



## *Fables: The Tortoise? The Hare? The Mathematically Underachieving Male?*

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**ABSTRACT** *This article reports on some results from an interview-based study with 70 practising research mathematicians, 35 women and 35 men, at universities in England, Scotland, Ireland and Northern Ireland. The aim of the study was to explore epistemologies of these mathematicians and any impact of them on how they conducted their professional lives. In this article, three conjectures are examined. The first was that career experiences would differ between females and males, as they indeed did. The second was that women would be differently distributed to men within the disciplinary areas, which was not the case. The third was that gender would have no effect on how these mathematicians understood and practised their discipline, which was the case. In the concluding section of the article, the findings are related to the learning of mathematics, particularly in schools, where the expressed heterogeneity of these mathematicians is replaced with an insistent drive towards homogeneity, and that homogeneity reflects a discipline which has been dominated by male styles, choices and expectations.*

I drew arrows in different colours to follow the path of her lover's mathematics, and hers. I used single lines for her, and double lines for his. I used all the colours of the spectrum. Slowly the sad empty room became as bright as a rainbow. It was like drawing two different journeys across a map, her journey and his. It took the rest of my adolescence. And though I joined up many arguments, by the time I'd left school, I could see how different two journeys could be.<sup>1</sup>

### **Introduction**

For more than 20 years in the UK, especially since the passing of the Sex Discrimination Act in 1975, and at least 10 more years in the USA, concerns have been expressed about the participation and achievement gap in mathematics studies between females and males. At the outset, the gap which was raising concern was in schools where despite

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equal numbers and apparent equal access, considerably more boys than girls were presenting themselves for, and gaining success at, public examinations in mathematics. In the past 5 or so years, growing concern has been publicly expressed about the performance of boys, particularly, in the UK, in relation to the examination taken at 16+, the General Certificate of Secondary Education (GCSE). However, a report in *The Times* in 1992 not only drew attention to the steadily widening gap with girls but pointed out that 'male candidates were much more likely to achieve the maximum points score used for university entrance. One in eight boys had the equivalent of three A grades compared with one in 11 girls'. Furthermore, 'studies at Oxford and Cambridge universities suggest that male students widen the lead they acquire at A level' (O'Leary, 1992).

In a recent seminar paper, Jannette Elwood & Chris Comber summed up the current position.

Media coverage, which has followed the publication of results, especially in the last two years, has made much of this perceived underachievement of boys and has contributed much to the growing backlash against girls' success. One such headline asks: 'They're falling behind girls at school. Are boys in terminal decline?' (*The Independent*, 18th October 1994) ... The purpose of the statistical review in this last section has been to show that the patterns of performance, especially at A level, are more complex than is generally assumed and at one of the most important stages of schooling and examining, males are still ahead. (1996, p. 5)

So, little has changed in terms of the grasping of opportunities for a future in the mathematical area. Despite the undoubted evidence overall of the underachievement of some boys at the end of compulsory schooling, a pattern of disparity in favour of males continues as students go forward toward choosing a mathematical career and embarking upon the necessary study at university. Elaine Seymour & Nancy Hewitt reported for the USA on:

the low ratios of women-to-men among college freshmen indicating an intention to major in science and engineering—five or six men to one woman in engineering, and two or three men to one woman in the sciences ... the proportions of women and men who declare an intention to enter mathematics majors are similar ... their [women's] persistence rates are significantly lower than those of their male peers ... [so] the under-representation of women increases during the undergraduate years. This picture is especially puzzling because there is some evidence that women entering S.M.E. [science, mathematics, engineering] majors have higher average performance scores than their male counterparts. (1997, p. 234)

When it comes to taking up career positions in universities as research mathematicians, Christine Heward and her colleagues have pointed out that '[w]hile women now constitute half of the undergraduate students in higher education in the UK and the representation of members of minority ethnic groups is rising steadily, this is not reflected in the composition of the academic profession, especially its senior echelons' (1995, p. 152).

In this article, I am reporting upon a recent study which involved the participation of some practising research mathematicians in the university sector. I wanted to investigate to what degree career differences were reported by female and male mathematicians both from the perspective of their experiences and from the ways in which they

understood and practised their discipline. I was interested in asking how this information compared with pupil experiences in schools and whether I could find evidence of continuities and discontinuities which may be relevant to the issue of achievement and representation in the discipline.

