

Australian year 12 “Intermediate¹” level mathematics enrolments 2000–2004: Trends and patterns²

Helen J. Forgasz
Monash University
helen.forgasz@education.monash.edu.au

In this paper, enrolment data in year 12 mathematics subjects across Australia for the years 2000-2004 are presented. Based on the Barrington and Brown (2005) year 12 mathematics subject categorisations, the focus is on examining enrolments in “Intermediate” level subjects, the most likely pre-requisites for tertiary-level mathematics/science-related courses. Enrolment numbers are examined, as too are enrolments expressed as percentages of year 12 cohort sizes. Data for all Australian students, and by gender, are explored and state/territory comparisons are made. The findings have important implications for educational authorities, the tertiary sector, mathematics teachers, and their students.

Background and context of the study

For some years, there have been concerns nationally and internationally about the declining numbers of students enrolled in and completing tertiary courses in mathematics (e.g., Jensen, Niss, & Wedege, 1998). Thomas (2000) claimed that the “mathematical sciences in Australia are in crisis” (p.5), with “an acute shortage of appropriately qualified teachers across schools, falling enrolments in advanced level mathematics and statistics, inadequate support for mathematics education research and a brain drain of many of Australia’s best mathematics scientists” (p.6). Since school level mathematics is the basis for tertiary level studies, it seems important to continue to scrutinise enrolments in year 12 mathematics subjects.

Prior to 2000, much of the Australian work on monitoring Australian year 12 enrolments in mathematics and science was undertaken by John Dekkers, John De Laeter, and John Malone (e.g., Dekkers, De Laeter, & Malone, 1991; Dekkers & Malone, 2000). For data prior to 1990, Dekkers, De Laeter and Malone (1986) used the following categorisations of year 12 mathematics subjects:

- Type 1:** These are “described as *terminal* mathematics courses. They are not designed to provide a foundation for any future tertiary studies involving mathematics”. (p.42)
- Type 2:** These “involved a level of *mathematics competence* which provide a satisfactory background for tertiary studies in which the mathematics content is minimal — for example, in architecture, pharmacy or economics”. (p.42)
- Type 3:** These “involved *specialised mathematics* leading to tertiary studies in which mathematics is an integral part of the discipline, as in mathematics, physical science or engineering”. (p. 42)

For year 12 mathematics subjects in the period 1990-1999, Dekkers, De Laeter, and Malone (2000) used a slightly different set of categories:

¹ Barrington and Brown (2005) category of year 12 mathematics subjects

²The technical report on which this paper is based was commissioned by the International Centre of Excellence for Education in Mathematics (ICE- EM), which is funded by the Australian Government through the Department of Education, Science and Training. ICE-EM holds the intellectual property rights to the technical report.

High:	“Those subjects involving specialised or advanced level Mathematics leading to tertiary studies in which Mathematics is an integral part of the discipline, as in physical Science, engineering or Mathematics.”
Intermediate:	“Those subjects which involved a level of mathematical competence which provides a satisfactory background for tertiary studies in which Mathematics content is minimal — for example in architecture, pharmacy or economics.”
Low:	“Those subjects that do not provide a suitable mathematical foundation for any tertiary studies.”

In an extensive overview of the year 12 mathematics offerings across Australia, Barrington and Brown (2005) examined the mathematical content of the subjects and defined three categories as follows:

Advanced:	“These subjects are generally taken by students who wish to proceed to tertiary studies that require the strongest of mathematical preparations, such as engineering, actuarial studies, mathematics, statistics and physical sciences. Such students normally undertake an intermediate mathematics subject (see below) in conjunction with their Advanced mathematics subject.”
Intermediate:	These subjects “are suitable for students who wish to proceed to tertiary studies that require significant but not extensive mathematical preparation, such as science, medicine, economics/commerce, dentistry and agricultural science.”
Elementary:	These subjects “are suitable for students who wish to study mathematics in their final year at secondary school, but do not intend to enter tertiary courses that require intermediate or Advanced mathematics subjects. These subjects may contribute to students’ tertiary entrance scores.”

