# Gender, school settings, and high achievers

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## Introduction

Gender issues in mathematics education were first brought to the wider attention of the research community in the 1970s (e.g., Fennema, 1974). Much research was to follow (e.g., see Leder, 1992, 2001) together with funding support for interventions to address females' identified disadvantages with respect to achievement, participation, and affective outcomes (see Leder, Forgasz & Solar, 1996). It became evident in the late 1990s that in some countries, including Australia, the gender gap appeared to be closing with respect to achievement; for example, there were no gender differences in the PISA 2003 results for Australian students (Thomson, Cresswell, & De Bortoli, 2004). For some affective measures, anticipated gender-stereotyped results, based on previous research, have been challenged (e.g., Forgasz, Leder, & Kloosterman, 2004).

Late in the 1990s, educational issues with respect to boys surfaced and became a funding focus in Australia and the UK. Boys' literacy levels are well below girls' (e.g., OECD, 2001) and research and funding attention to this was fully justified. However, boys were not disadvantaged with respect to mathematics and science, particularly with respect to participation rates (e.g., Forgasz, 2006; Lamb, 1996) and males remained more likely than females to be found among (e.g., Forgasz & Griffith, 2006; Giri, nd; Leder, 2006), and identified as, the highest mathematics achievers (e.g., Hallinan & S◔rensen, 1987). Yet funding to focus on females in mathematics and science education dried up.

For many, it was not surprising to find that the recent 2006 PISA results for mathematical literacy among Australian, UK, US, Canadian, and New Zealand students revealed statistically significant gender difference favouring males (OECD, 2007). There had been no statistically significant gender differences among Australian students in the PISA 2000 (OECD, 2001 ) and 2003 data (OECD, 2004). Data for Australian students in the PISA 2006 data tables (OECD, 2007) reveal that there was no discernible difference in males' performance levels over time; it was a decrease in females' performance levels that contributed to the significant gender difference in 2006. It seems reasonable to speculate that the lack of consistent government effort and funding support may well have contributed to the reversal in earlier trends towards the closing of the gender gap in mathematics achievement.

For the PISA 2000 data, McGaw (2004) noted a strong relationship between social background[1] and mathematical literacy achievement levels. The relationship was stronger for Australia, the UK, the US, and Germany than for the Organisation for Economic Co-operation and Development [OECD] as a whole. McGaw (2004)

[1] Information gathered on economic and social background included parents' education and occupation, and cultural artefacts in the home, and allowed for the construction of an index of social background that was comparable across countries. (McGaw, 2004)

concluded that there was a need in Australia to identify the sources of inequity in student performance in its education system "to determine where policy intervention might most effectively be made to improve the equity of outcomes" (p. 24), and that this should also involve analyses of differences in many factors including urban and rural environments.

Over time there has been recurring, often heated, debate and considerable research on whether the education of boys and of girls is affected by the gender mix of the school or the classroom (Forgasz, Leder, & Taylor, 2007). Findings are not equivocal. However, there is some evidence that co-educational settings appear to be more beneficial to boys than to girls (e.g., Wong, Lam & Ho, 2002), that when socio-economic backgrounds are taken into consideration there are no substantive differences in boys' or girls' academic achievements in single-sex and co-educational settings (e.g., American Association of University Women, 2004), and that girls in single-sex mathematics classrooms can benefit with respect to confidence and achievement (e.g., Forgasz & Leder, 1995). The quality of teaching is frequently found to be a more critical influence on students' learning achievements than the gender composition of schools or classrooms. (e.g., Warrington & Younger, 2003).

## *Aims of the present study*

Within a general framework of liberal (or mainstream) feminism, and rejecting a deficit view of females (see Leder, Forgasz, & Solar, 1996), one of the aims of this study was to continue the monitoring of large scale mathematics assessments in the Australian setting for gender differences. Determining the extent of any gender differences among the highest mathematics achievers, and investigating whether school type attended (single-sex or co-educational) and school location (metropolitan or non-metropolitan) may be implicated in any gender differences found were further aims of the study[2].

