Mathematics Enrolments in Australian Upper Secondary Schools: Trends and Implications

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Coping with and planning for developments in school mathematics requires informed debate based on factual information. A knowledge and understanding of school mathematics enrolment trends can facilitate planning and identify issues that need to be addressed. The trends in upper school mathematics up to 1990 have been well documented by the authors (Dekkers, de Laeter, & Malone, 1991). This paper presents highlights from that earlier research and reports on year 12 student numbers and mathematics enrolment trends for the period 1980 to 1998, based on the most recent statistics from State authorities. Implications of the trends are also discussed.

In recent times in Australia, concerns have been expressed at both State and Federal levels and within the community regarding the level of mathematical competence of school leavers. A particular concern is that of the decline in the number of students enrolling in the more academically challenging upper secondary school mathematics subjects (Brennan, 1994; The Herald Sun, 1996; The Age, 1997; The Australian, 1997, *Campus Review*, 1998). Clearly, as a developed country, Australia's future will increasingly depend upon its ability to compete in a competitive, technological world. It is equally important that schools are in a position to develop the mathematical potential of students who are mathematically able and talented. Coping with and planning for developments in school mathematics requires informed debate based on factual information. A knowledge and understanding of school mathematics enrolment trends can facilitate planning and identify issues that need to be addressed. The authors' data base, extending back to 1970, serves the purpose of contributing to that knowledge and understanding.

National School Enrolments and Mathematics Enrolments

The interpretation of upper secondary school mathematics enrolment trends needs to be considered in terms of the overall Year 12 enrolment trends. These national enrolments rapidly increased over the period 1980 to 1992 from 89 038 to 192 511. Thereafter they declined steadily before showing small increases in 1997 and 1998, when they reached 177 234. Hence there has been an increase of nearly 100% in Year 12 enrolments in the past 20 years. The number of females remaining at school to Year 12 is one of the major factors contributing to this increase as retention rates confirm. For example, in 1980 the female retention from Year 8 to Year 12 was 37% compared to 32% for males. In 1998 however, the retention rate for females was 78% compared to 66% for males.

Total mathematics enrolments for the period 1980 to1998 are shown in Figure 1. It can be seen from this Figure that increases in Year 12 mathematics enrolments have essentially 'paralleled' the growth in Year 12 student numbers. In interpreting Figure 1 it needs to be noted that many students do more than one mathematics subject, hence the graph is a comparison between mathematics subject enrolments and Year 12 student numbers.

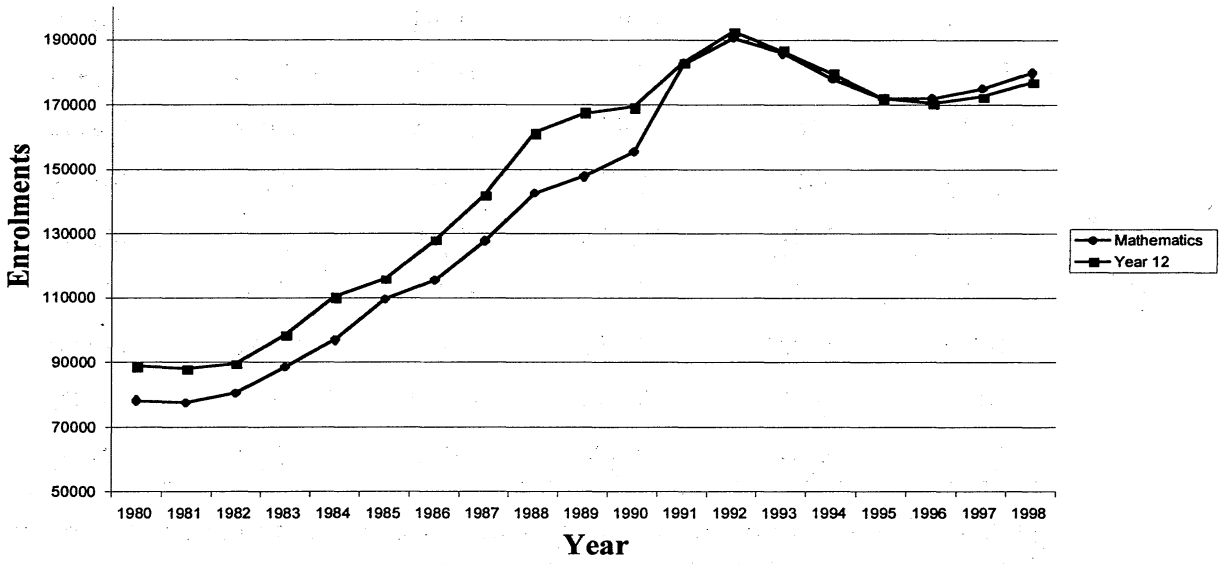

Figure 1. Year 12 student numbers and mathematics enrolments in Australia.

