics question asked during interviews, and the algebra context was chosen as a number of students had indicated in questionnaire data that they did not like/understand algebra, despite that question not being specifically asked. Although the question was thought to be rather innocuous, student responses revealed some differences in approach, mainly along the lines of the use of rules.

Further, these differences in approach could be categorized according to school type. The student groups arrived at a mathematically correct end in 3/4 single-sex schools and 2/6 mixed schools, and this 'result' compares somewhat to the previous outcomes in mathematics for these school types (Figure 2). The following is a sample of student responses from one of each school type (highlighted passages denote student use of a rule):

(Single-sex School, 3 boys)

B2: So 3a minus 7a… […] Plus 4b plus 2b. […] Like when you add 3a plus, no minus 7a, that's minus 4a plus 6b. […]

Int: So it's a case of doing what to the 'am… to the variables?

B1: Grouping… grouping like terms together.

(Mixed School, 1 boy and 2 girls)

G2: You like group all the like terms. […]

B: You can't add 3a and 4b and get an answer. […] You can get an answer if you 'am multiplying it. […] Because you can't add letters. […] You have 3a and you have… […] minus 7a, so you have 3a minus …

G1: No, you put the 7 first, you put…you don't bring… you don't… you carry the smaller number, you don't carry the larger number. […]

B: Yeah, that's what the teacher said. […]

G1: You see like you have 7, you carry the 3a over on that side, so you have 7a minus 3a. […]

B: Or 7a plus 3a. […]

G1: No…

B: Because it's a number without a sign is basically as positive. […]

G1: You always… if you have a positive and you going to move it on the opposite side, you always carry… you always change the signs, because it not going to be right… […]

B: Sometimes you change the signs. […]

G1: It goin' be negative 7a minus 3a. […] … positive 4b minus…

B: Because of the signs.

G1: … minus, minus, minus negative… minus 2b […]

B: Or you can, sometimes, sometimes, I would put, you have positive 4b because you already have the signs and them and you have a plus sign between the 7a and the 2b, so the 2b already has a sign, so it's gonna be positive, you don't really put the sign in front of the number because a number without a sign…

G1: You already know it's that.

B: … in front of it is positive, so you have 4b plus 2b.

A total of 9 rules could be identified in overall student responses, to include: group like terms; can't add (different) letters; carry the smaller number (let the smaller follow the larger); a number without a sign is positive; when carry (transmit, move) to the opposite side, change signs; sometimes you change signs; find what's common, and put in brackets; when moving, they carry the sign of the (larger?); try everything. In particular, students in mixed schools tended to make more use of rules and to use otherwise irrelevant and/or incorrect rules for this context. It seemed that some students in employing the use of rules were taking a mathematical hammer to the question with the hope that some *thing* would eventually be right (this interpretation supported by a student who said 'And then you go try everything' after another had said 'You group the like terms'). Students recognized the 'speciality' of the algebra context and were able to determine what 'rules' might apply, but some students seemed unable to distinguish amongst these rules to go on to determine which ones may be appropriate for the particular context, that is, they appeared to have limited access to an answering 'legitimate text' (recognition and realisation rules, from Bernstein, 1996, p32, as given in Cooper & Dunne, 2000, p48). Cooper & Dunne citing further from Bernstein noted that recognition and realisation rules can function independently of each other, and this way of working was more likely to be a characteristic of children from lower social classes. Thus, with respect to algebra (and perhaps mathematics in general), some students were aware of their relative powerless position in being able to produce the 'expected legitimate text', and so appeared to try to mathematically subdue such questions, or alternatively, surrender and do nothing. This last approach to doing mathematics was made clear during an exchange about algebra in an interview in a mixed school:

G2: […] but something just wrong with me and algebra.

Int: You don't like algebra?

G1: Neither me.

G2: It's not that I don't like it, nuh…

Int: It makes sense to you?

G1: No. E no mek no sense. […]

G3: It make sense, 'cause suppose you don't know something in the world you can use it. […]

G1: When you go work you ga have anything to do with b and a and x?

G3: So, if you're at the workplace and you don't know what something is…

G1: Ask somebody dat know. […]

G5: …sometimes e no mek no sense say me a go do it [algebra] because me nar go understand.

Interview data also showed that students in mixed appeared to have greater access to an option to fail in mathematics than students in single-sex schools based on their perceptions of their parents expectations. In responding to what they thought might be their parents' reaction to a hypothetical situation of their failing mathematics, students in mixed schools made comments such as their parents knowing that they don't like maths, so…, or their parents knowing that they usually failed, etc, and this more so than students in the single-sex schools.

CONCLUDING COMMENTS

The previous represents a synopsis of how some students, more notably those in mixed schools, knew how to *be* in relation to mathematics. It therefore does not seem improbable to conceive this *way of being* as structuring how some students approached doing mathematics in general. That is, in doing mathematics, where realisation failed, some students then appeared to be reaching beyond the confines of the mathematics content to find some way of organizing their approach to the mathematics. In doing so these students were finding coordination with how they knew to be, i.e. a part of their cultural capital, and this way of being was mediating how they approached doing mathematics. Further, that there may be some association between this way of being and the differences in the previous outcomes in mathematics by school type seems plausible, especially given the consistency of these outcomes. Thus, cultural capital as an explanatory model in this context does seem to provide some scope to account for the marked differences in student outcomes in mathematics which run along the lines of social class.

NOTES

1. Data from documentary analysis includes all 13 of the main secondary schools.

2. CXC CSEC – Caribbean Examinations Council's Secondary Examinations Certificate. These exams are taken by most students who reach the end of secondary schooling in most English-speaking Caribbean territories. The exams replaced the former GCEs in the early 1980s.

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