

Teaching for equity, teaching for mathematical engagement

POVEY, Hilary <<http://orcid.org/0000-0002-8524-0550>>

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/7594/>

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

Published version

POVEY, Hilary (2010). Teaching for equity, teaching for mathematical engagement. *Philosophy of mathematics Education journal*, 25.

Copyright and re-use policy

See <http://shura.shu.ac.uk/information.html>

TEACHING FOR EQUITY, TEACHING FOR MATHEMATICAL ENGAGEMENT

Hilary Povey

h.povey(at)shu.ac.uk
Sheffield Hallam University, UK

INTRODUCTION

In this article I draw together some existing research, my own and that of others, to explore the connections between alienation from the study of mathematics and teaching mathematics for equity, arguing that failing to address equity issues in the teaching of mathematics in secondary schools is inter-connected with the reasons given by young people for their alienation from mathematics itself. Educational discourse, classroom practices and all attainment teaching groups are considered for the contribution they can make both to teaching for equity and to enabling young people to find pleasure and purpose in learning mathematics.

I take as my starting point work by Margaret Brown, Peter Brown and Tamara Bibby (2008) which reports the reasons that were given by 16 year olds in a large scale survey for not continuing with their study of mathematics. The reasons they gave for not continuing were illuminating if not unexpected (see Table 1).

Table 1 Reasons from boys and girls for not continuing with studying mathematics

	Male (n=598)	Female (n=673)
Too difficult	37%	66%
Do not enjoy/ like it	24%	35%
Boring	12%	15%
Not needed for future degree/ career	7%	10%
Not useful in life	3%	3%

Prefer other courses	2%	3%
Not continuing with education	7%	3%

(Brown, Brown and Bibby, 2008, p12)

These reasons for rejecting mathematics are echoed throughout the literature (see, for example, Nardi and Steward, 2003). The authors cluster these responses into three categories: maths is 'difficult', maths is 'boring/ don't enjoy' and maths is 'not useful/ not needed' (p6). I use these three categories of response to inform the rest of what I have to say and to help us to see what could be different in mathematics education and more affirming of young people's lives. I argue that there is a social justice dimension to each of these sets of reasons for rejecting mathematics.

In the section "*maths is difficult*" I concentrate on patterns of contemporary educational discourse which militate against equity; in the section "*maths is not enjoyable, not liked, boring*" I draw on two small scale research projects in which I was involved, one based in school and one in a university, to suggest how patterns of interaction in the classroom are fundamental to the creation of positive or negative relationships with mathematics and to whether or not the classroom promotes equity; and in the section "*maths is not needed, not useful in life*" I draw on work by Jo Boaler in two schools (1997) and her more recent follow-up study (2005) to rethink ways in which this reason for rejecting mathematics might be understood and overcome.

"maths is difficult"

The view that "maths is difficult" helps to underpin the belief that mathematics is an elite subject suitable only for the most advantaged to study; it also helps to maintain the role of mathematical success as a gatekeeper to privilege. So it is particularly noteworthy that it was by far the most important reason pupils gave for not continuing with mathematics - 42% of the pupils predicted to get the top grades said they thought mathematics was too difficult a subject to continue studying. We can see that this is borne out by the data relating to those who actually do choose to study the subject to university entrance level. These pupils have the highest overall mean attainment GCSE score of all the major subjects and nearly four fifths of them have the highest grades (A/ A*). No other subject expects or obtains such a highly qualified cohort. Why should this be?

Mathematics seems to be one of the subjects most deeply inscribed in the discourse of "ability" - it is just common sense that one either can or cannot do it "naturally". Whenever we see "common sense", we should be alert in interrogating it to check out the extent to which it presents something as naturally given which in fact is socially constructed. We need to remind ourselves how discourses work upon us and limit what we can think.

