

Boys, Girls and Mathematics

BEGINNING TO LEARN FROM THE GENDER DEBATE

by Robin Bevan

Introduction

Mathematics and the teaching of mathematics have been amongst the subjects of close interest within the continuing gender debate. The implications for Heads of Mathematics arise in grouping, in teaching styles and in establishing departmental expectations. It is vital, however, that any responses are properly informed. Researchers have examined factors that influence students' experiences of school mathematics, and have sought to uncover those which account for variations by gender. Here we will consider some of their findings and their explanations, with a view to informing the planning of mathematics teaching.

It is difficult to offer specific guidance: schools vary! Single sex and co-educational schools, comprehensive and selective schools – each has particular circumstances to address. Departmental leaders are encouraged to review their pupils' performance data by gender, to interview their students to identify any particular perceptions they have of mathematics teaching, and to reflect after reading the evidence whether there might be some route to improvement.

Some Background

From the early 1980's feminist analysis served to illuminate the extent of sexism in education. It highlighted the widespread problems, and the degree of disadvantage experienced by girls in school (Spender and Sarah, 1980). To some extent these revelations were not new. More potent,

however, was the recognition at this time that, during the decade after Equal Opportunities legislation and despite all the earlier feminist commentary, gender equality in education remained a myth (Spender, 1982). The achievements of women were being left out of the curriculum. Boys were receiving privileged attention in the classroom (Kelly, 1988). It was striking how little had actually changed over the preceding years.

It is doubtful even now that the necessary transformation has occurred in education: whether in the curriculum, in the classroom, or in institutional frameworks. However, in the meantime, there has been extensive research, seeking to identify routes towards the more effective teaching of girls – and more recently boys. That research has suggested that the gender assumptions made by individual teachers '... strongly influence their specific judgements in relation to teaching and choice of curriculum materials' (Abraham, 1995, p. 136). It is necessary to challenge teachers regarding their own preconceptions, and to promote informed dialogue surrounding these issues.

Dominant Themes

In considering the research, it is possible to identify a number of distinct and dominant themes. Each of these themes will be significant in addressing variations by gender. First is the relative attainment of boys and girls, in a variety of mathematical assessments under a variety of conditions. It is perhaps the very fact that differences by

gender have been reported which has served to motivate and legitimize subsequent studies. Recent studies make frequent appeal to the work of the Assessment of Performance Unit (APU, 1980-2; Joffe and Foxman, 1988), some elements of which are outlined below. The second theme relates to attitudes towards mathematics that appear to differ according to gender. It is difficult to separate the adoption of these attitudes from the diverse and powerful forces that dictate student expectation – the third theme, which has also received attention by researchers. More recent studies have illuminated how gender differences in mathematics can arise through variations in learning styles, in teaching styles and in the organization of learning.

Relative Attainment

'An analysis of 98 studies of the differences in mathematics achievement between males and females shows that the average difference is very small and has been decreasing steadily.'

(Friedman, 1989, p. 32)

Much of the concern that has existed regarding the relative attainment of girls and boys in mathematics can be traced back to the work of the Assessment and Performance Unit. The second of their secondary surveys reported: 'Boys scored higher in 14 sub-categories (of mathematics) and the differences were significant in seven of them. The difference in modern algebra, where girls scored higher, was not significant ...' (APU, 1981, p. 76). Further analysis, looking at several years of data, allowed a more secure generalization to be made, that '... boys are best, relative to girls, in the applied and practical areas – measures and rate and ratio – while girls do best relative to boys in computation with whole numbers and decimals and some aspects of algebra ...' (Joffe and Foxman, 1984a, p. 26). However, although the overall results consistently supported these declarations, it was also true that the higher mean scores of the boys could be accounted for by the disproportionate number of boys in the top performance bands (APU, 1980). Not only that, but Joffe and Foxman comment that the actual '... differences in performance are minimal in most topic areas' (op. cit., p. 26).

Where differences in performance exist, they appear to be relatively small, and largely concentrated amongst the highest attainers. Moreover, there is an accumulating body of evidence which suggests that these differences are now in decline (Friedman, 1989), and current assessment at GCSE in mathematics reveals performance levels that are broadly similar (Arnot *et al.*, 1998). It is possible that this trend may be attributed, in part, to the changing style of examination assessments.

Attitudes

'... boys also showed a significantly greater tendency to judge topics as easy or very easy ... As a general rule, boys perceived the topics to be less difficult than their success rate would warrant ...'