The major difference between the Barrington and Brown (2005) categorisations and those of Dekkers and his colleagues in earlier times was that Barrington and Brown (2005) based their subject categorisations on mathematical content and not solely on pathways to tertiary study, i.e., Dekkers and his colleagues may have categorised some subjects as “high” that Barrington and Brown would have considered as “Intermediate” level subjects, or vice-versa.

In this paper, the Barrington and Brown (2005) categorisations were used to examine the year 12 Intermediate level mathematics enrolment data across Australia in the years 2000-2004. The subjects involved included: Mathematics (2-unit) in NSW, Mathematical Methods in Victoria, Applicable Mathematics in Western Australia, and their equivalents in the other states/territories.

Why “Intermediate” level mathematics subjects

There are several reasons for focussing on “Intermediate” level mathematics enrolment trends rather than for Advanced or Elementary level subjects.

Whilst it may be preferable for students wishing to pursue tertiary courses requiring strong mathematics backgrounds to study Advanced level year 12 subjects, as advocated

by Thomas (2000), they are generally no longer uniformly required as pre-requisites to courses such as Engineering, as they were in earlier years. Since competition for prestigious tertiary courses is now very fierce, students are often motivated to select subjects in order to maximise their tertiary entrance scores. Thus they may opt to study a mathematics course that is pragmatically, rather than more academically, appropriate and in which they believe they will perform at a very high level. As Barrington and Brown (2005) observed, "Teachers are well aware that if students perceive a subject to be too difficult, they will avoid it in favour of one they believe they can cope with" (p.17). Barrington and Brown (2005, p.25) also noted that:

Pre-tertiary mathematics subjects across the Australian States and Territories vary enormously in their philosophy, in the mathematics covered, in the use of graphics calculators and in their assessment. The differences are so great that no two State's intermediate mathematics subjects could be described as equivalent. Yet tertiary admissions authorities deem the listed intermediate subjects to be equivalent for the administrative purpose of tertiary entrance score calculation.

Previously identified gender differences in enrolments were another reason to consider Intermediate level subjects. Much of the earlier work on gender differences in mathematics enrolment patterns, particularly for the higher levels of schooling, has focussed on the most challenging levels of mathematics courses offered. For enrolments at those levels, males are almost universally found to outnumber females. For mathematics courses considered the least challenging, females are sometimes found to outnumber males. For courses between these two extremes, the gendering of enrolment patterns is less clear. For Victoria's year 12 mathematics subjects offered in the Victorian Certificate of Education from 1994-1999, Cox, Forgasz and Leder (2004, p.35), for example, reported that:

In all three mathematics subjects there is a higher proportion of males than of females. The ratio of females to males changes along the 'degree of difficulty continuum' from approximately 1:1 in the least difficult subject (Further Mathematics), to 3:4 in Mathematics (sic) Methods, and finally 1:2 in the most difficult subject, Specialist Mathematics.

Why focus on the period 2000-2004

Findings on enrolment patterns in year 12 mathematics subjects prior to 2000 have been published (e.g., Dekkers & Malone, 2000; Thomas, 2000). Barrington and Brown's (2005) new subject categorisations are based on different criteria to those used by Dekkers and his colleagues. This suggests that the data over the two periods are incompatible and comparing recent trends with those from earlier times, if made, should be interpreted with extreme caution. However, it is of interest to note that enrolments in Dekkers, De Laeter, and Malone's (2000) Intermediate category of year 12 mathematics subjects varied somewhat over the period 1990-1999. Compared to 1990 data, by 1999 there had been a very small percentage decrease in enrolments for all students (1.8%), with male enrolments decreasing (9.0%) and female enrolments increasing (6.3%) (Forgasz, unpublished data). Whether the direction (but not the magnitudes) of the trends evident in the Intermediate level data prior to 2000 persisted into 2000-2004 was of interest in this study.