Being involved in a certain discourse implies being entangled in a certain "myth". A language is not a simple tool but part of a structure which anticipates interpretations. In this sense a language exercises "symbolic power". (Alro and Skovsmose, 1996, p5)

In England, the 'feudal' (Tahta, 1994, p.25) idea of "ability", and labelling by ability, is central to the way learning mathematics is thought about and discussed. The discourse of ability seems so natural that any suggestion that ability is *constructed* tends to be met with bafflement. Despite the vocabulary of "low attainment" (which describes performance without implying a cause) having been around for the last three decades (for example, Denvir *et al*, 1982), my experience is that almost all teachers and student teachers still refer to "low *ability*" school students. "Low ability" children, "bright" children are produced by this discourse, a discourse of inherent characteristics. Thus, for example, remarks like the following, all of which I have heard.

'He wasn't really low ability, he just appeared to be.'

'She does well through hard work not through real ability.'

'How do teachers know who the real low ability children are?'

'Someone might appear low ability just because they don't speak the language or have been ill and missed some school.'

When we say something like "he is able" instead of, say, "he is skilful in his use of algebra", we are participating in a discourse which is supporting young people in structuring themselves as capable or, more generally, *incapable* of gaining intellectual competences. The discourse of ability both permits and, more crucially, legitimates placing learners in a hierarchy and then allocating rewards accordingly. Specifically, it sanctions, indeed is used to promote, the grouping of learners into sets and streams despite extensive research over many decades indicating that such practices are harmful rather than beneficial to learners. The associated ranking and

competition alienates many who 'are unwilling to engage in this hierarchical game' (Nardi and Steward, 2003; 359). In general, the few who like competition are most often found to be male, middle class and confident (Bartholomew, 2001; Boaler, 1997).

An alternative discourse, seldom heard in English schools asserts:

Given an effective school, children make greater progress. Greater progress leads to greater capability and, if handled sensitively, to greater confidence. In this way, *children's ability grows*. ... The responsibility of teachers is to ensure that their pupils do not adopt fixed views of their own abilities ... (Mortimer et al., 1988, p264, emphasis added)

Instead of drenching pupils in a discourse of inherent and fixed ability, we need to use a discourse of "can do" where competence is understood to be a product of effort, engagement and learning. Dweck (for example, 1999; 2006) has argued altogether convincingly that having a theory of malleable intelligence rather than a theory of fixed intelligence makes a fundamental difference to educational progress and achievement.

It's not that people holding this theory [of malleable intelligence] deny that there are differences among people in how much they know or in how quickly they master certain things at present. It's just that they focus on the idea that everyone, with effort and guidance, can increase their intellectual abilities... This view too has many repercussions for students. It makes them want to learn... [Students with this theory] thrive on challenge, throwing themselves wholeheartedly into difficult tasks - and sticking with them. (Dweck, 1999, p3)

Dweck has also argued that the holding of a malleable or fixed intelligence theory is itself not fixed: different experiences are capable of affecting to which theory learners subscribe; and we can work in mathematics classrooms with young people to support the development of ideas of malleable intelligence. So, the real problem with "maths is difficult" is that it is adjoined to a disabling notion of inherent ability rather than to one in which challenge is understood to be an essential component of learning itself and therefore inherently necessary and worthwhile.

We might also take a look at the word "confidence", a word related to "ability", which also seems, empirically, to work oppressively in educational talk. I want to link it to "challenge". Confidence is a word much used by school teachers, most often 'in the context of describing ability, learning behaviour or potential' (Watson, 1996, p57). In general, for teachers, "confident" children are bold, take sensible risks, have trust in themselves

and in their own competence: they "perform" successful mathematics. However, there are a number of problems with this. First, the rhetoric of teaching suggests that teachers help "unconfident" children build their "confidence" by taking lots and lots of small, safe steps. This seems inherently contradictory. Certainly I have more immediate success if I take small safe steps but success at what? As Anne Watson writes,