(APU, 1981, p. 90)

'... significantly more girls than boys believed that they had difficulty in remembering formulae, in understanding mathematical topics, and in applying the work that had been studied in class. Almost 20 per cent more girls than boys considered themselves lucky if they did well on a maths test ...'

(APU, 1981, p. 83)

Pupils' perceptions of mathematics matter. Three factors influence this arena: (i) the pupils' expectations of mathematics, (ii) the types of activity that constitute their mathematics education, and (iii) any prevailing stereotypes. The greater the agreement that exists in these strands, the less the 'divorce between gender and success' (Walden and Walkerdine, 1982, p. 28).

Although the variations in attainment can be considered to be relatively small, the variations in the attitude of boys and girls towards mathematics are striking. Joffe and Foxman (1984a) noted not only that girls express greater uncertainty about their mathematical performance, but also that boys express a greater expectation of success. Furthermore, there is evidence of a disparity between a pupil's expectation and their subsequent performance – a disparity with an observable gender bias. 'Examination of comments reveals frequent occasions when pupils have been successful on the item but still express doubt about their performance or if they think they have completed it successfully attribute their success to luck. This appears to be more frequent in the case of girls.' (Joffe and Foxman, 1984b, p. 16). The evidence also suggests that girls' uncertainty, and boys' confidence, extend beyond individual problems to their general view of mathematics. When pupils were asked to rate the perceived difficulty and usefulness of mathematical topics and items, girls tended to make more moderate assessments; they use the extremely positive and extremely negative positions on the scale far less than boys do (Joffe and Foxman, 1984a, p. 25).

If confidence varies by gender then so does enjoyment: Joffe and Foxman (1984b) observed that a statistically significant sex difference arises in rating the enjoyment of mathematics, with 7% more girls opting to disagree with the statement: 'I enjoy working on maths problems'. Whilst this variation relates specifically to tackling problems, overall enjoyment of mathematics reverses during the secondary school. 'Overall girls at age 11 say that they enjoy mathematics slightly more than boys do. However, at age 15, the position is reversed with girls indicating that they enjoy the subject less.' (op. cit., p. 8). Aspects of the secondary curriculum, and how it is taught, appear to be instrumental in this change of outlook.

It does not help when seeking to address the decline in either confidence or enjoyment, to find subjects such as science and mathematics '... are rated as *'masculine'* by pupils and preferred by boys; English, humanities, ... rated as *'feminine'* and preferred by girls.' (Arnot *et al.*, 1998, p. 31). In this regard there has been little recorded change in the past decade. Fox *et al.* recorded two key findings in 1981, following a survey of American high school students. First they noted that more students believe boys are better than girls at maths; and, secondly, more boys than girls are likely to agree with the statement that 'maths is a male domain'. Based upon their observations, they concluded that only through specific intervention could the effect of these attitudes be countered. Specifically they argued for the early identification and 'tracking' of the mathematically gifted as crucial to their later willingness to continue studying maths (Fox *et al.*, 1981, pp. 197-8). This is an approach of particular relevance in promoting the confidence and interest of able girls.

Expectations

'One of the most pervasive findings in the literature on sex differences is the lower expectations which females hold for their performance as compared with males.'

(Deaux, 1976, cited in APU, 1981, p. 103)

It would be a mistake to assume that attitudes towards mathematics arise solely as the result of school experiences, and classroom activity. In the study mentioned earlier Fox *et al.* (1981) sought to identify an accumulation of factors which 'conspire' to generate and reinforce the gender-specific expectations in mathematics.

Both the roles and the particular predisposition of parents serve to inform the attitudes embraced by pupils. Parents often have lower educational expectations, in general, for daughters than sons. Moreover, they tend to have a greater acceptance of low levels of achievement in maths for girls than boys. When considering future aspirations, parents are inclined to think of maths as a more appropriate career for boys than girls; and within the domestic situation help for maths homework is more frequently sought from men than women. There is some evidence that both the careers advice and the counselling offered in relation to subject choice fail to redress this bias.

However, the outlook of the teacher remains a significant factor, and Fox *et al.* (1981) reported that this is not primarily a matter of the teachers' sex, which seems to be less important than behaviour and attitude. Indeed teacher encouragement is claimed to have been of considerable importance to many mathematics students, and is particularly noted in the biography of female mathematicians. It is unfortunate then to note that, at the time of their study, many teachers saw maths as a masculine domain.

In the Classroom: Teaching and Learning Styles

'Mathematics, as it is currently and widely taught, is not equally accessible to girls and boys and this appears to relate to preferences of pedagogy.'