Aims and methods

The main aims of the study reported in this paper were:

- To examine Australian trends in Intermediate level year 12 mathematics enrolments for the period 2000-2004 and to determine if there were gender differences in these enrolments
- To examine Australian trends in Intermediate level year 12 enrolments expressed as percentages of year 12 cohort sizes for the period 2000-2004 and to determine if there were gender differences
- To examine and compare state/territory trends in Intermediate level year 12 enrolments expressed as percentages of year 12 cohort sizes for the period 2000-2004.

Enrolment data for the years 2000-2004 were gathered from state/territory publications and related websites, and from relevant state authorities as required. Total Australian data were derived from the state/territory data. All data were entered into Excel spreadsheets; pertinent calculations were undertaken and graphs drawn. Australian and state/territory population data were obtained from the Australian Bureau of Statistics website.

Enrolment data for Intermediate level year 12 mathematics subjects, 2000-2004

Australia-wide data. *The overall enrolment figures for enrolments in Intermediate level year 12 mathematics subjects across Australia for the period 2000-2004 are shown in Figure 1.*

The enrolment figures shown in Figure 1 reveal that:

- there was an overall decrease in total numbers from 68,146 in 2000 to 64,596 in 2004, i.e., a 5.2% decrease over the five-year period;
- in each year from 2000-2004, there were higher male enrolment numbers than female enrolment numbers; and
- while male numbers decreased slightly over the five year period from 35,891 in 2000 and 35,143 in 2004 — a 2.1% decrease, female numbers decreased more dramatically from 32,255 in 2000 to 29,453 in 2004 — an 8.7% decrease.

Interestingly the trends for the period 2000-2004 were similar in many respects to those of 1990-1999 noted earlier in the paper. There was an overall decrease in enrolments (5.2%) over the period 2000-2004 and male enrolments decreased (2.1%). However, unlike the period 1990-1999 when female enrolments increased, from 2000-2004 they declined quite sharply (8.7%).

Since year 12 cohort sizes vary from year to year, the trends evident in raw enrolment numbers may be misleading. Hence it was deemed important to consider year 12 Intermediate level mathematics enrolment numbers expressed as percentages of the year 12 cohort sizes over the period 2000-2004 to obtain a more meaningful impression of what transpired over the five year timeframe — see Figure 2.