## *Context of the study*

The relationships between gender, school-type attended, school location, and mathematics performance amongst the highest performers enrolled in grade 12 mathematics subjects offered in Victoria's (Australia) final year of schooling (the second year of the Victorian Certificate of Education [VCE]) in 2007 were of particular interest in this study. Statistics related to secondary schools (including schools spanning the primary and secondary years) in Victoria in 2007 are shown in Table 1.

Table 1. Schools in Victoria (2007) by gender mix and location[1]

| **Schools in Victoria** | **N** | **% of all schools** |
|---|---|---|
| All secondary and primary/secondary schools | 561 | |
| Single-sex boys schools [SSB] | 27 | 4.8% |
| Single-sex girls schools [SSG] | 50 | 8.9% |
| Co-educational schools [Co-ed] | 484 | 86.3% |
| Metropolitan schools [Met] | 343 | 61.1% |
| Non-metropolitan schools [NMet] | 218 | 38.9% |

[2] It should be noted that a paper in which findings related to socio-economic factors from the same data has been submitted elsewhere.

[1] Data source: Department of Education and Early Childhood Development (2007). *Summary statistics Victorian schools*. Melbourne: Author

As can be seen in Table 1, in Victoria in 2007 there were 561 secondary schools. Of these, co-educational schools (484) far outnumbered single-sex schools (27 SSB and 50 SSG), and there were about half as many SSB schools than SSG schools. The number of schools outside the state's metropolitan capital (Melbourne) comprised 38.9% of all schools in Victoria.

Participation rates by gender and the gender break-up of students in the various grade 12 VCE mathematics subjects are described next.

## Participation by gender in the VCE and in the VCE mathematics subjects

Enrolment data from 2007 for grade 12 VCE and for each mathematics subjects offered at the grade 12 level – Specialist mathematics (the most challenging), Mathematical Methods and Mathematical Methods CAS, and Further Mathematics (the least challenging) and the relative proportions of males and females are summarised in Table 2.

Table 2. VCE and VCE mathematics enrolments 2007 by gender

| | **All** | **M** | **%** | **F** | **%** |
|---|---|---|---|---|---|
| *VCE enrolments* | 48840 | 22588 | 46.2% | 26252 | 53.8% |
| *Specialist Mathematics* | 4804 | 3012 | 62.7% | 1792 | 37.3% |
| *Mathematical Methods & CAS*[2] | 15427 | 8600 | 55.7% | 6827 | 44.3% |
| *Further Mathematics* | 24787 | 11623 | 46.9% | 13164 | 53.1% |

[1] Data source: Victorian Curriculum and Assessment Authority's [VCAA] website: www.vcaa.vic.edu.au

[2] Includes enrolments in Mathematical Methods and in Mathematical Methods CAS, an alternative to Mathematical Methods. In the former, students use graphics calculators; in the latter, students use CAS calculators. The curricula are very similar.

The data in Table 2 indicate that males and females did not participate in equal proportions in the VCE or in any of the VCE mathematics subjects in 2007. To be proportionally represented in each of the VCE mathematics subjects, females should have represented 53.8% of the cohort. As can be seen, however, the proportion of females was less than 53.8% in each VCE mathematics subject, that is, females were under-represented, even though there were more females than males enrolled in Further Mathematics.

Students' performance in VCE subjects are reported in various ways. One of these measures – the focus of the present study – is the study score. The study score is a normalised result such that in each subject the maximum score is 50, the mean is around 30 and the standard deviation is about 7; adjustments are made for subjects in which fewer than 1000 students are enrolled. The study scores are used to produce tertiary entrance scores (currently known as ENTERs) that are used for selection into various university courses (see http://www.vcaa.vic.edu.au/schooladmin/handbook/2007/PartC07.pdf).

For each VCE subject, and for study scores of 50 down to 40, the names of students and the schools attended are published in newspapers. The data used in the present study were based on a secondary analysis of the information published in a lift-out section of one of Victoria's daily newspapers, The Age, of December 19, 2007.

