MULTIPLE METHODOLOGIES IN RESEARCH ON ADULTS LEARNING MATHS: RIVALRY OR COOPERATION?

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Drawing on a study of cognition and affect in the context of numerate activity among adult students, I show the strengths of each of three research strategies - quantitative, qualitative cross-sectional, and qualitative case study - for critically considering claims about gender differences in mathematical performance.

Introduction

Perhaps the most obvious way to distinguish types of research is by *data type*: quantitative research produces numerical data, analysed statistically, and qualitative produces textual data, analysed non-statistically. But almost immediately we find dilemmas: for example, how should we classify data based on classification, analysed by counts and cross-tabulations (e.g. Table 2 below)?

What about *method type*? Thus experiments, tests and surveys can be seen as "structured" (by the researcher), and many types of interview (e.g. life history), case studies and document use are seen as semi-structured or "unstructured". But this breaks down too: case studies may use test and questionnaire results, and experimental de-briefing may often be semi-structured.

Can we distinguish research by its *aims*, or its *epistemology*? Cook and Reichardt (1979) claim that quantitative research aims at the *testing* of theory, whereas qualitative emphasises *discovery*. Many would agree, arguing the need for research to be based on subjects' perspectives, but the researcher's "avoidance of preconceptions" may lead to a minimal acknowledgement of the role of theory.

The most promising basis, in my view, is the distinction between *types of explanation*: research using *causal* or *covering law* explanation can be distinguished from that using *purposes* or *reasons*. Put roughly, the former tends towards determinism - based on forces (e.g. socialization, instincts, characteristics and/or attitudes) - and aims for generality, whereas the latter emphasises subjects' freedom and often celebrates particularity.

Illustrative material comes from a study of thinking and affect in the context of "practical" activity among adults (Evans, 1993; Evans and Tsatsaroni, 1994). The

subjects were students on a social science degree at a London Polytechnic in the mid-1980s. Most were studying a compulsory maths (pre-calculus) / statistics course, and most were familiar with a range of numerate practices outside of school. Here I focus on methods and findings related to gender differences in mathematical performance.

The Quantitative Research: Theory and Methods

At the start of the course, subjects ($n > 900$) completed the questionnaire at one of their lectures. It included questions on gender, age, qualifications in school maths, and (in later versions) social class measured by occupation; performance; and maths anxiety. Here performance was considered to be explained (causally) by the above characteristics, and by measures of anxiety or affect.

The maths anxiety items were selected from the Mathematics Anxiety Rating Scale (MARS) analysed by Rounds and Hendel (1980) into Maths Course / Test Anxiety (MTA) and Numerical Anxiety (NA). MTA and NA were considered to relate to school and everyday contexts respectively, parallel to the distinction between school maths and practical maths; the latter measure included questions used in the survey of 3000 adults done for the Cockcroft Report (ACACE, 1982).Thus, in the quantitative phase of this resesarch, *context* was specified by the *wording* of performance or anxiety questions.

Results from the Quantitative Research

We can scrutinise the sometimes mythic claims about gender differences in maths performance (Walkerdine *et al.*, 1989), using the quantitative data. First, the men's and women's average score on School Maths performance (10 items) were compared, yielding an uncontrolled difference of 3/4 of a question (statistically significant; $p<.001$) in favour of the male students; see Table 1.

Qualification in maths (i.e. maths course-taking), age (since more of the women were mature students), maths test anxiety and confidence (self-rating) in maths, were controlled for (using statistical modelling). Now the difference for younger students (aged 18-20), about 1/6 of a question, was no longer statistically significant, and that for mature students (21+), just over half a question, was borderline; see Table 1.

Table 1. Gender Differences in School Maths Performance: Uncontrolled Group Means and Estimates Controlled for Qualification in Maths, Age, etc.

	Number of questions correct		
	Men's Average	Women's Average	Difference
Uncontrolled	8.78	8.07	0.71 (Std. Error 0.11)
Controlled			
Young (18-20)			0.17 (S.E. 0.17)
Mature (21+)			0.57 (S.E. 0.24)

Thus the gender differences in performance, which are fairly substantial, become much less so after controlling not only for maths qualification, but also for age, affective variables, and relevant interactions, and the quantitative analysis allows us to do this. (Quantitative research with similar aims is presented in Chipman, Brush and Wilson (1985)).

Qualitative Research: Theory and Methods

We can think of *discourses* as sets of ideas, goals, values and techniques, "competing ways of giving meaning to the world and of organising social institutions and processes." (Weedon, 1987, p.35). Since all our activities are based in discourses, we sometimes speak of *discursive practices*. Basing our analysis on discourses allows us to develop a much fuller idea of the context of mathematical thinking or affect, to include: the crucial role of *language;* the *goals* of the activity, (Newman Griffin and Cole, 1989); the *relations of power* exercised (e.g. Weedon, 1987) and the *material and institutional resources* (e.g. training, equipment, professional associations) made available for the activity.

