MATHEMATICS AS SOCIAL: UNDERSTANDING RELATIONSHIPS BETWEEN HOME AND SCHOOL NUMERACY PRACTICES

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This article offers a way of viewing mathematics as social, drawing upon research on numeracy practices at home and at school carried out by the School and Community numeracies team in the Leverhulme Numeracy Research Programme [1] The rationale for the focus of the article is that although research on, and educational policy for, raising achievement in numeracy in many countries of the world has recently focused on aspects such as teacher subject knowledge, pedagogy (pace, style, whole-class teaching, setting, calculators, homework), schools (leadership, effective management, policies) and educational structures (assessment regimes, local education authorities), consideration of the effect of 'social' factors has tended to be marginalised, despite considerable research indicating their significance For instance, macro-visible social factors like relative poverty clearly do play a role in educational achievement:

> [ ] there is a strong relationship between children's performance in maths and reading tests between the ages of six and eight and their parents' earnings, with the children of higher earning parents performing better. (HM Treasury, 1999, p. 29 drawing on data from the National Child Development Survey, 1991)

This correlation is further emphasised in the evaluation, commissioned by the UK government, of the National Numeracy and National Literacies Strategies:

> outcomes of schooling are heavily influenced by non-school factors especially family background [ ] School outcomes have higher correlations with family variables than with any factor in the school (Levin, 1999, p. 4)

Within the school and community focus of the Leverhulme Programme, we sought understandings and explanations for such correlations and of the influences of non-school factors on attainment and outcomes of school numeracy. The research was therefore founded on a model of what the social means when looking at mathematics This article seeks to explain this use of *social* and draws on the research as an illustration of these ideas. Fieldwork within the research was ethnographic in style (Green and Bloome, 1997) It was conducted in three schools, Mountford, Rowan and Tarnside [2], which provided contrasting, 'telling' cases (Mitchell, 1984) to cover, where possible, the main dimensions of class, ethnicity and urban/ suburban (Street *et al*, forthcoming).

We begin with a brief excerpt, that we call a 'numeracy event', from the field diaries of Alison Tomlin We then attempt to provide sufficient knowledge about background and contextual issues to begin to offer some interpretations of what is going on. What significance do these interpretations have for a wider consideration of schooled achievement in numeracy?

The numeracy event

> I said the class didn't have many children. Aaysha tried to count them by silently running through them in her mind, totting up numbers on fingers. I noticed she finger-counted in threes, three to a finger or thumb. I asked about this: *Mr Anwar says we count three to a finger, so 15 to a hand, 30 in two hands*. Mr Anwar's description included folding over two fingers and saying six - I think he was saying to me that it's well internalised, you know how many several fingers represent Implication in standard maths terms would include, for example, speed in multiples of 3 He said one to a finger is no good because you only get up to 10 I asked if they had taught this to Aaysha, or if she'd just picked it up from watching them. There was no clear answer to this, so we don't know if it was deliberately taught or picked up from home practices I'd expect they taught it to her, since it's unlikely her parents do it enough themselves for her to 'pick up' without prompting (AT, 21st November, 2000)

Home and school contexts

This critical incident was taken from the field notes of Alison during a home-visit to Aaysha, a young girl of Pakistani origin, whom we first encountered in Tarnside, one of the target schools of the research project [2] 72% of the children come from minority ethnic groups. Aaysha's achievement in numeracy is above average for her year. Information about the social background and current conditions of Aaysha's parents provide the context within which to interpret her use of different mathematical practices

Home background

At the time of this story, Aaysha was 5 years old. She lived with her two younger siblings and with both parents in a locally well-known, very run-down hostel for homeless people The family came to the UK from Pakistan one and a half years before this meeting and are currently living in relatively poor conditions Their accommodation consisted of one bedroom, one reception room that served as a single bedroom, and a kitchen. The toilet and bathroom were shared with others on their corridor There were lots of families, many with little English, crowded in an oversized 'Portacabin', in a yard full of these Portacabins with gates that made it feel like a compound. Alison met Mr and Mrs Anwar and their three children in a room with a single bed

and two hard chairs. The walls had old graffiti from previous occupants. The family language is Urdu. Mr Anwar was studying English at the local college but was not yet fluent. Mrs Anwar was at home with the three children. Aaysha's English was, by this time, fluent. At the start of her reception year she had had very little English. Her father said, with some humour, "She's the interpreter now". Gregory (1999) indicates that for many migrant families young children may act as mediators or interpreters.