(Boaler, 1997, p. 123)

Although substantial differences in performance have been discounted, and attitude differences attributed to extraneous sources; it is nonetheless critical to consider the influence of the classroom. The literature tends to focus upon the disadvantage experienced by girls in the mathematics classroom, but this serves to illuminate mathematics education for boys also. Drawing upon research (Gilligan, 1982; Belenky *et al.*, 1986) in developmental psychology, Becker (1995) claims that girls have traditionally been denied access to success in mathematics because of the styles of learning that characterize their approach. It is argued that they tend to be 'connected' thinkers who require the exploration of context and interrelationships when encountering new mathematics. It is proposed further that traditional models of mathematics teaching have encouraged 'separate' ways of working: discrete topics, techniques and abstract development of the subject. Placed alongside evidence from other sources, this argument appears tenable.

Style of presentation is not alone in influencing learning style. Head (1995) has suggested that girls prefer cooperative,

supportive working environments whereas boys work well in competitive, pressurized environments. Traditional models of pedagogy for more able students are then at variance with those apparently favoured by girls. Motivated by the view that neither inherent gender attributes nor the nature of mathematics itself could explain variations in attitude, Boaler summarizes the argument: 'Where feminist researchers have diverged from the more general reformists is in their claim that school mathematics has traditionally disadvantaged girls, because of the way girls tend to think and work and the ways they come to know.' (Boaler, 1997, p. 111).

This position is not new, and gains support from cognitive psychology. Drawing upon Pask (1976) and Holloway (1978), it is possible to mark a distinction in the learning of mathematics between 'serialists' and 'holists'. Neither writer provides an explanation of the origins of a disposition to adopt one or other learning approach, but they do report that a disproportionate number of boys exhibit holistic tendencies. Furthermore it has been established that '... the level of uncertainty at which individuals are happy to work is a distinguishing characteristic between serialists and holists ...' (Scott-Hodgetts, 1986, p. 74). A formal sequential teaching approach to mathematics not only relies upon frequent 'excursions into unknown territory', but also affords little opportunity to confirm dependencies between differing elements of the subject. The holistic learner is advantaged: he is more comfortable with the unknown, and more inclined to infer connections as they arise. In contrast the serialist is disadvantaged, as serialistic teaching doesn't address the needs of the serialist! Moreover, this can be formulated into an argument concerning learning style by gender. 'Because of the serialist nature of teacher input in the ... mathematics classroom, pupils who are predisposed to a serialistic approach are less likely to develop into versatile learners of mathematics than those inclined to adopt holistic strategies; the most successful mathematics students will generally be versatile learners; the existing evidence concerning difference in performance between girls and boys is consistent with there being a greater proportion of girls (than boys) with serialistic tendencies.' (Scott-Hodgetts, 1986, p. 75).

This explanation of gender differences has received more recent support: 'Boys show greater adaptability to more traditional approaches to learning which require memorizing abstract, unambiguous facts and rules that have to be acquired quickly. They also appear to be more willing to sacrifice deep understanding, which requires sustained effort, for correct answers achieved at speed.' (Arnot *et al.*, 1998, p. 28). Although such a traditional approach might appear to favour serialists, this will only be so in circumstances where the pace and style of the teaching permit consolidated understanding. If the sequence of 'facts and rules' appears arbitrary, the serialist suffers relative to the holist – notwithstanding any intrinsic mathematical connections understood, or even articulated, by the teacher.

This approach to gender differences serves to illuminate the differing needs of those who learn in different ways. It is cautionary to note, first, that Adey *et al.* (1998) identify a number of researchers who were unable to find significant gender differences in learning style. Secondly, '... that even if there were overall differences, the amount of overlap between the styles used by boys and girls would be so great

that it would be impracticable ... to treat boys and girls differently ...' (p. 18) on this basis alone. Nonetheless, it remains the case that recent summaries of research, such as Arnot *et al.* (1998) present no evidence that the gender variations in learning style are reversed. We are left then with the reasonable understanding that when compared across the population boys and girls do have different learning styles; but that such variations are either small or negligible in any one sample.

However, other dispositions appear to vary with gender also: some to the advantage of girls. 'There is evidence that girls are more attentive in class and more willing to learn. They do better than boys on sustained tasks that are open-ended, process-based, related to realistic situations, and that require pupils to think for themselves.' (Arnot *et al.*, 1998, p. 28). Whereas Boaler (1997) has noted in relation to a traditional approach: success appears to relate to pupils' adaptability. The boys adapted to this style of teaching and learning – tending to rush through questions in order to achieve speed, if not understanding; whereas the girls generally did not.