### Career Research Mathematicians

In 1997, I undertook a study of some women and men in career positions as university mathematicians. I wanted to find out how they come to know mathematics, what their feelings are about the nature of knowing mathematics and what career experiences they have had that might have influenced the positions they take. I approached female mathematicians since one of my interests was in similarities and differences between the sexes and I knew from previous work (Burton, undated) that female mathematicians were more difficult to find than males. They were invited to be interviewed about their 'life history' as mathematicians, especially their feelings about the nature of knowing mathematics for them, and how they come to know. When a female agreed to participate, I asked her to nominate a male in her institution who was equally agreeable to join the study. Although the choice of male, and reasons for choice, were left to the female participant, the majority chose someone at the same level of the hierarchy as themselves. However, I do have three pairs who are marital partners. By this means (snowballing), I gathered 70 participants, 35 women and 35 men. My participants were well spread in terms of their employment status (see Table I).

There were twice as many male as female professors; however, we are looking at very small numbers and so these can only be observations about the distribution of my participants. The Oxbridge (the universities of Oxford and Cambridge) system is such that I have listed anyone who is not a reader or professor as a lecturer, including some who have senior administrative responsibility and others who are tutorial fellows. I interviewed at 22 institutions, of which four were new universities, in England, Scotland and Ireland, North and South.

I met all except six participants face to face in their offices, the remainder being interviewed by telephone. The interviews ran from an hour to the longest which was two and a half hours. Most were between one and a quarter and one and a half hours. The telephone interviews were among the shortest and I attribute that to the lack of personal, non-verbal information to both parties in the conversation. (For a useful discussion on telephone interviewing see Miller, 1995.) However, it is also fair to say that, overall, the interviews with my female participants were longer than those with the males and I conjecture that the reverse would have been the case if I had been a male. All the interviews were tape-recorded and, additionally, I took notes. Prior to the interview, I sent a list of areas that I wanted to explore about them and about their coming to know mathematics. I invited them to delete anything that they did not wish to discuss. No one

TABLE I. Distribution by status

	Post-doc	Lecturer	Senior lecturer	Reader	Professor	Senior research officer	Research fellow
Females	1	19	7	3	3	1	1
Males	1	17	9	2	6		

requested any deletion. I also gave them details about the conduct of the study, including my commitment to return to them notes of the interview for agreement/amendment or deletion prior to my undertaking analysis. They were, of course, assured of confidentiality.

In this article I am reporting upon three conjectures with which I began. First, there is considerable evidence that the career experiences of males and females differ substantially and so I was interested to see if this was the case for these mathematicians and, if so, in what ways. Second, previous work (Burton, undated) had found that female mathematicians were more likely to be in some areas than in others so I expected that the distribution across the mathematical specialities would be different for women and men. Third, I believed that the process whereby mathematicians are cultured into their discipline during their period of study would lead to there being no substantial differences between the ways in which females and males understand and practise mathematics; that is, I believed that where I found differences between mathematicians, gender would not be an important variable. I will deal with each of these conjectures in turn. In the final section I relate my findings to the learning of mathematics in schools and point to lessons which I believe must be learnt if success in mathematics is to be equally achievable by any pupil who desires, or needs, it. I also address the evidence my study adds to the debate about boys' underachievement.

### **Do Females and Males have Different Career Experiences?**

Some of my female participants, similarly to those in many other studies, had different career patterns from their male counterparts. Such differences have been extensively reported in the literature (see, for example, Marshall, 1984; Aisenberg & Harrington, 1988; Lie & O'Leary, 1990; Acker & Feuergerger, 1996; Heward, 1996; Morley & Walsh, 1996) and, as Christine Heward has pointed out, 'depend[s] on an understanding of "career"' (1996, p. 11). One frequently explored phenomenon is that of women who 'tread water' while in their childbearing years and this is certainly one difference on which my participants reported. However, additionally, they spoke about themselves in distinctive ways, they discussed PhD supervision differently, they reported examples of sexist behaviour, and a few spoke of their negative experiences of Oxbridge. I deal with each of these in turn.