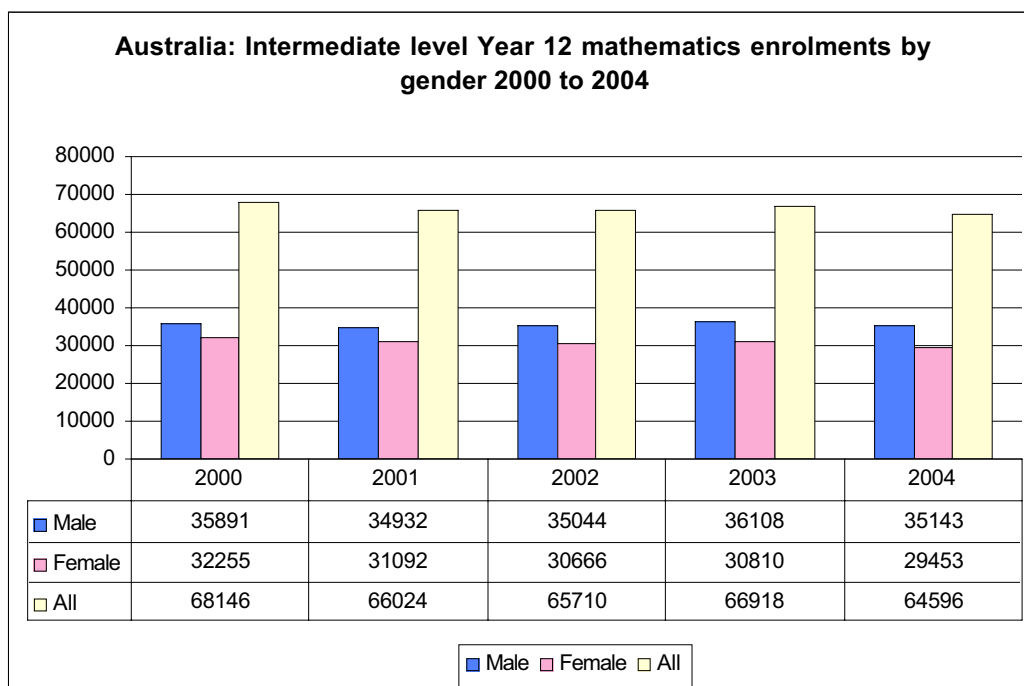


Figure 1. Australia: Enrolments in year 12 intermediate level mathematics subjects, by gender, 2000-2004

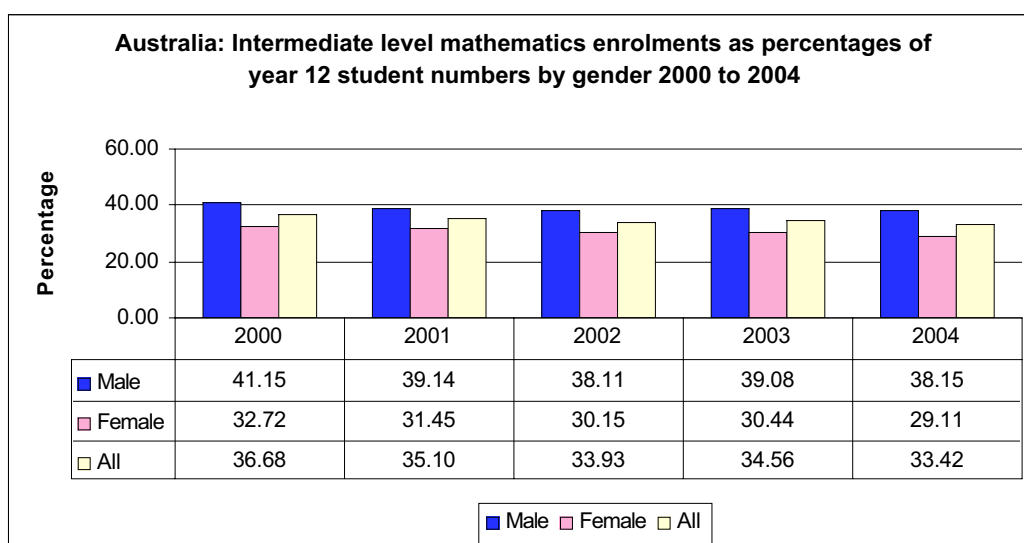


Figure 2. Australia: Enrolments in year 12 intermediate level mathematics subjects expressed as percentages of year 12 cohort sizes by gender, 2000-2004

For Intermediate level year 12 mathematics enrolments, the data in Figure 2 indicate that:

- there was a fairly steady, but small, decrease in the enrolments expressed as percentages of all year 12 students from 36.7% in 2000 to 33.4% in 2004 (mean for the five year period of 34.7%).
- both male and female enrolments as percentages of their respective year 12 student numbers also decreased: the decrease for male enrolments was from 41.2% to 38.2% (mean of 39.1% over the five year period), and for female enrolments from 32.7% to 29.1% (mean of 30.8%)

- in each year from 2000 to 2004 male enrolments expressed as percentages of male year 12 student numbers were higher than female enrolments as percentages of female year 12 cohort sizes. The differences in percentages for male and female enrolments were stable during the period 2000 to 2004 at about 8%-9%.

Interestingly, for the period 1990-1999, the directions of all trends evident in 2000-2004 were similar: an overall decrease in enrolments as percentages of year 12 cohorts, with both male and female enrolments also showing decreases: male more so than female enrolments (Forgasz, unpublished data). During 1990-1999, the difference in male to female enrolments as percentages of their respective year 12 cohort sizes also favoured males.

The male to female [M:F] ratios in enrolments in Intermediate level mathematics for each year, 2000-2004, in Australia and in each state/territory, as well as the mean values over the five year period were calculated and are shown in Table 1.