Both parents had worked for an insurance company in Pakistan. Mr Anwar was a senior manager, with responsibilities including actuarial issues, recommending changes to premium policies and levels. Mrs Anwar was also a manager, but with a lower rank. Mr Anwar had an M.A. in statistics and "loves statistics". His insurance examinations were USA accredited. He was hoping they would be accepted here and intended to look for work in insurance when his English was up to it. Mrs Anwar said she did some things at home with Aaysha such as counting things in the flat. Aaysha helped with cooking by measuring things in terms of cups. Aaysha chose books from the library and counted how many books she had. Aaysha played teacher with her nursery-aged sister and liked "games" on TV. According to the school, neither parent saw Aaysha in school. She was quiet at home and at school. Both the father and teacher called her "shy".

On a second home-visit, Aaysha was asked by Alison about the finger counting. An interpreter gave Aaysha's views:

> She can do it on hands and she can do the school [...] like the school what they teach and she can do both ways now. And now she is using more whatever they learn in school that way, instead of her method. (AT with interpreter, 1st June, 2001)

Mrs Anwar commented, through the interpreter:

> She's learning much faster, you know, whatever they teach in school, instead of [...] whatever she learns from home. (AT with interpreter, 1st June, 2001)

Some preliminary interpretations

We are interpreting Aaysha's counting 'three-to-a-finger' as an example of a numeracy event set within home numeracy practices which are different in some ways from those at school. Alongside literacy events and practices, which are key methodological tools in New Literacy Studies (Street, 2000), we define *numeracy events* as those "occasions in which a numeracy activity is integral to the nature of the participants' interactions and their interpretative processes" (Baker, 1996). We see numeracy practices (like literacy practices) as more than the behaviour that occurs when people 'do' mathematics or numeracy. Numeracy practices are not only the events in which numerical activity is involved, but are the broader cultural conceptions that give meaning to the event, including the models that participants bring to it.

Using these concepts, we are able to ask: what numeracy practices is this numeracy event embedded in that give it meaning? How do those underlying practices differ in the home and at school? In school, for instance, finger counting of one per finger leads to a maximum of 10 from both hands. Counting three-to-a-finger is unusual in both schools and homes in England. What do we add to our understanding by seeing these events as embedded within different numeracy practices? For instance, we might then recognise that such practices may differ in terms of meanings, authority, social relations between different homes and between a child's home and the school she attends.

From the numeracy event described here, the purpose of the count was to get an idea of the number of children in the class. Aaysha, then, has authority in this event as she is clearly the one with the information with which to answer the question and the one to select the way of doing it. From our work in classrooms and from approaches of the National Numeracy Strategy (DfEE, 1999, section 3, p. 6), schooled numeracy practices appear to enact different authority relations. They serve different functions and involve different social relations and procedures from the home. The purpose of counting in school, for instance, has tended to be educational, directed towards learning a new skill or concept. The values associated with this function are different from those at home in terms of the expected roles of the participants and to what counts as knowledge. Teachers are in control of the knowledge and information in the class with the authority in the classroom, whereas Aaysha is the one with authority in the home.

There may also be a significant difference in the mathematical principles underlying both sets of practices. A greater emphasis on counting in threes, evident in the home situation, has the potential to shift attention away from solving problems by counting in ones, a dominant and central strategy in schooled numeracy, towards patterns and calculation procedures (Wing, 1996). This adds weight to the argument that there are some differences in the techniques and procedures used to solve problems and ways of thinking about and representing problems between homes and schools. The practices of this home place a different emphasis on ways of thinking and representing numbers than in school. It is not claimed here that any 'finger counting' practice is better or worse than any other practice, but that they are an example of a difference between home and school numeracy practices in terms of authority and techniques.