#### *'Treading Water'*

None of my male participants experienced the kinds of delays in completing their formal education on which some females reported. Among my participants, in every case such career breaks were to do with marriage and children whereas a year out between, say, school and university was seen as an enhancement to education and certainly not as a disadvantage. Four typical examples follow:

I actually went to university 8 years after I left school. (Female pure mathematics lecturer)

At the end of my undergraduate career, I married and started a family. I had seven years off with the children and then came back to do a PhD. (Female pure mathematics lecturer)

A third described how she went into teaching straight from graduating. After about 3 years, married, she started a research degree but had to move with her husband when

he was posted abroad. Returning 3 years later, with a child, she began again but had to change her area. Again, a posting abroad left her working at her dissertation on her own in a foreign country. She finally submitted it as an MPhil but has maintained her research career despite her lack of a PhD. She said:

It has taken twelve years for me to discover that everyone else doesn't know much more about it than I do. (Female pure mathematics lecturer)

The fourth went to Oxbridge where she was unsupported and undirected. She dropped out, married, had children and while her husband completed his qualifications and began an academic career, she spent 10 years outside mathematics by which time she had lost self-confidence. She reclaimed her academic interests through voluntary work and gaining a language 'Ordinary' level GCSE, after which she applied to start a mathematics degree at the university where her husband was then working. She got her degree and then a PhD:

I do now describe myself as a mathematician but I think for a long time I just said 'I do maths'. (Female senior lecturer applied mathematician)

Hearing stories such as these, I felt enormous respect for the ways in which these women persisted, managed complicated lives in a manner which enabled them to continue their studies, and often had to cope with the kinds of social and personal problems and responsibilities from which their male counterparts are frequently protected by their female partners. However, the academic world in which they have chosen to make their careers values only the products of their academic work, neither recognising nor respecting the contribution that some of these experiences could make to the organisation and management of their institutions. Despite starting out on their university lives qualified and motivated equivalently to the males, these females' ambitions now lie in their work and not in expectations of higher status within the academic world. That they were aware of this was demonstrated when they pointed out that, in involving a male colleague at the same level of the hierarchy to join the study as their 'pair', they might have to choose someone considerably younger.

### *Self-image*

Women are frequently described, especially in the gender and mathematics literature, as lacking in confidence. The notion of 'confidence' is treated unproblematically (see Clute, 1984) and the idea is now very widespread that females are less confident than males in the mathematics classroom, although it could be that they are just more willing than males to express their lack of certainty. Indeed, so widespread is this assumption of female lack of confidence that one begins to wonder how much of a self-fulfilling prophecy it has become. In schools, confidence is persistently linked to 'ability' and achievement and it is possible that part of learning to be a mathematician is also learning about the kind of behaviours that are deemed appropriate for your sex. Many of my female participants described themselves as lacking in confidence. For example:

I tend to think things I do aren't terribly important which is probably to do with my own lack of confidence. (Female applied mathematics lecturer)

I am so inclined not to believe myself, I have to be 105% certain that I know something before I believe it. (Female pure mathematics lecturer)

One woman described by her colleagues as very able and respected said:

Maybe a personal chair would be over-reaching myself. (Female reader in applied mathematics)

They were also good at self-labelling *and* at picking up the labels pinned on them by others:

I don't think I am a very original person. (Female pure mathematics lecturer)

At 23 or 24 I felt like the thickest PhD student ever. It ceased to matter what I had done. My perception of my work was completely out of kilter. All these men talked. I couldn't talk. (Female pure mathematics lecturer)

If I am stuck, I try to think if I have been stupid. I have a great tendency to assume that it is me. (Female pure mathematics lecturer)

However, lest it be imagined that *only* women spoke in this way:

Mathematics had always been easy but it had never occurred to me that I was good enough to do it. (Male applied mathematics postdoctoral fellow)

Some people can face a problem that is rather ill-defined and we don't know what the answer is and there are others, and I am one of them, who are a bit more uncertain when faced with new challenges. (Male lecturer in statistics).

One way of expressing your self-image is by describing whether you see yourself as centrally placed in your discipline. If you don't, a way of coping with that is to distance yourself from the behavioural norms that you observe since, once inside, you will be expected to conform to these norms. I asked my participants, 'Who are the mathematicians?' One of my female participants expressed what was said many times over by females:

I consider myself a mathematician because I lecture and research in mathematics and I suppose that by definition makes me a mathematician. But I have met people whom I consider to be 'real' mathematicians and I am not one of those people. (Female pure mathematics lecturer)

But there was another variant which was equally widespread:

I suppose I feel that people whose life and soul is entirely within mathematics and they have a high profile on the public front I would consider to be mathematicians. People who are so engrossed in it that they cannot see anything else in life. I don't think it is a particularly admirable state. (Female applied mathematics senior lecturer)