## *Research approach*

For each of the four mathematics subjects offered in the VCE, the data from the newspaper were scanned and entered into an Excel spreadsheet. Scores of 50, 49, 48, 47, and 46 were included. For each subject, scores between 46 and 50 represent 2% or less of the cohort for each subject. Only students' names and the schools they attended were published in the press. Hence, student gender [male [M], female [F], unknown [?]), school type (single-sex boys [SSB], single-sex girls [SSG], co-educational [Co-ed]), and whether the school was located in metropolitan Melbourne or not (metropolitan [Met] or non-metropolitan [NMet]) had to be identified. Whilst it was fairly straightforward to determine a student's gender for the vast majority of names, some unknown first names were checked on the Internet as well as with people who were likely to know (e.g., Chinese and Vietnamese names). Even so, for a small proportion of students, gender could not be determined as the names were either obscure or unisex (could be used for males or females). The Internet was used to check the type of school and its location; unfortunately details of some schools were not able to be verified.

## *Data analyses and results*

For each VCE mathematics subject and for each study score from 50 to 46, frequency counts were determined of student gender (male [M]/female [F]), school type (single-sex boys [SSB], single-sex girls [SSG], co-educational [Co-ed]), and whether the school was located in metropolitan Melbourne or not (metropolitan [Met] or non-metropolitan [NMet])

### Specialist maths

In 2007, there were 4804 students enrolled in Specialist Mathematics, of whom 3012 (62.7%) were male and 1792 (37.3%) were female. There were 65 students (~1.4% of cohort) who were awarded study scores between 46 and 50. Of these, 49 students were male (75%) and 15 (23%) were female; one student's gender could not be determined from the name provided. The results of the analysis by gender, school type, and school location are recorded in Table 3.

Table 3. Top-scorers in VCE Specialist Mathematics by study score, gender, school type, and school location.

| | | Gender | | | School type | | | | | School location | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Co-ed | | | SSB | SSG | | |
| Score | All | M | F | ? | M | F | ? | (M) | (F) | Met | NMet |
| 50 | 14 | 12 | 1 | 1 | 6 | - | 1 | 6 | 1 | 13 | 1 |
| | | 86%[1] | 7% | 7% | 43% | | 7% | 43% | 7% | 93% | 7% |
| 49 | 5 | 5 | - | - | 3 | - | - | 2 | - | 5 | - |
| | | 100% | | | 60% | | | 40% | | 100% | |
| 48 | 12 | 6 | 6 | - | 3 | 1 | - | 3 | 5 | 12 | - |
| | | 50% | 50% | | 25% | 8% | | 25% | 45% | 100% | |
| 47 | 13 | 11 | 2 | - | 7 | - | - | 4 | 2 | 12 | 1 |
| | | 85% | 15% | | 54% | | | 31% | 15% | 92% | 8% |
| 46 | 21 | 15 | 6 | - | 7 | 1 | - | 8 | 5 | 21 | - |
| | | 71% | 29% | | 33% | 5% | | 38% | 23% | 100% | |

[1] Percentage within grouping variable

While males represented about 62% of the Specialist Mathematics cohort, it can clearly be seen on Table 3 that, with the exception of those scoring 48 for which only

50% were males, males were over-represented in terms of their cohort representation for each of the other scores, with proportions ranging from 71% (score of 46) to 100% (score of 49).

When data from Table 1 are compared with those in Table 3, it is very clear that boys attending SSB schools are vastly over-represented among the top scorers in Specialist Mathematics. SSBs represent only 4.8% of all secondary schools in Victoria, yet 43% of all students scoring 50 attended SSBs; there were slightly lower percentages of students (31% for a score of 47, and 40% for a score of 49) obtaining scores of 49-46 who had also attended SSBs.

The data in Table 3 also clearly reveal that for each of the scores, 50-46, males were the dominant high scorers among students attending co-educational schools, and that females attending SSG schools outperformed their Co-ed counterparts. While females seemed to be advantaged by attending SSG schools over Co-ed schools, so too were males (NB. 27 SSB schools compared to 484 Co-ed schools – Table 1).

When the school location data in Table 3 are compared to the data in Table 1, it is blatantly clear that students from non-metropolitan schools were grossly under-represented among students with scores of 46-50.

## Mathematical Methods and Mathematical Methods CAS

In 2007, there were 15427 students enrolled in Mathematical Methods and Mathematical Methods CAS, of whom 55.7% (8600) were male and 44.3% (6827) were female. There were 199 Mathematical Methods and Mathematical Methods CAS students (approx. 1.3% of total cohorts) whose scores ranged from 46 to 50. Of these students 133 (67%) were male, 50 were female (25%) and, based on the names provided, it was not possible to identify the gender of 16 students (8%). Study scores of 46 to 50 were analysed and the results are shown on Table 4.