Two implications for schooling

First implication: Aaysha's achievements in school mathematics suggest that she is successfully managing two practices or codes and switching between them. She can in fact "do both ways now". The differences here do not seem to cause her difficulties. The evidence suggests that at school she accepts that she uses the school approach, that is the school numeracy practice. There is little evidence of home practices being drawn on in the school. Aaysha told Alison that she uses 'three-to-a-finger' counting for "harder" [bigger] numbers. When Alison asked Aaysha if she did that at school, she said "I think so". However, it is possible she was led by Alison, and we have not seen her using her method in the lessons we have visited. On the other hand, Aaysha's mental imaging of numbers may have been influenced by her counting system.

Second implication: To what extent do schools and teachers know about these home practices and use or exploit them

to help their teaching and the children's learning of schooled numeracy practices? Here is an example of a potential "fund of knowledge" (Moll *et al.*, 1992) from the home that could be drawn on in schools This research project seeks evidence of such school use of home funds or resources We have not found many examples of this occurring

Broader issues

Aaysha is doing well at school, despite living in an environment that is, as we have described above, very difficult This is an example of poverty itself not determining success, as she comes from a home that is relatively poor in a financial sense and seems to challenge some of the research on poverty and attainment (Machin, 1999). However, in Aaysha's case her parents are highly educated, highly motivated and confident in mathematics and languages For example, Mr Anwar is confident he will learn English well enough for a good job, of the kind he had as a senior manager in Pakistan As a family, therefore, they have cultural resources which may not be as different from those required in the school as the immediate poverty of their social conditions might lead observers to expect The gross statistics on poverty and school achievement need refining with respect to qualitative accounts of cultural as well as material resources

The central concepts of numeracy events and numeracy practices have enabled us to seek contrasts between practices in homes and schools and between different homes and different schools We have grouped these contrasts into themes:

- the concepts and possible impacts of *cultural resources* in homes
- *relationships between schools and homes*
- *contrasts between home and school numeracy practices*

After discussing these themes we consider the methodological value of *the concept of numeracy practices* when seeking contrasts in relationships between homes and schools

Cultural resources

In the discussion about Aaysha above, we referred to what we called the *cultural resources* of the family. It is clear that her parents are highly educated and confident in their approaches to mathematics and to their own learning of languages This family has cultural resources that could be consonant with schooling and contribute to Aashya's present successes at school. Such a model of cultural resources draws on Bourdieu's views of cultural capital Jenkins (1992), in his analysis of Bourdieu's views, says:

> Pupils whose familiarisation bestows upon them the appropriate level of cultural capital - both more of it and the right kind - will necessarily achieve more academically than those whose relationship to the cultural arbitrary is more distant (p 112)

In this study, we limit the use of the concept to those cultural resources that are significant to the support or development of home or school numeracy practices Our model of cultural resources is that all homes have cultural resources and that these are context specific We are not claiming any deterministic model of this concept It is a way of looking at and describing relationships between home and school numeracy practices that could shed some light on the complexities of such relationships We have chosen to use the notion of cultural resources rather than cultural capital to emphasise positively the nature of home resources and to avoid any suggestion that some homes do not have cultural capital The concept may help us describe, to understand and to seek similarities or differences in cultural resources of homes, communities and schools, providing ways of seeking explanations for children's achievements in schooled numeracy It is not expected that the concept will lead to instrumental understandings and thence to predictions of what the effect of cultural resources might be The concept, as we see it, explicitly rejects a deficit model and instead seeks to expose those home or community resources that could be drawn on by schools when teaching formal schooled numeracy. That does not mean that such resources are readily accessible or exchangeable, but that exposing them and increasing teachers', schools' or parents' knowledge about them could contribute to transforming schooled numeracy, making it potentially more accessible to those from different backgrounds

In Aaysha's case, her home numeracy practices as well as her parents'attitudes, knowledge and views about education can be seen as a cultural resource that in some contexts contribute to her attainment in schooled numeracy It could be that if the school knew about her counting practices they might be able to employ them or extend them On the other hand, it could be that the differences and distance between the practices she manages and the switching she does between them provide her with the meta-cognitive skills and understandings that raise her attainment in school numeracy. This switching and meta-knowledge, as well as the actual three-to-a-finger counting system, can be viewed as cultural resources and thereby contribute to her attainment. Her cultural resources contrast with those of some other children in our research In some cases, the parents of our children have had little formal education beyond compulsory schooling, having had other experiences In other cases, carers' own experiences of pedagogy could be seen to conflict quite drastically with the schools' pedagogy The home cultural resources in these cases may not be so consonant with schooling We intend to explore this idea more fully