In my approach, the context is understood as *positioning in practice(s)*. Each practice produces positions which subjects take up; in some contexts / practices, the availability of a particular position may depend on the subject's gender, age, etc. (cf. Hollway, 1989). For example, in the activity of feeding children, the child is positioned as demanding ("more"); the parent is positioned as having to regulate the child's consumption; the form of this regulation is likely to depend on the parent's income and social class. For a discussion of how positioning in such practices might provide the context for children's thinking in one topic of primary school mathematics (the idea of *more*), see Walkerdine and Girls and Mathematics Unit (1989, pp.52-53). Thus the specific practice (or mix of practices) in which a particular subject has his/her positioning will provide the context for that subject's thinking and

affect in that setting.

Semi-structured interviews were conducted in my office with a randomly designed sample (n=25) of students at the end of their first year. The interviews had *life history* and *problem solving* phases; in the latter, subjects were presented with a number of "practical" problems - e.g. deciding how much (if at all) they would tip after a restaurant meal (see below), deciding which bottle of tomato sauce they would buy, etc. (cf. Sewell, 1981). But this interview differed in its use of *contexting questions*: when the student was first shown the "props" for the problem - e.g. a facsimile of a restaurant menu in Qu.4 - before being asked anything "mathematical" - s/he was asked: "Does this remind you of anything you currently do?" And after discussing the question: "Does this remind you of any earlier experiences?" Subjects' responses to these questions were to help me judge the context of their thinking about the problem, etc.

My analysis of positioning in the interview setting was that all subjects would tend to be positioned in two main practices:
academic maths (AM), with positions teacher / student; and
research interviewing (RI), with positions researcher / respondent. To the extent that RI, rather than AM, was called up by the subject, s/he would be able to call up ways of thinking, emotions, etc. from further non-academic practices, with numerate aspects I called "practical maths" (PM). For Qu.4, I expected these to be practices of "eating out", with several configurations of related positions possible:
host / guest;
friends each paying their own share; or perhaps
customer / wait(e)r(ess).
Each position in practice will support different ways of thinking and feeling, including different kinds of numerate or mathematical thinking.

In order to judge which practice the subject called up, I drew on various indicators (Walkerdine, 1988, Ch.3; Evans, 1993):
(i) the "script": e.g. how the interview, problems, etc. were introduced - as "research", "views", "numbers", rather than "test", "maths", etc.;
(ii) unscripted aspects of the researcher's performance;
(iii) the subject's talk, especially the responses to the contexting questions; and
(iv) reflexive accounts: e.g. whether I had been in the position of maths teacher to each student, before the interview.

Two "qualitative" approaches were used. First, a *cross-subject* approach, based on that of Miles and Huberman (1984), aimed to consider, in a comparative way, the results from all of the interviews. Second, each interview was considered as a *case study* of a particular subject's thinking and affect.

Results from the Qualitative Cross-sectional Research

Let us consider the results for all interviewees for problem 4, which presented a restaurant menu; see Appendix. For this analysis, I aimed to record the practice that

predominated in each subject's positioning. Indicators for a predominant academic maths (AM) positioning were considered to be:
- the use of written calculations; or
- the giving of an answer which involved a fraction of 1p.

Indicators for a predominant positioning in "practical maths" (PM) were: - the use of mental calculations; or
- the formulating of an answer in practical, i.e. money, units.

The results from the cross-subject analysis of the relationship between gender, predominant positioning and performance judged as correct for problem 4 (a 10% tip when eating out) are in Table 2.

Table 2. Gender, Positioning and Performance: Cross-tabulation of number of questions judged correct by gender and predominant positioning for problem 4

	Number (and Percentage) Correct		
Predominant Positioning	Women	Men	Total
Practical Maths (eating out)	6 / 7 (84%)	10/11 (91%)	16/18 (89%)
Academic Maths	3 / 5 (60%)	-	3 / 5 (60%)
Total	9 /12 (75%)	10/11 (91%)	19/23 (83%)

We must first stress the small numbers involved - 23 students in all. (Two students did not reach Qu.4, because other life history material intervened.) Also, the level of performance, among both women and men, was rather high. And the gender differences were *very* small (especially remembering the small numbers). However, there are two findings, which - if they can be replicated - would be interesting. First, a slightly lower level of performance among those judged to have a predominant positioning in academic maths than among those positioned in practical maths / eating out (60% - 3 out of 5 - compared with 89%). Second, almost half of the women - but no men - called up academic maths. Taken together, these very tentative findings pose the question as to whether some of the gender differences in performance could be explained by differences in *positioning*. And whether this might be true in other settings, e.g. in large scale testing?