It can also be seen from the graph that since 1996, mathematics enrolments have exceeded Year 12 student numbers, and this gap has continued to widen each year since. Table 1 below is illustrative here. A comparison of male and female mathematics enrolments and Year 12 student numbers over the period 1980 to 1998 in the Table indicates a number of trends:

- In 1980 there were approximately the same number of male mathematics enrolments and male Year 12 students, while for females there were approximately 11 000 fewer mathematics enrolments than Year 12 students. Male mathematics enrolments exceeded female mathematics enrolments by approximately 8 000.
- During the 1980s these trends continued in general, but the difference between male and female mathematics enrolments declined, whereas the number of female Year 12 enrolments increased more rapidly than for males.
- In 1992 enrolments peaked for both male and female mathematics enrolments and Year 12 student numbers.
- Since 1992 male mathematics enrolments and male Year 12 students have declined. For females, mathematics enrolments have declined only slightly, while enrolment numbers have declined significantly.
- In 1998, male and female enrolments were approximately equal while the mathematics enrolments exceeded the Year 12 student numbers.

Table 1
Year 12 Student and Mathematics Enrolments in Australia

Year	Mathematics Enrolments			Year 12 Students		
	Male	Female	Total	Male	Female	Total
1980	43302	35104	78406	42221	46817	89038
1982	43543	37118	80661	41704	47941	89645
1984	52567	44432	96999	52728	57766	110494
1986	61314	54521	115835	61038	67074	128112
1988	74524	68189	142713	76322	85147	161469
1990	79678	76020	155698	79150	90321	169471
1992	99483	91381	190864	92944	99567	192511
1994	91266	87022	178288	85973	93890	179863
1996	87057	84972	172029	80682	90047	170729
1998	90573	89441	179978	83738	93496	177234

The data from Table 1 indicate the overall increase in mathematics enrolments resulting from increasing levels of enrolments in mathematics by females when compared to males. Whilst the total number of mathematics enrolments for males and females were approximately equal in 1998, there were some 10 000 fewer male Year 12 students than females.

The State and Territory Scene

Upper school subjects (Years 11 and 12) in each State and Territory can be categorised as either a Public Examination Subject (PES) or as a School Assessed Subject (SAS). A Public Examination Subject is defined as one that meets entry requirements and/or selection criteria for university level study. A School Assessed Subject is defined as one designed for students who are not intending to pursue university study.

The PES and SAS combined trend for (total) mathematics enrolments for the period 1980 to 1998 in each of the States and the Territories is presented in Figure 2. Each State trend reflects more or less the National trend provided in Figure 1.