Table 1

Australia and states/territories: M:F ratios in Intermediate level year 12 mathematics enrolments, 2000–2004.

	Intermediate level					Mean M:F
	2000	2001	2002	2003	2004	
<i>Australia</i>	<i>1.11</i>	<i>1.12</i>	<i>1.14</i>	<i>1.17</i>	<i>1.19</i>	<i>1.15</i>
ACT	.81	.89	.74	.83	1.00	.85
NSW	1.04	1.05	1.09	1.13	1.14	1.09
NT	.79	1.38	1.08	1.22	1.56	1.21
Queensland	1.09	1.14	1.16	1.15	1.15	1.14
SA	1.21	1.29	1.29	1.40	1.44	1.33
Tasmania	1.13	1.29	1.18	1.29	1.46	1.27
Victoria	1.19	1.14	1.15	1.18	1.20	1.17
WA	1.29	1.26	1.33	1.38	1.43	1.34

For Intermediate level year 12 mathematics enrolments for 2000-2004, the data in Table 1 indicate that:

- except for the ACT in 2000-2003 and the NT in 2000, male enrolments were higher than female enrolments;
- the mean M:F ratio for all Australian Intermediate level enrolments was 1.15, with a small, but steady increase evident over the five year period;
- WA and SA had the highest M:F ratios (1.34 and 1.33 respectively);
- Only in the ACT were there consistently more females than males enrolled in each year of the five year period; and
- Of all the states/territories, only in SA was there a steady increase in the M:F ratio over the five year period.

In summary, in each state/territory except the ACT, there were higher male than female enrolments in Intermediate level mathematics, and there was some variation in the M:F ratios across the states.

It is important to note that the male to female enrolment ratios calculated and presented here do not take into consideration the differences in male and female year 12 cohort sizes.

Since the mid-1970s, there have been more females than males enrolled in year 12 (Collins, Kenway & McLeod, 2000), a pattern which has persisted to the present. Thus, if representative of their respective cohort sizes, there should be more females than males enrolled in Intermediate level mathematics subjects for there to be “equity” in enrolment numbers. Thus, the ratios reported here are an under-estimate of the extent to which males are over-represented in Intermediate level mathematics subjects.

State/territory data enrolment data comparisons

State/territory populations, and therefore also year 12 cohort sizes, vary greatly — see, for example, Table 2 for year 12 cohort sizes in each state/territory and for Australia overall in 2004.

Table 2
Year 12 cohort sizes by state/territory in 2004

ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
4098	59943	1390	40592	13324	4161	49975	19792	193275

Hence, simply comparing enrolment numbers in Intermediate level year 12 mathematics subjects across the states/territories is meaningless. There were two ways in which state/territory enrolment data were compared to identify any real differences:

- percentage increases/decreases in raw enrolment numbers over the five year period, 2000–2004
- enrolments expressed as percentages of year 12 cohort sizes.

Percentage increase/decreases in enrolments

A summary of the percentage changes in enrolments in Intermediate level mathematics in each state/territory for the period 2000-2004 by gender is shown in Table 3.

Table 3.
Percentage changes in Australian Intermediate level mathematics 2000-2004 and by gender

ACT		SA	
All	-12.6%	All	-22.9%
Male	-2.7%	Male	-17.1%
Female	-20.6%	Female	-30.1%
NSW		Tasmania	
All	-12.2%	All	+14.1%
Male	-8.2%	Male	+27.4%
Female	-16.3%	Female	-0.9%
NT (very small numbers — percentages not calculated)		Victoria	
All	+	All	+7.5%
Male	+	Male	+7.6%
Female	-	Female	+7.4%
Queensland		WA	
All	-2.1%	All	-14.0%
Male	+0.3%	Male	-10.0%
Female	-4.8%	Female	-19.2%

The data in Table 3 reveal that:

- There were increases in total enrolments in Intermediate level mathematics in only three states/territories: Victoria, Tasmania and the NT.
- The largest percentage increase in Intermediate level enrolments was in Tasmania (14.1%)
- The largest percentage decrease in Intermediate level enrolments was in SA (22.9%).
- In all states/territories with percentage decreases in enrolments, female enrolment numbers were the major contributors to the decreases:
 - ACT — Males: -2.7%; Females: -20.6%
 - NSW — Males: -8.2%; Females: -16.3%
 - Queensland — Males: +0.3%; Females: -4.8%
 - SA — Males: -17.1%; Females: -30.1%
 - WA — Males: -10.0%; Females: -19.2%
- In all states/territories with percentage increases in enrolments, male enrolment numbers were the major contributors to the increases:
 - Tasmania — Males: +27.4%; Females: -0.9%
 - Victoria — Males: 7.6%; Females: 7.4%
 - NT — Males: +; Females –

Enrolments expressed as percentages of year 12 cohort sizes

Intermediate level mathematics enrolments expressed as percentages of year 12 cohort sizes for each state/territory for each year in the period 2000-2004 are shown in Figure 3.

The data in Figure 3 indicate that for Intermediate level mathematics from 2000-2004:

- Across the states/territories, there was great variation in the enrolments expressed as percentages of year 12 cohort sizes;
- Queensland had the highest percentages of enrolments with respect to Year 12 cohorts — mean of 41.5% over the five year period — with a fairly consistent pattern for the period 2000-2004;
- Tasmania had the lowest percentages of enrolments with respect to Year 12 cohorts. Tasmania was the only state showing an increase in the percentages of enrolments with respect to Year 12 cohorts over the five year period — from 14.5% in 2000 to 19.8% in 2004. The mean over the five year period was 16.2%;
- The NT also had low percentages of enrolments with respect to Year 12 student numbers and there was a decrease in the percentages from 19.1% in 2000 to 17.5% in 2004. The mean was 18.4%; and
- In Victoria, the percentages of enrolments with respect to Year 12 cohorts were fairly consistent over the five year period — mean of 36.7%
- In the ACT, NSW, SA, and WA there were decreases in the percentages of enrolments with respect to Year 12 cohorts. The most dramatic decrease was in SA from 33.5% in 2000 to 25.1% in 2004. The decreases from 2000 to 2004 for the other states/territories were: ACT — 30.3% to 26.7%; NSW — 39.6% to 33.0%; WA — 26.0% to 21.6%. For each of these states the mean percentages over the five year period were: ACT — 29.0%, NSW — 35.7%, SA — 29.4%, and WA — 23.7%