My worry about this approach is that success may only ever be related to [such] small steps. I looked ... for any voluntary mention of pupils having confidence to take large steps or suggest links and connections in general. These are essential attributes for pupils to be independent thinkers ... Nowhere did any teacher talk about how these mental skills might be developed through teaching ... (Watson, 1996, p60)

That notions of "confidence" are problematic from an equity perspective is well established (Walden and Walkerdine 1985; Rodgers 1990; Rodgers 1990). If, for example, white, middle class boys behave "confidently", asserting themselves and their own thinking, challenging their teachers and provoking classroom interaction and debate, such behaviour is read as appropriate and as indicative of "ability" (Bartholomew, 2001). On the other hand, there is good reason to think that such behaviour from, for instance, Afro-Caribbean boys (Gillborn, 1990) or lower attaining pupils (Bartholomew, 2001) or girls (Walden and Walkerdine, 1985) will be experienced by many teachers as threatening and disruptive; and that, say, "unconfident" white working class girls will be "cosseted" (Rodgers 1990) apparently with their interests at heart but actually denying them opportunities to develop intellectual competences, attributing them instead with 'anxiety, lack of confidence, and feelings of insecurity' (Walkerdine 1989, p155). Research shows that, instead, requiring deep thinking from lower attainers and presenting them with challenge promotes learning (Ollerton and Watson 2001; Watson and De Geest, 2005; Watson and De Geest, 2008).

It is not helpful to seek to resolve this by suggesting that 'the learning situation must contain a fine balance of sufficient challenge and sufficient experience of success' (Rodgers 1990, p36). It is not a *balance* between these two that is needed, suggesting as it does that the two are in some way in conflict; rather what is required is a re-inspection of how, and by whom, intellectual competence is, and is expected to be, developed. Pat Rogers

(1990) describes a teacher working at a college in the USA which attracts primarily lower middle class, rural students who are

invariably the first in their family to attend college. With no tradition of post-secondary education to support them, poor self-concept and low self-esteem is often a problem. (p39)

This college and this teacher are highly successful (in mathematics); he tells his students that they are all capable of learning provided they are prepared to work hard and

believes that students need to know they are capable of intelligent thought, not as a reward for finishing the course successfully, but as a prerequisite for engaging in it productively. (p43)

Which children consider themselves within the school context as capable of intelligent thought and also see that reflected back to them?

"maths is not enjoyable, not liked, boring"

There is a great deal of research evidence to show that most pupils do not like, perhaps one can go so far as to say are alienated from, existing practices in mathematics classrooms (see, for example, Alro and Skovsmose, 2002; Boaler, 1997; Boaler and Greeno, 2000; Nardi and Steward, 2003). So what are mathematics classrooms like where learners enjoy themselves, where they are not bored and where they sense of self is engaged? When we identify characteristics which will motivate learners of mathematics we find they are also the characteristics which support in them the development of those democratic competences we so desperately need – critical consciousness, sustained and sustainable action and co-operation (Moreira, 2002). In elaborating what is required I draw on two qualitative empirical studies in which I was involved, one with school pupils aged about fifteen (Angier and Povey, 1999) and one with students studying university mathematics as part of a programme of initial teacher education (Povey and Angier, 2004).

Leone Burton conducted interviews with thirty pupils who were beginning the study of university entrance mathematics and found that they talked unprompted about the value of

... working collaboratively, undertaking open problems in ways that gave them agency, and disliking competition ... They wanted (although not in these terms) agency, authorship, collaboration and reflection. (Burton, 2004, p374)

But mathematics classroom practices which take social justice issues seriously precisely include: promoting a willingness to share ideas, making space for the ideas of others, supportive listening and less valorising of the individual and of individual success (Povey, 2003); and these practices also help learners set up productive relationships with the processes of not knowing and of coming to know. Developing authoritative knowing - where one sees oneself both as the possible author of knowledge and also as the possible authenticator of knowledge - needs to be a central goal in teaching for equity. Geoff (Povey and Angier, 2004) had developed a passionate love of and engagement with mathematics. He said