Results from the Qualitative Case Study Research

One case study will show the potential of this approach. "Ellen" (not her real name) was aged 19 at entry, middle class (by parent's occupation), with A-level in maths (which was rare among students in this cohort). A student of Town Planning, she was working part-time as an electronics assembler, and had worked previously in a shop.

In the interview, Ellen expresses overwhelming confidence after almost every question - except for problem 4 (on tipping after a restaurant meal)! When I ask what a 15% service charge would be for her "chosen" meal (seafood platter, costing £3.53), she says "Well, I'd have to use pencil and paper". Then -

> **S**: [7 sec. gap / inaudible / coughs / 6 sec.] Well, 23 1/2 pou- no, that's wrong ... [12 sec.] ... what I've done wrong, oh - (**JE**: Is it wrong?)
> Yeah, umm [laughs nervously] ... I don't know what I'm doing...
> [She realises she has divided 15% into £3.53, and begins to redo the calculation by multiplying the two numbers.]
> **JE**: You might not be used to doing these questions in such a setting as this, so (**S**: Yeah) take - there's lots of time, don't worry.... S: [15 sec.] ... 52.95, 53 pence.
>
> (interview transcript, p.7 - Appendix in Evans, 1993)

But she recovers from her slip, and explains that she rejected the answer produced by dividing because "I just saw that it was obviously not right... it was far too small".

Thus, my **1st Reading** of the episode: The "slip" may be just that, an aberration, a response perhaps to the relative difficulty of calculating 15%, as compared with the first three questions. For the first time in the interview, she momentarily expresses confusion - surprising for someone who has A-level in Maths. A reasonable conjecture is that she is feeling some anxiety, and it appears to be "maths anxiety" (or perhaps "interview anxiety"). This is the sort of analysis that a "clinical interview" would produce. But let us consider this episode more closely.

What is the context of her performance, and of her apparent anxiety? In response to the first contexting question, whether she ever went to a restaurant with a menu like that shown, she had seemed to reply very quietly and hesitantly - and this was *before* any numerical problem was posed. After she "chose" the seafood platter [£3.53], I ask how much she would tip for a restaurant meal: she had replied, again somewhat hesitantly, "...well, 15%, I suppose...".

> After she has performed the calculation with the result described above, I ask
> **JE**: Does this sort of situation here remind you of anything, any earlier experiences, a restaturant, a meal, thinking about service, and so on ...?
> **S**: No ... I don't usually pay ... I mean, I usually look at prices and things, ... add them up in my head...
> **JE**: Even if you're not paying?
> **S**: I don't want to be an expense.
>
> (interview transcript, p.8)

We can offer a second interpretation based on the ideas to do with positioning

in practices. At the beginning of this episode, she seems to have called up a practice (or cluster of practices), which might be called "eating out at restaurants": she chooses a dish and produces a rule for tipping. However, it is not clear how *familiar* she is with practices which require tipping, as she reverts to using pencil and paper - which in this context is likely to be indicative of academic maths (AM) - to calculate a 15% tip. Thus I would argue that her positioning is "inter-discursive", i.e. in a mix of more than one discourse, since she calls up "eating out" as well as being positioned as student in AM, and as interviewee.

Using her responses to the contexting questions and other indicators, we can also understand her anxiety as specific to one, or more, of these practices. Further support for her positioning, and hence her anxiety, being related to eating out comes from her hesitation, etc. at the presentation of the restaurant menu; i.e. the anxiety seems to be exhibited *before* the 15% calculation has been mentioned, and to interfere with her doing it. And her final comment in this episode is also indicative of anxiety related to eating out: "I don't want to be an expense".

Now, calling the anxiety "mathematical", as in the 1st reading, would be accurate only if we were to assume that she was positioned *solely* in an academic maths discourse. It would not be appropriate if, as I argue, her positioning is based, at least to some extent, in eating out as well.

We can note the specificity of her positioning in gender, and other, terms. She "doesn't usually pay" in restaurants. The position of not paying when you eat out is one which is (in the British culture) relatively more available to women, and/or to people younger than their hosts. Also, her specified rule of tipping 15% would have been very unusual for most people, especially students, in the mid-1980s in London. Therefore, the restaurants where she ate seem likely to have been for middle-class patrons, or at least for those not constrained financially.