Relationships between schools and homes

Our data suggest that the parents of some of our children are struggling with both formal and informal access and communication between schools and homes In Rowan, a white middle-class school, the parents have open access to the class and to the teacher at the start of the day, enabling an ease of informal communications In both Mountford and Tarnside communication is more fraught In Mountford, the white working-class school, some parents cannot make use of the formal sessions made available after school because of organisational issues at home In the case of one mother,

for instance, she lacks the material and social resources to have her other children looked after at the times of the meetings. Such problems are compounded by the fact that the school has restricted informal contacts between parents and teachers in the first year by preventing parents having access to their children's classes at the start and end of the day. This has been done for many reasons, including school security, but the end result is that parents feel that communication with the teacher has been restricted. With respect to Tarnside, Aaysha's parents have had almost no informal access and communication with the teacher. They have not been to a parents' evening, yet they have confidence in the school.

The reasons Aaysha's parents did not at first attend a parents' meeting are not yet clear, but it may be that in terms of the social relations involved they view schooling as the province of the teacher. This is a further cultural consideration, of the kind indicated by Alexander (2001), for different European traditions of schooling. Their reasons might also include unfamiliarity with the processes and practices involved in such meetings and a lack of confidence in their English and their ability to interact effectively with an English schoolteacher. Certainly, more recently they have said they are now starting to attend meetings, since Aaysha's father's English is improving. However, there is no evidence that the school has created systems or committed resources to ensure or even encourage such contacts. The data suggests that access and communication between homes and schools is a substantial issue for the parents of young children and that there are sometimes conflicts and barriers between home and school on this issue. The percentage of parental responses to an inspection survey conducted by the Office for Standards in Education [3] reflects differences we have found between Mountford and Rowan in particular, suggesting that qualitative accounts may help complement and perhaps throw further light on evidence derived from such statistical surveys.

Such issues to do with communication between homes and schools also impact on ways that home knowledge and experience can be exploited or used in schools. Aaysha's experience of counting three-to-a-finger seems to be a potential resource to use in the school. However, it is hard to see how the teachers or the school would have known about this practice, given the education policies and practices which do not provide the structure, resources or the climate for teachers and parents to develop the kinds of relationships in which teachers could gain such information.

Contrasts between home and school numeracy practices

The events we have described briefly are indicative of differences between home and school numeracy practices that suggest a focus for further research into how far such differences might be a factor in children's underachievement. Schooled practices such as the teaching of money, for instance, differ from home uses of money in a variety of ways. Such schooled numeracy practices have quite clear educational purposes, such as the learning of subtraction. They do not often draw on home experiences of the kind indicated by the numeracy event of Aaysha. Indeed, in our project, we have seen almost no examples of this. On the other hand, equivalent home practices where money is involved are to do with domestic management such as pocket money, rather than directed at becoming good at formal subtraction at school. As Walkerdine (1988) says:

> Of fifteen exchanges between mothers and their preschool children concerning money, in all but one the focus of attention is the domestic economy. In almost every case there is concern with the high costs of necessary goods and the material effect of this for the children (p. 140)

Our own research indicates that cases where parents struggle with such domestic accounting procedures as those relating to a shopping catalogue company, these provide the context against which their children come to experience counting and numeration (Baker, 2002). Such cases are suggestive of the different purposes and values associated with home numeracy practices and those of school: home values about what is important financially to the family are embedded in material activities at home, which are not replicated at school. Similarly, when Aaysha counts three-to-a-finger in her home practices there is a difference, not only in techniques, but also in ways of viewing numbers from those required in school: she is exposed to patterns in numbers at home rather than following the routines of counting in ones in school. Home numeracy practices, then, may have different techniques, wider purposes, perhaps different epistemological views of mathematics and different social relations: it is in this sense that they can be viewed as different numeracy practices. From this perspective, it is possible to identify a range of other practices at home and at school, in which the uses and meanings of numeracy vary, of the kind indicated briefly in the research on teaching of money at school in contrast to domestic exchanges at home (Walkerdine, 1988). This is an area worth exploring further.