I've got my work from previous degrees where a big NO written in the margin all over the place and you can't be wrong. Whereas ... you can be wrong or you can explore ... that's part and parcel of the whole thing... All the things that are supposedly proved and are correct mathematically all came from dead ends and so on. All the great mathematicians made mistakes and said well "That didn't work." You don't see it any more because it's all been polished up into the thing that is correct but there are so many mistakes that are quite valid and certainly things come from them sometimes. (Geoff, initial teacher education student)

If we are to generate and support authoritative knowing, that is, to nurture learners who see themselves both as authors and as authorities, our classrooms have to be spaces for dialogue (Alro and Skovsmose, 2002) where sometimes learners are in control of both the content and the direction of the talk. Building such a fluid and responsive social space is not easy and is not accomplished quickly, not least because it is so different from many of the accepted practices of mathematics classrooms.

Our mathematics tasks need to be designed less to elicit information and more to point up relatively complex problems where multiple lines of inquiry are possible. Katrina (Angier and Povey, 1999) had been unhappy in the mathematics classroom but expanding the social space to include more of the person changed that and she began to develop authoritative knowing.

I believe maths is different for every person... Maths is also about understanding about how other people think and appreciating opinions... Everyone's got a different ... People might

get to the same answer in the end but there are loads of ways you could do it. (Katrina, school student)

Encouraging discussion in pairs or small groups gives everyone the chance to explore ideas and then rehearse their articulation before presenting them to others. Myra (Povey and Angier, 2004) had developed a confident love of mathematics in part through such practices.

So the fact that both in the sessions and outside the sessions you can talk to people in a small group, people that you know well and that helps me I think... talking to other people on the course, they're able to put links in for you and you are able to put links in for them you know they might not have noticed. (Geoff, initial teacher education student)

We were bouncing off each other like one of us would have a good idea and the other would try and implement it because we had different strengths that we could bring in to what we were doing... I think talking about it, it gives you more ideas that you can then go away and develop on your own and then you come back and you talk a bit more and I think that's how it develops. (Myra, initial teacher education student)

Genuine dialogue is needed to critique meanings and to build shared ones which are based on respect for what the learners bring, striving for a deep democracy that stresses interconnectedness. Tasks which can be approached in a variety of ways, and for which a wide range of approaches can be offered as appropriate, provide useful opportunities for learners to see themselves as active, as choosing, deciding, producing arguments for and against, assessing validity and generating questions and ideas.

Our curriculum needs to be problem-centred: a problem centred curriculum involves the need to take risks, which is a precondition for imagining a different and more just world (Giroux, 1992); and posing and re-posing problems helps uncover the linguistic assumptions hidden in their original formulation. There needs to be intellectual "room to move" and tasks set will be significant problems requiring time and space to be worked on: there will be a sense of spaciousness (Angier and Povey, 1999). Naomi (Povey and Angier, 2004) talks about her response to such space.

The work what we've been given, sort of a topic or a title, you just go and find things out about it and just do it your own way instead of having structured work like "First do this, then that, follow on to that, as long as you put this you are okay"... I can never say "Right, that's it. I'm going to end it here". 'Cos I think "Well, what if, instead of when I were doing that, but instead of going that way I did that way" and I end up doing another so many pages

about that thing because I can't stop thinking about it... for me I like these kind of assignments where you're given "This is the unit, this is what we've talked about, find something interesting about it and work on it and see where you get or where you don't get and what you find out". (Naomi, initial teacher education student)

"Spaciousness" can also be a metaphor for the social relationships in the classroom where students are asking for more of themselves to be recognised and expected to participate. Some students use the metaphor of family relationships and such a metaphor helps us to understand that 'the emotional qualities of classroom interactions will exert a significant influence on what is learned' (Confrey, 1995: 39). To promote equality through classroom practice in mathematics means creating space to be human, space to think and space for difference.