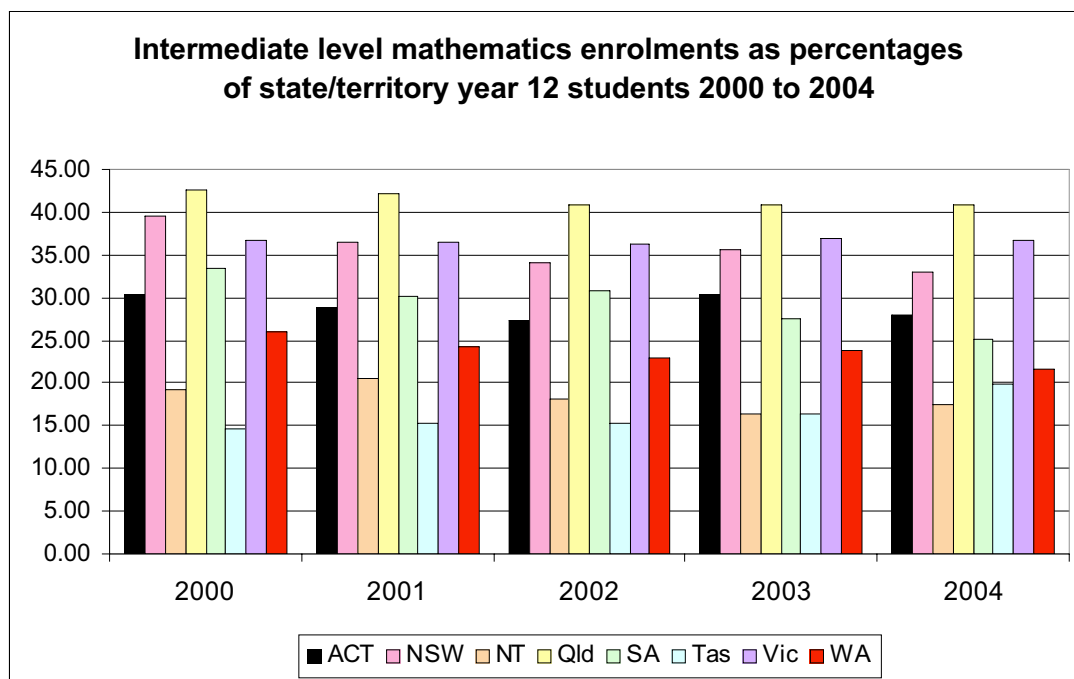


Figure 3. State/territory enrolments in year 12 intermediate level mathematics subjects expressed as percentages of year 12 cohort sizes, 2000-2004

In summary, Barrington and Brown's (2005) conclusion about the huge variation in state/territory differences in the requirements and expectations of Intermediate level mathematics courses seems also to be reflected in the vast differences in the patterns of enrolments in these subjects from one state/territory to another, despite the fact that for tertiary entrance purposes the subjects are treated similarly. The decreases in enrolments as percentages of year 12 cohort sizes in the ACT, NSW, SA, and WA should be of concern to relevant educational authorities. Unfortunately, space constraints did not allow for the examination of gender trends in each state/territory, however, the overall Australian pattern of higher proportions of male than female enrolments in Intermediate mathematics subjects and higher decreases in female than male enrolments vindicates continued concerns about limitations on girls' educational opportunities in the mathematics/science and related fields.

Concluding comments

The data presented in this paper reveal that across Australia, enrolments in year 12 Intermediate level mathematics subjects have declined over the period 2000-2004 both in terms of raw data and when year 12 cohort sizes were taken into consideration. Over the five year period, there were consistently more male than female enrolments in these subjects. When state/territory enrolment numbers were examined, female enrolments were found to be the main contributors to the decreased enrolments found in some states/territories, and males the main contributors in states/territories with increased enrolments.

Huge variations in enrolments expressed as percentages of year 12 cohort sizes were found across the states/territories of Australia. Yet, in all jurisdictions, Intermediate level mathematics is similarly treated by tertiary entrance authorities. Only in Tasmania was there an overall increase in enrolments with respect to year 12 cohort sizes. Among the

other states/territories, Queensland and Victoria had fairly consistent enrolment patterns over the five year period; the remainder showed decreases. In all states/territories except the ACT, male to female ratios revealed that there were more male than female enrolments in Intermediate level year 12 mathematics subjects. The reasons for the state/territory differences cannot be determined from the data presented here, yet, an explanation for them should be sought.

The trends and patterns in the year 12 Intermediate level enrolment data presented here portray a somewhat pessimistic future should the overall general decrease in numbers continue. The impact will be felt in mathematics/science tertiary course numbers as relatively fewer students will have completed the common pre-requisite year 12 mathematics subject for the many of the courses. The data also indicate that females are continuing to limit their career options by not pursuing subjects at the Intermediate level at year 12 and that their numbers are declining at a greater rate than males'. With decreasing enrolment numbers, there will be fewer students of tertiary mathematics who feed into teacher education programs and, as a consequence, the shortage of mathematics teachers with strong mathematical backgrounds, identified by Thomas (2000), will become critical. Something must be done to address this situation if future generations of school students are to have adequate and appropriate mathematical learning opportunities.

Acknowledgments

This project was funded by ICE-EM. My thanks are extended to Nike Prince who scouted hard to gather all the needed data for the project and assisted in the analyses. I am also grateful to Frank Barrington for his support in sorting all the year 12 mathematics subjects offered across Australia in the years 2000-2004 into the Barrington and Brown (2005) subject categories — Advanced, Intermediate, and Elementary — and for reading an earlier draft of this paper.

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