Mathematics as social

This article has attempted to provide a way of viewing mathematics as social drawing upon research on numeracy practices at home and at school. The concept of 'social' in which the account is located is broader that that usually implied in recent 'social' theories of learning, such as that used by 'sociocultural' theorists following Vygotsky and other social psychologists, a position that has tended to dominate thinking in mathematics education theory (Lerman, 2000). Nor do we mean by 'social' the immediate interactions to be observed, for instance, amongst children in classrooms or conversations between learners of mathematics when doing mathematics (Baker, 1999). Whilst not discounting these perspectives, we would like to build upon "the social turn", already evident in some mathematics research (Lerman, 2000), to draw upon a yet broader tradition of social theory, of the kind already applied by some researchers to adults' mathematics practices (Coben, 1997; Civil, 2000). Such a broad tradition provides a social perspective on mathematics itself, that is, mathematics, like other forms of knowledge, is itself socially constructed. This does not entail simply privileging 'everyday' mathematics or treating everything as 'social', which can be rather vacuous. Rather, it provides a vehicle for an exploratory inquiry

into considering mathematics as a social practice in the sense we have attempted to indicate above.

This approach, then, provides a different, extended (both broader and deeper) model of the social, which sees it in terms of ideology and discourse, power relations, values, beliefs, social relations and social institutions (Baker, 1999, p. 50). Such an approach, as we have tried to show, allows for the identification, analysis and comparisons between numeracy practices sited in different social settings, especially those in homes and schools. For example, this broad concept of the social allows a researcher to focus on the values and beliefs that feature in choices made and in contexts in which numeracy is sited. If home and school contexts are different in ways that affect children's schooled achievement, as our research hypothesised, then we need to understand the extent to which the numeracy practices sited within them are different. Social relations refer to positions, roles and identities of individuals in terms of numeracy in relation to others. Social institutions and procedures are constitutive of control, legitimacy, status and the privileging of some practices over others in mathematics, as evidenced through accepted and dominant paradigms and procedures.

The narrower views of social, to which we referred above, based as they are on an autonomous model of numeracy (Baker and Street, 1996), together with conventional pedagogy and curriculum, lead to blaming failure or underachievement in numeracy on the teacher, the child or the home. Such a perspective sees them as in some sense in deficit, teachers in terms of subject knowledge or use of ineffective teaching practices; the children in their lack of skills, knowledge and understanding; the home as lacking the schooled numeracy knowledge to support children (Freebody *et al.*, 1995). Our broader social model, in making the epistemological and ideological explicit (Baker and Street, 1996; Street *et al.*, forthcoming), provides other ways of viewing and understanding underachievement and could lead to policies that go beyond access and empowerment towards transformations of curriculum and pedagogy. Instead of viewing formal underachievement in terms of deficit, the model recognises social notions of difference and multiple practices, seeking to represent and build upon informal numeracy practices (Ginsberg *et al.*, 1997) and "funds of knowledge" (Moll *et al.*, 1992). We hope that the approaches used in the project and the concept of numeracy practices indicated in this article will make a contribution towards ways of researching and understanding the relationship of home and school numeracy practices that allow such bridge-building to occur.

Notes

[1] The Leverhulme Numeracy Programme was a five-year research programme (1997–2002), based at King's College London, that focused on student attainment in numeracy. There was a core longitudinal project and five focus projects linked to it and to one another. Each of the five focus projects explored in depth explanations of student underachievement. Names of schools and individuals have been invented to preserve anonymity. The three authors are the team of researchers for Focus 4, *School and community numeracies*.

[2] Mountford was in an economically disadvantaged area in a town on the south coast of England, Rowan was in a wealthy London suburb and Tamside was in multicultural and multilingual inner London.

[3] Response rate to parents' survey by the Office for Standards in Education, whose role is to inspect schools in England and Wales, monitoring standards in schooling: Mountford - 9%; Tamside - 26%; Rowan - 47%.

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