And if it isn't an admirable state, then:

I didn't want to be totally obsessed with mathematics. There were too many other things that I enjoyed ... there was the maths building which was a really nice environment but you did see people sitting around on their own at blackboards scribbling away. There was an obsessive sense about it. (Female pure mathematics senior lecturer)

The culture of the profession, in this case in the USA, may set up personal conflict:

In the States, I worked in an Institute where the work was unsupervised but the atmosphere was highly competitive. I became disillusioned with that, and the sense of self-belief that Americans seem to have but also the fact that everything had to be instantly commercially viable. (Male applied mathematics lecturer)

Once established, competition operates everywhere. For example, in seminars:

There is a particular culture which we are not used to where a seminar is a defence of your result against the audience which interrupts all the time, questions you aggressively, it is highly competitive. I hate that. The seminar is based upon the following structure—here is somebody's results ... here is why it is wrong, aren't they idiots. Nasty. I can't cope with that. (Female reader in pure mathematics)

or in the collaborative role:

I think two of us were trying to play the same role and I felt challenged all the time. It was also too competitive and the wrong things were made too important. One of the collaborators was used to a very argumentative style and I hated it. (Female pure mathematics lecturer)

And male feelings of insecurity with respect to language may lead to cultural constraints on their view of mathematics:

There is a macho view that the verbal is a corruption and a mortal danger. That once you get into words there is an associated lack of rigour. (Female pure senior lecturer)

### *Research Supervision*

There is great room for damage as well as advantage within the research supervisory relationship and it is an area which, in most universities, has not been addressed from the perspective of staff development. For some of my participants, it worked very well indeed although a few males acknowledged that they were aware that there were colleagues who were less well supervised by the same supervisor. Others suffered. Often, but not always, these were women.

One thing I learnt from my own experience of undergraduate and post-graduate work was the isolating experience of being the only one. (Female pure mathematics lecturer)

I never got beyond being intimidated by my supervisor and the earlier part of my PhD left me feeling that I wasn't well able to cope and there wasn't much help or support. (Female senior lecturer in statistics)

I started off with the Head of Department as supervisor. He is a bit intimidating as a person. I couldn't cope with his style. After a while I was adopted by another lecturer so I switched. This was good initially but then I realised that perhaps the second supervisor had a slightly false impression of me and thought that I was needing looking after so we discovered that personality-wise we weren't really suited. (Female pure mathematics lecturer)

Not one of my 70 participants had been supervised by a female. However, many of the women were currently supervising so this is, presumably, a transient phenomenon. But for one of my male participants:

My supervision was an awful experience because my supervisor was, in my judgement, an emotional bully. (Male applied mathematics senior lecturer)

Since so many were reporting unsatisfactory experiences when they were supervisees, I asked if, when they became supervisors, they applied this learning to reflect on how they

would supervise. The majority said that they did not. They felt that every student was an individual and must be treated as such. They did not seem to feel that there were things that could be generalised and learnt. However, most of the women made statements consistent with one or both of the following:

I do try not to be remote and to be approachable. (Female applied mathematics lecturer)

I am sure that students can benefit from working on problems together. It is how I learnt ... As a supervisor, I make myself available, but I think students often find help in other places, from other students. (Female applied mathematics lecturer)

Many of the women who were supporting students working together explained how they had helped this to happen in their institution. Only at Oxbridge did such staff/student seminars seem to have a long history and those who had experienced them spoke positively of these experiences and their attempts to institutionalise something similar.

Both men and women expressed concerns about the supervisory relationship, often in respect of the practice of supervisors of mathematics research providing supervisees with the problem(s) on which they work for their PhD. This poses a challenge to many prospective supervisors, which they find to be onerous. From the disciplinary perspective, it ensures both continuity and control—practices which can be very different from those which may be found outside of mathematics.

Finally, I was told a story of sexual harassment represented in the tip of the iceberg that follows:

The supervision was good in terms of work but he wanted more than that so there were personal difficulties and I was too young to know what was going on and appreciate that I had to do something about it. So it was difficult and I did have to manage not to be on my own with him. Obviously I was very reliant on him and the working relationship was good but it still makes me feel pretty angry about his behaviour. (Female pure mathematics senior lecturer)

The misuse of power, the location of blame and management on the recipient of the behaviour, the expectation that it must be possible to separate the personal from the professional are all present in this story. We see them again in the next section.