Table 4. Top-scorers in VCE Mathematical Methods and Mathematical Methods CAS by study score, gender, school type, and school location.

| | | Gender | | | School type | | | | | | School location | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Co-ed | | | SSB | SSG | ? | | | |
| Score | All | M | F | ? | M | F | ? | (M) | (F) | - | Met | NMet | ? |
| 50 | 36 | 24 | 9 | 3 | 13 | 2 | 3 | 11 | 7 | - | 33 | 3 | - |
| | | 67%[1] | 25% | 8% | 36% | 6% | 8% | 31% | 19% | | 92% | 8% | |
| 49 | 29 | 24 | 5 | - | 8 | 1 | - | 16 | 4 | - | 28 | 1 | - |
| | | 83% | 17% | | 28% | 3% | | 55% | 14% | | 97% | 3% | |
| 48 | 27 | 18 | 6 | 3 | 7 | 2 | 3 | 11 | 4 | - | 27 | - | - |
| | | 67% | 22% | 11% | 26% | 7% | 11% | 41% | 15% | | 100% | | |
| 47 | 41 | 29 | 11 | 1 | 13 | 5 | 1 | 16 | 6 | - | 40 | 1 | - |
| | | 71% | 27% | 2% | 32% | 12% | 2% | 39% | 15% | | 98% | 2% | |
| 46 | 66 | 38 | 19 | 9 | 11 | 8 | 8 | 26 | 11 | 2 | 62 | 2 | 2 |
| | | 58% | 29% | 14% | 17% | 12% | 12% | 39% | 17% | 3% | 94% | 3% | 3% |

[1] Percentage within grouping variable

As can be seen in Table 4, the proportions of males receiving each of the study scores from 50 to 46 were higher than their representation in the Mathematical Methods and Mathematical Methods CAS cohorts (55.7%), that is, the females who comprised 44.3% of the cohorts were very much under-represented amongst the highest scorers.

Although not quite to the same extent as for Specialist Mathematics, boys from SSB schools were greatly over-represented among the highest achievers in Mathematical Methods and Mathematical Methods CAS. Again, not quite as blatant as for Specialist

Mathematics, much higher proportions of males than females from Co-ed schools were among the highest achievers. Keeping in mind the vast differences in the numbers of schools in the various categories, females in SSG and males in SSB schools again greatly outperformed their Co-ed counterparts.

As for Specialist Mathematics, students from metropolitan schools were greatly over-represented among the highest achievers.

## Further Mathematics

In 2007 there were 24787 students enrolled in Further Methods, of whom 46.9% (11623) were male and 53.1% (13164) were female. There were 312 Further Mathematics students (approx. 1.3% of cohort) whose scores ranged from 46 to 50. Of these, 187 students were male (60%) and 114 were female (37%); based on the names provided in the newspaper, it was not possible to identify the gender of 11 students (4%). The results of the analyses of the study scores 50-46 are shown on Table 5.

Table 5. Top-scorers in VCE Further Mathematics by study score, gender, school type, and school location.

| | | Gender | | | School type | | | | | | School location | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Co-ed | | | SSB | SSG | ? | | | |
| Score | All | M | F | ? | M | F | ? | (M) | (F) | - | Met | NMet | ? |
| 50 | 60 | 43 | 13 | 4 | 27 | 6 | 4 | 16 | 7 | - | 52 | 8 | - |
| | | 72%[1] | 22% | 7% | 45% | 10% | 7% | 28% | 12% | | 87% | 13% | |
| 49 | 36 | 19 | 14 | 3 | 11 | 9 | 3 | 8 | 5 | - | 24 | 12 | - |
| | | 53% | 39% | 8% | 31% | 25% | 8% | 22% | 14% | | 67% | 33% | |
| 48 | 48 | 30 | 17 | 1 | 18 | 8 | 1 | 12 | 9 | - | 36 | 12 | - |
| | | 63% | 35% | 2% | 38% | 17% | 2% | 25% | 19% | | 75% | 25% | |
| 47 | 60 | 37 | 22 | 1 | 27 | 15 | 1 | 10 | 7 | - | 45 | 14 | 1 |
| | | 62% | 37% | 2% | 45% | 25% | 2% | 17% | 12% | | 75% | 23% | 2% |
| 46 | 108 | 58 | 48 | 2 | 42 | 33 | 2 | 16 | 15 | - | 82 | 25 | 1 |
| | | 54% | 44% | 2% | 39% | 31% | 2% | 15% | 14% | | 76% | 23% | 1% |