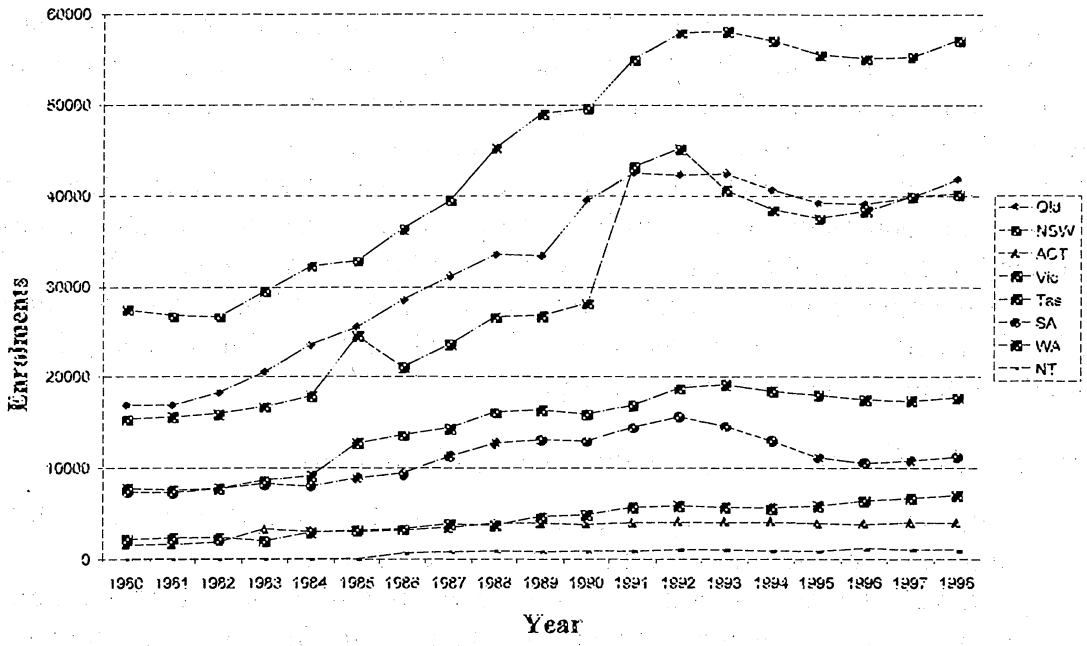

Figure 2: State territory total mathematics enrolments.

Total enrolments in mathematics and the Year 12 student populations in each State and the Northern Territory are shown in Table 2. For Queensland, New South Wales and Tasmania there are more mathematics enrolments than students. In the case of Table2

A Comparison of Mathematics Enrolments and Year 12 Student Numbers - 1998

	Total Maths			% SAS			Year 12			Maths Participation Ratio		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
Qld	21115	20707	41822	8.5	6.9	7.7	17577	18786	36363	1.20	1.10	1.15
NSW	27258	29919	57177	0.1	0.1	0.1	25868	29087	54955	1.05	1.03	1.04
ACT	1916	2013	3929	20.6	13.9	17.2	2189	2081	4270	0.88	0.97	0.92
VIC	21382	18868	40250	0.0	0.0	0.0	20935	24429	45364	1.02	0.77	0.89
Tas	3670	3285	6955	57.1	57.6	57.4	2132	2356	4488	1.72	1.39	1.55
SA	5710	5459	11169	37.5	42.9	40.1	5820	6630	12450	0.98	0.82	0.90
WA	9021	8705	17726	21.8	24.1	22.9	8726	9537	18263	1.03	0.91	0.97
NT	465	485	950	66.2	74.8	70.6	491	590	1081	0.95	0.82	0.88
Nation Total	90537	89441	179978	9.6	9.4	9.5	83738	93496	177234	1.08	0.96	1.02

Tasmania, students can opt to do mathematics in either Year 11 or Year 12 or in both years, and no distinction is made in the statistical data available from that State. Hence, in this analysis, it is not valid to compare the Tasmanian data with that for the other States and the Territories.

The data presented in Table 2 reflect higher levels of mathematics participation in Qld and NSW than for the other States and the Territories. The very considerable difference in the extent each State and Territory provides PES and SAS mathematics offerings in Year 12 is significant. There is no SAS mathematics available in Year 12 in Victoria whereas, in the Northern Territory and Tasmania, these subjects attract 70.6% and 57.4% of the total mathematics enrolment respectively. The data in Table 2 provides tentative support for the notion that extensive availability of SAS subject offerings (as is the case in Tasmania, South Australia and the Northern Territory) does encourage a greater level of participation in mathematics. In 1998, SAS enrolments comprised 10% of the total mathematics enrolments in Australia.

Enrolment in Mathematics Subjects by Level of Complexity

In addition to categorising mathematics subjects as either PES or SAS, a classification in terms of their level of difficulty is informative:

High Level: Those subjects involving specialized or advanced mathematics leading to tertiary studies in which mathematics is an integral part of the discipline, as in physical science, engineering or mathematics (e.g. Specialist Mathematics in Victoria; Mathematics 4U in NSW; Calculus in WA; Applied Mathematics in Tasmania).

Intermediate Level: Those subjects which involve a level of mathematical competence which provides a satisfactory background for tertiary studies in which mathematics content is minimal – for example in architecture, pharmacy, economics (e.g. Mathematics B in Qld.; Discrete Mathematics in WA; Mathematics 2U in NSW, Mathematics 1D in South Australia).