### *Sexist Behaviour*

Whilst the head of the group is married to a feminist woman, he is sexist and he couldn't quite believe that a woman could do the kind of stuff that they did. There was a definite prejudice. The second supervisor was very different. Again, pretty sexist but he was keen to have someone working with him so he did give me quite a lot of support ... I occasionally get in touch, but he never gets in touch with me. (Female reader in applied mathematics)

In the first couple of weeks at university, one of my lecturers said, 'Now you girls, I want you to be married to maths. I don't want you getting up on top of your wardrobes and saying go away, go away. This is to be a real marriage'. (Female pure mathematics lecturer)

A colleague who was at a conference where someone was discussing my work referred to me as 'she', to which the response was that that work could not



have been written by a woman. That happened in the seventies. (Female reader in pure mathematics)

In looking at applications for a postdoctoral position, a supervisor:

made a comment that if it was a choice between someone like me and a man with a family he would give it to the man [and] a younger colleague mentioned to me when I got my PhD when was I going to marry and he asked what else was there for me to do now I had my PhD? (Female reader in applied mathematics)

One participant said:

I think there is a body of mathematicians who make the rules up, and I don't understand how they have made them up, therefore they can't be logical so they must just make them up because they are part of the Old Boys' Club. (Female pure mathematics senior lecturer)

These quotations describe the ways in which some men construct the mathematics environment so that their female colleagues can be in no doubt about their lack of 'proper' fit. There is clearly ambivalence since an able woman can and does contribute, but while that contribution may be valued, *she* does not necessarily feel valued unequivocally. Most woman academics can recount experiences of this kind, no matter what their seniority or their specialism.

The inner battle that professional women fight is particularly difficult because its terms are rarely clear. Unpredictably, women will encounter trouble that looks like a knot of circumstance that they seek to pull loose, not recognizing at its center—except possibly in retrospect—a profound conflict concerning their own identities. (Aisenberg & Harrington, 1988, p. 8)

*Oxbridge*

The culture of mathematics classrooms is not only one which reifies confidence and 'ability' but also has a 'sink or swim' feel to it. Many of my participants referred to lack of support or nurturing when they were doing their undergraduate or their postgraduate degrees. Whether it is due to the predominance of the role of Oxbridge in the training of future mathematicians, or to some imbalance in the distribution of the participants in my study, almost half of my participants had experience of Oxbridge as career mathematicians and/or as learners (see Table II). That this is not an artefact of this study is borne out by Halsey (1992). The teaching and learning style which dominates in Oxbridge, and which clearly suited some, equally failed to meet the needs of others. (I refer to Oxbridge in order to offer my participants some protection.)

TABLE II. Experience of Oxbridge

	Oxbridge only Undergraduate	Oxbridge only Postgraduate	Oxbridge Undergraduate and postgraduate	Graduated elsewhere, working Oxbridge
Female	6	1	5	1
Male	2	5	5	5



At Oxbridge I felt that I was being put down all the time and I am still quite angry about it. I could have done so much more with a bit of encouragement. (Female pure mathematics lecturer)

I went to Oxbridge but I left after a year and took a year out. I had found that year really hard. I thought the mathematics was beyond me. I think their system is very bad for a certain kind of person. They don't do any nurturing. Your main source of knowledge was the hell of one-to-one tutorials. I used to feel ill every week before seeing my tutor.

A year later, at another university, she

started really enjoying mathematics. Basic things that I hadn't been able to grasp at Oxbridge I got interested in there. (Female pure mathematics lecturer)

She went on to complete a Master's degree and a PhD. The lack of nurturing was underlined by another female who had gone to Oxbridge as an Exhibitioner and said that:

I didn't even find the Library till the third year. (Female statistics professor)

### Are Females and Males Differently Distributed in their Mathematical Specialities?

As Table III shows, females and males in my study were well distributed across pure and applied mathematics and statistics. While these distinctions are neither robust nor prevalent everywhere outside, or even inside, of the UK, from the perspective of my participants' confidentiality and the small numbers in some specific cells, it seemed more useful to use these three groupings.