Mathematics as currently taught valorises a particular kind of heterosexual masculinity, a masculinity - damaging to all, boys as well as girls, and destructive of the planet - based on competitive hierarchy. Heather Mendick proposes 'queering mathematics' (2006) arguing that currently mathematics is gendered; to do mathematics is to do a certain sort of masculinity. Drawing on queer theory she argues that the closed nature of mathematics calls for an approach that aims to transgress and bring pleasure to the mathematics classroom. Katrina, Geoff and Sue (Angier and Povey, 1999) display that pleasure:

Mathematics is the strangest and probably one of the most important and interesting subjects I will ever learn. (Katrina, school student)

I like to explore things. Never before have I sat down in my spare time and just started doodling triangles or something like that, you know proving things which have been proved many times before but I'm just doing it for my own sake, I've never done that before but I am now. (Geoff, initial teacher education student)

Our maths classes were fun and fantastic and they made you learn better. (Sue, school student)

This description of a mathematics classroom is a long way removed from most learners' experiences exists in most mathematics classrooms in England and one that is always difficult to enact. However, such classrooms can be created and developed (Angier and Povey, 1999; Boaler, 2006 and 2008): where they exist, both equity and pleasure are enhanced.

"maths is not needed, not useful in life"

The final set of reasons that pupils gave for not continuing with mathematics was that "maths is not needed, not useful in life"ⁱ. I approach the issue somewhat tangentially and draw on Jo Boaler's *Experiencing School Mathematics* (1997). She studied two broadly comparable schools in both of which mathematics staff were very committed to their students and worked hard to teach them well. How they tried to do this, however, was very different. In Amber Hill, the students were put into sets early in their time at the school and all the teachers followed the same approach of exposition from the front including worked examples on the board followed by individual work on exercises from the text book.

Well, sir usually goes over the work we have to do before we do it. So he'll write on the board what we have to do and explain the questions and that and the rules, the basics of what we have to do in the work and then he'll tell us to get on with it ... from books and if we need help he'll come along and help us. (p13)

In contrast, at Phoenix Park, the pupils worked in mixed attainment classes often in small groups on open-ended projects which they explored using their own ideas and mathematical knowledge.

You're just set a task and then you go about it ... you explore the different things, and they help you in doing that ...

You get a choice ... a couple of things, you choose what you want to do and you carry on with that. (p17)

Now, neither at Amber Hill nor at Phoenix Park did the pupils follow a deliberately "real world" mathematics curriculum; but the difference between the pupils' attitudes to the connections between school mathematics and mathematics in their daily lives was dramatic. The Amber Hill pupils regarded school mathematics as completely separate from the real world.

JB: When you use mathematics out of school, does it feel different to using it in school or does it feel the same?

R: Well, when I'm out of school, the maths from here is nothing to do with it to tell you the truth.

JB: What do you mean?

R: Well it's nothing to do with this place, most of the things we've learned in school we would never use anywhere. (Richard, Amber Hill, Year 11, set 2) (Boaler, 1997, p98)

However, the pupils at Phoenix Park seemed much more confident about using mathematics in new and real situations. The combination of an open curriculum and their mixed attainment groupings created "can do" learners who could take their mathematics into their lives.

V: Most of the activities we did you could use.

L: Yeah, most of the activities you'd use - not the actual same things as the activities, but things you could use them in. (Lindsey & Vicky, Phoenix Park, Year 11) (Boaler, 1997, p99)

In even sharper contrast, they not only thought that they could use school mathematics in real world mathematical situations; they also thought that school mathematics had equipped them to tackle real world problems that were not mathematical.

J: Solve the problems and think about other problems and solve them, problems that aren't connected with maths, think about them.

JB: You think the way you do maths helps you do that?

J: Yes.