Further research suggests that if children are brought up to obey rather than to challenge rules it might mean they are well prepared for maths in the primary school, but the attitude might hinder them later on (Buxton, 1981). Here again the 'well-behaved' serialist is disadvantaged, in comparison with the 'provocative' holist: the former learning through repetition and sequenced development. The latter predisposed to question the place of any new learning.

Given these aspects of gender variation it is not surprising to find that '... teachers' judgements of ... performance ... depend on indications of the challenging of rules which are understood as *real understanding, flair or brilliance* ...' (Walden and Walkerdine, 1986, p. 143). Moreover, '... evaluations are made in terms of the presence or absence of these attributes ...' (op. cit., p. 144), and these attributes are gender-related. 'The characteristics taken to be indicators of *real understanding* are to a large extent co-terminous with those used to describe masculinity ...' (op. cit., p. 144). The need arises to consider changes in the assessment of mathematics, and indeed to question what exactly it is that warrants recognition in mathematical performance at different levels.

Arnot *et al.* (1998) have recently noted that such changes in mode of assessment may well contribute to the contrast between GCSE performance and patterns in outcomes post-16. Elwood and Comber (1996, p. 81) were quite emphatic: '... if the required style of response is very different between GCSE and A level in particular subjects, as this research has shown, then teachers need to support those students whose preferred style is being challenged.' Earlier (p. 80) they had noted the gender distinctions associated with these styles, allied to success beyond GCSE: 'Words such as *flair, sparkle, unique* characterized descriptions of a good A level performance which they attributed more to males than to females.' Although the explanation is complicated by entry patterns (by gender and tier) to GCSE and A level, this particular outlook may be applied to help explain current trends in performance. Whilst gender variations in outcome at GCSE are '... quite striking, ... at A level ... the gap between boys and

girls is gradually closing. [Most notably there is a] cross-over which shows the boys ahead at the higher grades: which are important for entry into Higher Education.' (p. 77).

In the Classroom: Grouping

'... the nature of high set classes contributes to the disparity in attainment of girls and boys at the highest levels.'

(Boaler *et al.*, 1998, p. 5)

'The requirement to work at an inappropriate pace is a source of real anxiety for many students, particularly girls ...'

(op. cit., p. 10)

It has already been noted that girls may prefer cooperative, supportive working environments whereas boys work well in competitive, pressurized environments (Head, 1995); but caution is required. Not all studies that have looked specifically for gender differences in learning styles have identified them: examples include Riding and Douglas (1993), and Kirby and Powell (1991). Although gender variations may exist in learning styles, any variation is small and measures the difference between the *average* disposition of each population. Any deviation between these averages is likely to be very much smaller than the variation within any one teaching group: whether compiled with reference to gender, ability, or arbitrarily (Adey *et al.*, 1998).

The difficulties arising from the homogeneous grouping of students follow directly: '... setted lessons are often conducted as though students are not only similar but identical – in terms of ability, preferred learning style and pace of working.' (Boaler *et al.*, 1998, p. 7). Although Boaler's research findings are derived from only a small number of schools, ability grouping remains particularly prominent in the teaching of mathematics at secondary level throughout the country. The principal claim emerging from her studies is that: '... it seems likely that the under-achievement and non-representation of girls at the highest levels is linked to the environments generated within top set classrooms ...' (ibid., p. 5). 'The students (in top sets) that were most disaffected were very able girls, apparently because able girls, more than any others, wanted to understand what they were doing – in depth – but the environment ... did not allow them to do this.' (ibid., p. 3).

The argument combines two separate strands. First, it is asserted that there is a distinction between preferred learning styles by gender. Second, the practice of setting appears to give rise to the adoption of uniform teaching styles. This is especially true with the more able, who tend to be subject exclusively to: '... transmission pedagogies. For some students, who were able to conceptualize the new material as it is covered, the experience may be satisfactory, but for the remainder, the effect is to proceduralize the curriculum until it becomes a huge task of memorization' (ibid., p. 12). The thesis is not that girls are alone in being disadvantaged, rather that boys are probably '*less disadvantaged*' by existing approaches. The boys cope better, surviving the 'classroom context', rather than specifically benefiting from it. Our earlier caution applies here also: such statements refer to the typical pupil, and variations within any single-sex group would be expected to exceed the deviation between the average boy and average girl. ☒

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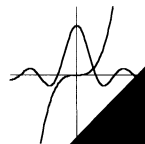
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