My previous work (Burton, undated) had led me to expect that I would find more female statisticians and fewer female applied mathematicians. This is not the case amongst the group that I interviewed, although the pure mathematicians do dominate; I did not choose for specialities or search within particular speciality groups. When a prospective female participant asked me if there were any criteria for choosing a 'pair', I said I did not mind as long as I was given information about the grounds for the choice. In no case was I led to feel that the choices caused any problems to the study. However, they were almost always made on level in the hierarchy and frequently on speciality. So a female applied mathematics lecturer was more likely to choose a male applied mathematics lecturer and this is one explanation for why the numbers are so close within specialities. However, some women *did* have difficulties in persuading a male colleague to participate, so it is fair to remark that my males might be less representative of the kinds of men in academic mathematics than my females, not as mathematicians, but as people. In summary, then, females, in my study, were as well distributed as males but, also, were themselves well-distributed across pure mathematics (48.5%), applied mathematics (28.6%) and statistics (22.9%).

TABLE 3. Distribution within mathematics

	Pure mathematics	Applied mathematics	Statistics
Females	17	10	8
Males	15	13	7

### **Do Females and Males Think About and Practise Mathematics Differently?**

My third conjecture that the sociocultural system which produces mathematicians is far stronger than differences in gender was borne out by my participants. I found, of course, many different ways of 'understanding' mathematics, including a small number of mathematicians (12 of the 70) who did not adopt the simple objectivist, positivist stance on the discipline expressed as follows:

I think it is there and it is waiting to be discovered.

The existence of wide diversity on the nature of mathematics in a group of 70 mathematicians must lead us to expect that vastly different positions do exist within the discipline on important issues such as its nature, how you work within the discipline, how you come to know something and how you know when you know. It is clear that this diversity should, but at present does not, affect the wider view on mathematics and especially the view that influences what is done in schools. I will take this up in the conclusion. Where there are patterns, these are more likely to exist within a speciality than across specialities but even within, say, applied mathematics, I found quite substantial differences in how members of my group of mathematicians understood their discipline. The following quotations give a small sense of this diversity.

I think that maths is a creation of our minds that sometimes coincides with reality in a useful way.

There is something too strong in it for mathematics to be considered as a cultural artefact.

I realised that the mathematics wasn't out there, you didn't stumble upon it, it is in my head and that was the biggest shock of my life.

I take a sort-of Chomskian view of mathematics. There is some deep structure in it which causes us to do the mathematics we do. It isn't out there in any sense, but it goes against the evidence to say that it is all invented.

Mathematics is a product of people. It does turn out to be extremely useful. But even utility is a cultural product.

Gender did not feature as relevant to these differences. The range of quotations underlines how heterogeneous are the views of these mathematicians about the nature of mathematics. Despite the assumption widespread in society generally that mathematics is actually mathematic, that 's' at the end of the word is central to the breadth and diversity of positions which these mathematicians are adopting.

### **Conclusion: fables and realities. School to University? Underachieving Boys?**

The impression that I have been given and on which I have reported in this article is of two distinct cultures affecting career mathematics, a female and a male. As with all cultural differences, there are individuals who either span both cultures or who lie close to the alternative. But the overall impression is that their gender has affected their careers in important ways which have been addressed in the first section of the article. It would appear from my participants that the women's and the men's career paths are certainly not the same, as they recounted their own difficulties with the cultural climate—particularly its competitiveness, the use of language, the role of supervision, the

privileging of certain kinds of people *and* their behaviours. These support the norms which operate in favour of the existing majority and leave the rest stigmatised as unacceptably 'other'.

[I]t is time to go beyond simple accusations of a discriminatory climate ... it is what the university stands for, and what it rewards and what it ignores, that is at issue. The disadvantage that women encounter is more systemic than it is intentional—though no less problematic for all that. (Acker & Feuerverger, 1996, pp. 417–418)

I believe that the spread of my participants across the mathematical specialities and what I think is best described as their heterogeneity on the nature of mathematics, irrespective of sex, is both to be expected and a source of strength within the discipline. If mathematics *were* as homogeneous as is sometimes pretended to be, and mathematicians matched that homogeneity, not only would the discipline itself suffer from these constraints but the people within it would be unable, and possibly unwilling, to draw on their differences to influence their work. Of course some of my participants would deny that their mathematics was a function, in part, of their personal history, seeing it as 'objective' and independent of individual influence, but they have colleagues who do not agree with them. So my interviews were a source of great interest, partly because the people I was interviewing were so different, had such varied histories, experienced life in so many different ways. However, here I must introduce a caveat. Although I interviewed equal numbers of men and women, all except one of my participants were white and European. (Some had come to the UK from the [white] Commonwealth.) Not all, but most, were first language English speakers. Only by extending the study outside of Europe and outside of the white community would I be in a position to draw stronger conclusions. However, the universality of the mathematics culture is so pervasive and exerts such a hegemony that possibly local culture would be unable to intrude upon mathematical culture. That is a conjecture yet to be tested.