JB: Things that aren't to do with maths?

J: It's more the thinking side to sort of look at everything you've got and think about how to solve it. (Jackie, Phoenix Park, Year 10) (Boaler, 1997, p100)

The sense of self revealed by such responses had a long term impact which was highly significant from an equity perspective; it spilled over into their understandings of their life chances and their possible trajectories. In a follow-up study conducted when the ex-students were about 24 years old (Boaler, 2005), Phoenix Park adults were found to be working in jobs that were significantly higher in terms of social class, than comparable Amber Hill adults.

The Phoenix Park adults reported that their school had excelled at finding and promoting the potential of different students and that teachers had regarded everyone as a high achiever. The Phoenix Park adults communicated a positive approach to work and life, describing the ways they used the problem solving practices they had been taught in school to get on in life. The Amber Hill adults, by contrast, told me that their ambitions were 'broken' at school and their expectations lowered. They told me that they had been taught to expect little of their own achievement and most of those I interviewed were unhappy in the jobs they were in, believing that they could have done a lot more. (p142)

The open nature of the curriculum and the mixed attainment groupings had created learners who both saw mathematics as needed and useful and also saw themselves as able and competent to use it.

CONCLUSION

I have argued that there are deep interconnections between teaching for equity and teaching for mathematical engagement. Adopting a discourse of challenge as appropriate for all promotes equity and combats "maths is hard". An open curriculum studied in open social spaces provokes mathematical engagement, overcoming "maths is not enjoyable, not liked, boring" and supporting authoritative knowing, vital for the development of critical consciousness. And problem-solving in the "can do" environment generated by mixed attainment groupings both counters "maths is not needed, not useful in life" and has long-lasting benefits on social equality.

The vision I have tried to share - of a different way of understanding mathematical attainment, of different ways of working with young people in the mathematics classroom and of different ways of grouping young people for mathematics learning - speaks of a very different mathematics and a very different mathematical knowledge from the traditional one. This in turn opens up different possibilities in terms of how we relate to the subject and therefore to questions of who we are and who we can become.

ⁱ There are currently several initiatives in England which are trying to address this student concern by generating mathematical tasks which draw on "real world" contexts. Whilst this, in itself, seems a reasonable activity, and some of these materials are making positive changes in mathematics classrooms, I do not think it is the *context* per se that is achieving the changes. Rather it is the open and problem-solving nature of the materials.

References

Alro, Helle and Skovsmose Ole (1996) On the right track. In *For the Learning of Mathematics*, 16 (1)

Alro, Helle and Skovsmose Ole (2002) *Dialogue and Learning in Mathematics Education: Intention, Reflection, Critique*, Dordrecht: Kluwer

Angier, Corinne and Povey, Hilary (1999) One teacher and a class of school students: their perceptions of the culture of their mathematics classroom and its construction. In *Educational Review*, 5 (2) pp 147-160

Bartholomew, H. (2001) *Learning environments and student roles in individualised mathematics classrooms*, unpublished PhD thesis, Kings College University of London.

Boaler, Jo (2008) *Promoting 'relational equity' through a mathematics approach focused upon social justice*. Paper presented at International Commission for Mathematics Instruction (ICMI) Centennial Symposium, Rome, March 2008 available at <http://www.unige.ch/math/EnsMath/Rome2008/WG3/Papers/BOALER.pdf>

Boaler, Jo (2006) How a de-tracked mathematics approach promoted respect, responsibility and high achievement. In *Theory into Practice*, 45 (1) p40-46.

Boaler, Jo (2005) The 'Psychological Prisons' from which they never escaped: the role of ability grouping in reproducing social class inequalities. In *Forum*, 47, (2 & 3) p135-143

Boaler, Jo (1997) *Experiencing School Mathematics: Teaching Styles, Sex and Setting*, Buckingham: Open University Press.