She mentions that she doesn't want to be "an expense". The term "expense" signifies in different ways - as an amount which could be arithmetically calculated within a mathematical or related discourse, *and* as being a burden within a relationship with other(s) more wealthy or powerful, and/or on whom the subject is dependent (a parent or partner). This "key signifier" thus functions at the intersection of these two discourses. Its negative connotations in the latter context also suggest anxiety - anxiety associated with the activity of eating out, with the related social relationship(s), and with the operations involved in the activity, e.g. choosing a dish, calculating the total cost of her meal.

Thus, my *2nd reading*: It is reasonable to suppose that Ellen's positioning is *interdiscursive* - in eating out, in academic maths, and in being interviewed. Her "performance" - her thinking, the methods used, and the possibilities for critical reflection - need to be understood in this context. The same holds for the anxiety that she seems to be exhibiting.

Could there be other readings? There still seems to be a conflict or

contradiction between the picture Ellen gives of overwhelming confidence about maths and the use of numbers, and the indications of anxiety in this (and other) episodes. Is she perhaps "protesting too much"? This question, which (with others) suggests a need for insights from psychoanalysis for the interpretation of my interviews, cannot be pursued here, but see Evans (1993) and Evans and Tsatsaroni (1994).

Conclusions

In this paper, I have argued the need, when considering the context of cognition, to move beyond the mere wording of problems, to consider the aspects of language as discourse, the goals of the activity, power relations, the wider social and institutional setting. A subject's thinking, the methods used, the possibilities for "critical reflection" need to be understood in the context of her positioning in discursive practices; in Ellen's case, her interdiscursive positioning included being a "guest" in eating out practices. The same holds for affect. For example, this analysis questions whether anxiety, which might at first seem "mathematical", might be considered instead as specific to a positioning in other practices; in Ellen's case, this may have been related to "being an expense" as a guest.

In this research, both quantitative and (two types of) qualitative methodology have been used. Rather than polarising the discussion by asking which method is "best", we can note the relative strengths of each, and attempt to combine the different approaches in a way that is effective for the problem at hand. The *quantitative* approach is useful when we wish to make comparisons across subjects, or groups of subjects, and we aim for some degree of generality: we have seen the importance, and the power, of the controls used above. For example, this approach is useful for studying gender differences in participation or performance, and outcomes of policy interest more generally. The *qualitative case study* approach is useful when we wish to explore the richness, coherence (i.e. not being separated into variables) and process of development of a limited number of cases. We can display episodes of problem solving, in order to understand the process - for research purposes or to improve teaching and learning. The sort of semi-structured life-history / problem solving interview with contexting questions used here allows the tracing of multiple signification (as with "expense"), and the making of judgments about the positioning of subjects. In order to produce different readings, it is advantageous that (some of) the research method(s) should produce "semi-structured" talk which can be reread in the manner illustrated above. The *qualitative cross-subject* approach provides an intermediate approach, for cases where it may be challenging to produce comparability across subjects (as in judgments about "predominant positioning"), but where some generality in findings is sought.

Note

An earlier version of this paper was published as Evans (1994a). The case study is from Evans (1994b).

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Appendix Details of problem 4 in the interview

[Show the "menu" (see Fig. 1) to the subject.]
(CA) Do you ever go to a restaurant with a menu anything like this? ....
(CB) Would you please choose a dish from this menu? ....
(CC) Suppose the amount of "service" that you leave is up to the customer: what would you do? ....
Could you tell me what a 10% service charge would be ? ....
(CR) Does this remind you of any earlier experiences? ....

Note: Questions CA, CB, CC and CR were considered as *contexting questions* (see above).

Fig. 1 The "menu" for problem 4 in the interview

CHICKEN MARYLAND

Served with sweet corn, banana fritter, bacon, fresh tomato, whole French beans, jacket baked potatoes with sour cream and chives or French fried potatoes.

Roll and butter.

Ice cream, or a selection from our cheese board, biscuits and butter.

£3.75

SEA FOOD PLATTER

Served with tartare sauce, whole French beans, jacket baked potatoes with sour cream and chives or French fried potatoes.

Roll and butter.

Ice cream, or a selection from our cheese board, biscuits and butter.

£3.53

GRILLED TROUT 10 OZ

Served with tartare sauce, whole French beans, Jacket baked potatoes with sour cream and chives or French fried potatoes.

Roll and butter.

Ice cream, or a selection from our cheese board, biscuits and butter.

£3.81

Coffee

Special blend black or with cream **27p**

Connoisseur Coffees

Served in large goblet glass with cream: Irish (*Irish Whiskey*), Caribbean (*Rum*), Russian (*Vodka*), Parisienne (*Brandy*), Calypso (*Tia Maria*), Highland (*Scotch Whisky*), Mine Hosts (*Cointreau*)
Connoisseur coffees include sugar unless otherwise requested **67p**