Nonetheless, similarities were also very noticeable. I have used quotations that were representative of the statements of sufficient numbers of participants so that they can be relied upon not to be maverick. However, where many fewer men have been quoted, such as in the section on 'Self-image', this is because there were very few who expressed the kind of self-doubts more frequently heard from the women, and none talked in terms of sexist behaviour. My male participants either spoke positively of Oxbridge or, where there was a caveat, this was described in very personal terms. For example:

At school I had been best at lots of things and I was horrified to discover at Oxbridge that I wasn't the brightest mathematician there. (Male pure mathematics lecturer)

So the fable of the underachieving boy has not yet permeated the lived experiences of the professional mathematician in universities to the degree where a diminution of the masculinist culture is observable. Whether it will, in the future, is an empirical question which it is yet too early to test. Like the hare of the fable, there are small indications that the practices and beliefs of the past, which constitute the pervasive masculinist culture, are at risk of challenge. But this does not appear to be intruding upon the current conviction of many male mathematicians of the rectitude of the positions they adopt with respect to their perceived superiority. Some women *are* complaining about many of the manifestations of this culture and, indeed, attempting changes, and, like the tortoise, they are making slow and steady progress. Their numbers, however, are still very small. They

are more broadly spread across the discipline but the power is not distributed. To be accepted, some women seem to feel the need to demonstrate the acceptability of those aspects of the culture against which other women react so powerfully. (For example, in the content analysis of their published papers, which I am undertaking with a colleague, we have noted that it is more likely to be men who deviate from, or reject, positivist language.)

Most distressing is the difference between the richness of mathematics understood by my participants and the narrow, bounded subject encountered at school. One offered a definition of the discipline:

Mathematics is that part of knowledge where structures can be abstracted and axiomatised in a completely systematic way without the recourse to examples.  
(Male pure mathematics lecturer)

I would like to draw out the difference between the mathematics of this quotation and the mathematics of the extract which headed this article, a mathematics which is responsive to the person and can represent or describe very different journeys. The existence of a highly prescriptive mathematics which does not match the discipline experienced by all of those within it should raise questions about who feels included and who is, or feels themselves, excluded. In mathematics, the underachieving boy is, in fact, an underachieving person, a person who finds little motivation or interest to pursue mathematics. Numbers entering university mathematics degrees have been falling for some time. Amongst those who are undertaking mathematical study, males continue to be in the majority and amongst those gaining employment in universities, females are still rare. The further up the hierarchy one goes, the rarer are the females. That they are there at all and in growing numbers demonstrates that being female is not the indicative criterion that is excluding women. That is, women who fail to enter mathematics are not doing so because women's mathematical minds are not quite able to cope. The kinds of descriptions reported upon here are of a culture, not of intellect. Cultures are created by and for people and are changeable by people. But only if they want to change them. At the present time, the culture of schooling is in conflict with the disciplinary culture in many different ways. Schools are pushed to demonstrate equal access and opportunity but the pervasive culture of the discipline is of exclusivity. Schools are expected to teach mathematical content which is narrow and prescriptive and in no way matches what mathematicians describe as their focus. Schools, and universities, choose to teach mathematics in a way which is restrictive, homogeneous and expert-dominated. But the same people in universities are practising a mathematics which is rich, heterogeneous and people-created. Finally, many pupils in schools speak of mathematics as boring (see Keys & Cres, 1993; Boaler, 1996). My participants presented a world of excitement, of fun, of challenge, of fascination. Let two of them have the final word:

It is very exciting when you make a connection, put a piece in a jigsaw, see how some ideas that were understood by one group of people were exactly what another group of people needed to make something work. (Female applied mathematics lecturer)

When I think I know, I feel quite euphoric. So I go out and enjoy the happiness. Without going back and thinking about whether it was right or not, but enjoy the happiness. When I discover something, I just enjoy the feeling.  
(Male pure mathematics lecturer)

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### NOTE

[1] Sue Woolfe (1996) *Leaning towards Infinity*, p. 282 (Sydney, Random House).

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