[1] Percentage within grouping variable

As can be seen on Table 5, males were again over-represented among the highest scorers (males comprised 46.9% of the Further Mathematics cohort), but this dominance was not as marked as for Specialist Mathematics and Mathematical Methods and Mathematical Methods CAS.

While males enrolled in SSB schools were again very highly represented among the highest achievers, this was again not as marked as for the other two mathematics subjects. There remained a clear difference favouring males over females with respect to proportional representation from co-educational schools among the highest achievers. Yet, again, the difference was not as great as for the other two mathematics subjects. Similarly, the difference in representation of females in Co-ed and SSG schools again favoured girls in SSG schools, but the difference was less than for the other two mathematics subjects.

With respect to school location, there was a more equitable distribution of results than for the other two mathematics subjects; students enrolled at non-metropolitan schools were represented in relatively higher proportions among the highest achievers (ranging from 13% for the score of 50 to 33% for the score of 49). Yet, the students from non-metropolitan schools were still under-represented (NMet schools comprise 38.9% of all schools).

## *Conclusions and recommendations*

The results of the analyses of the VCE mathematics results for 2007 show a very clear pattern of male dominance among the highest achievers in all of the mathematics subjects examined. The proportions of these high achieving males far exceeded their relative proportions of enrolments in the various subjects. The dominance of males among the highest achievers was greatest in Specialist Mathematics, the most challenging mathematics subject in which male enrolments represented about 62% of the cohort. The proportions of males achieving scores of 46-50 decreased as the level of difficulty of the VCE mathematics subjects decreased and as, simultaneously, male enrolment numbers became more closely representative of the overall gender pattern of grade 12 enrolments.

English is often considered a subject in which females dominate. Yet, a cursory glance of the published VCE English results revealed that of the 98 students who scored 50, the female to male ratio was close to 1:1, that is, the relative dominance of males in mathematics was not replicated by females in English.

It was very clear that students in single-sex schools, particularly in SSB schools, were highly over-represented among the highest achievers in all three VCE mathematics subjects. It must be remembered, however, that there is also a socio-economic factor at play here. All but eight SSGs and one SSB of the 77 single-sex schools were either fee-paying Catholic or Independent (ie. non-government, non-Catholic) schools[3].

The study undertaken has again provided strong evidence of the dominance of males at the highest achievement levels of mathematics subjects in a high stakes context – VCE results are used for tertiary selection. These findings are consistent with the PISA 2003 results (Australian Council for Educational Research, 2008), for example. There would also appear to be evidence that single-sex environments benefit both females and males with respect to high mathematics achievement when compared to the performances of their co-educational counterparts. However, caution is required here. As noted above, socio-economic factors are strongly implicated in the context under study. In Victoria in 2007, all but nine of the 77 single-sex schools were non-government fee-paying schools, that is, parents must be able to afford the fees needed to send their offspring to these schools. The findings also clearly reveal that students attending non-metropolitan schools are not achieving as highly as their metropolitan counterparts. In part this is likely to be due to the recognised shortage of highly qualified mathematics teachers in Victoria being more acutely felt in non-metropolitan regions.

More research is needed to compare findings from local and national high stakes testing programs to identify the sources of inequities in mathematics achievement. Comparisons should be made with national findings and those from international programs such as TIMSS and PISA. The reasons behind inequities identified at local levels can then be isolated and ways sought to confront and overcome them. Undoubtedly, this is an ongoing process. The will to persist and the commitment to support financially such moves must be found in order to pave the way for the longer term goal of attaining equity. McGaw (2004) called for the Australian government to identify and address the causes of inequities. This call must be heeded in Australia and elsewhere.

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[3] It should be noted that fees vary greatly in both sectors – Catholic and Independent. However, on average fees are higher in the Independent schools.

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