Boaler, Jo and Greeno, James (2000) Identity, agency and knowing in mathematical worlds. In Jo Boaler (Ed) *Multiple Perspectives on Mathematics Learning and Teaching*, Westport, CT: Ablex Publishing

Brown, Margaret, Brown, Peter and Bibby, Tamara (2008) "I would rather die": reasons given by 16-year-olds for not continuing their study of mathematics. In *Research in Mathematics Education*, 10 (1) p3-18

Burton, Leone (2004) "Confidence is everything": perspectives of teachers and students on learning mathematics. In *Journal of Mathematics Teacher Education*, 7, p357-381

Confrey, Jere (1995) A theory of intellectual development: part III. In *For the Learning of Mathematics*, 15 (2) p36-45.

Denvir, Brenda, Stolz, Chris & Brown, Margaret (1982) *Low Attainers in Mathematics 5-16: Policies and Practices in Schools*, London: Methuen Educational, for the Schools Council

Dweck, Carol S. (2006). *Mindset*. New York: Random House

Dweck Carol S. (1999) *Self-theories: Their Role in Motivation, Personality, and Development*, Philadelphia: Psychology Press

Gillborn, David (1990) When cultural display is seen as a challenge. In *The Times Educational Supplement*, p10, 30.11.90

Giroux, Henry (1992) *Border Crossings*, London: Routledge

Mendick, Heather (2006) *Masculinities in Mathematics*. Maidenhead: OUP.

Moreira, L. (2002) Mathematics education and critical consciousness. In A. Cockburn & E. Nardi, (Eds) *Proceedings of the 26th Annual Conference of the International Group for the Psychology of Mathematics Education (PME)*, Norwich.

Mortimer, Peter, Sammons, Pamela, Stoll, Louise, Lewis, David and Ecob, Russell (1988) *School Matters: the Junior Years*, Wells: Open Books

Nardi, Elina and Steward, Susan (2003) Is mathematics T.I.R.E.D? A profile of quiet disaffection in the secondary mathematics classroom. In *British Education Research Journal*, 29 (3) p345-367

Ollerton, Mike and Watson, Anne (2001) *Inclusive Mathematics 11-18*, London: Continuum

Povey, Hilary (2003) Teaching and learning mathematics: can the concept of citizenship be reclaimed for social justice? In L. Burton (Ed.) *Which Way Social Justice in Mathematics Education*, Westport CT: Praeger Publishers.

Povey, Hilary and Angier, Corinne (2004) Some undergraduates' experience of learning mathematics. In *Proceedings of 28th Psychology of Mathematics Education (PME) Conference*, Bergen, July 2004

Povey, Hilary and Angier, Corinne (2006) Storying Joanne, an undergraduate mathematician. In *Gender and Education* 18 (5) p459-471

Rodgers, Maire (1990) Mathematics: pleasure or pain? In Leone Burton (Ed) *Gender and Mathematics: an International Perspective*, London: Cassell

Rogers, Pat (1990) Thoughts on power and pedagogy. In Leone Burton (Ed) *Gender and Mathematics: an International Perspective*, London: Cassell

Tahta, Dick (1994) Coming up to Russian expectations, *Mathematics Teaching*, 146

Walden, Rosie and Walkerdine, Valerie (1985) *Girls and Mathematics: From Primary to Secondary Schooling*, Bedford Way Paper 24, London: Institute of Education

Walkerdine, Valerie (compiler) (1989) *Counting Girls Out*, London: Virago

Watson, Anne (1996) Problematising confidence: is it a helpful concept? In *Proceedings of British Society for Research into the Learning of Mathematics* Day conference, 9 November 1996

Watson, Anne and De Geest, Els (2005) Principled teaching for deep progress in mathematics: improving mathematical learning beyond. In *Educational Studies in Mathematics*, 58, 209-234.

Watson, Anne and De Geest, Els (2008) *Changes in Mathematics Teaching Project*, www.cmtproject.co.uk