Low Level: Those subjects, which do not provide a suitable mathematical foundation for any tertiary studies (e.g. Mathematics A in Qld; Mathematics in Practice in NSW; Quantitative Methods 2U in South Australia).

Figure 3 below presents mathematics enrolment trends within Australia for the period 1990 to 1998 based on level of course (High to Low) as described above. The most apparent feature is the decline in the number of enrolments for high-level mathematics courses, although this trend has levelled off between 1996 and 1998. Concomitantly there have been increases in mathematics enrolments for the low and the intermediate-level mathematics enrolments.

In 1998, within Australia high-level mathematics enrolments comprised approximately 18% of the total mathematics enrolment whereas the intermediate and low level enrolments comprised approximately 44% and 37% of the total mathematics enrolments. In 1990, the percentage enrolments for high to intermediate to low-level mathematics enrolments were 24%, 42 % and 33% respectively .

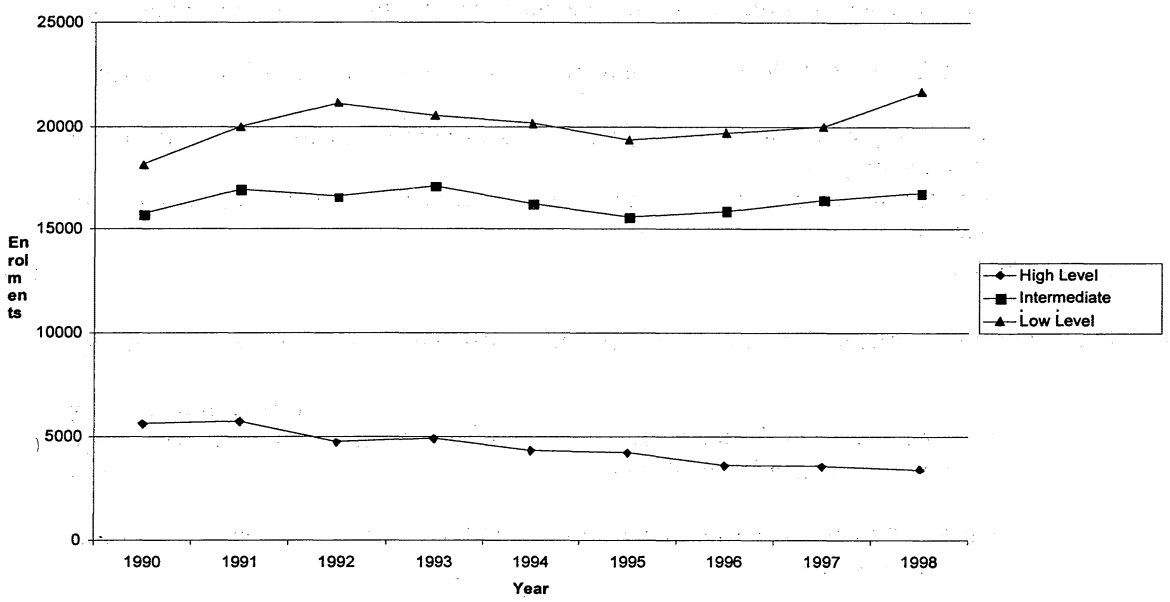

Figure 3: National mathematics enrolments by level of course.

It is well documented that a considerable proportion of students who take mathematics in Year 12 often also enroll in science subjects and more recently, in computing subjects at the tertiary level. This is particularly the case for students who take PES mathematics subjects for tertiary entrance purposes. Table 3 provides a

Table 3
Year 12 Science, Mathematics and Computing Trends in Australia (1990 - 1998)

	Year			90/98 Diff
	1990	1995	1998	
National				
Male	79150	81751	83738	4588 (5.8%)
Female	90321	90606	93496	3175 (3.5%)
Total	169471	172357	177234	7763 (4.5%)
Science				
Male	87148	79937	78362	-8786 (100%)
Female	80191	74563	74208	-5983 (7.5%)
Total	167339	154500	152570	-14769 (8.8%)
Mathematics				
Male	79678	87520	90537	10859 (12.6%)
Female	76020	84566	89441	13421 (17.6%)
Total	155698	172086	179978	24280 (15.1%)
Computing				
Male	10879	25426	29525	18646 (170%)
Female	10296	22339	20659	10363 (100%)
Total	21175	47765	50184	29009 (140%)

comparison between National Year 12 mathematics, science and computing enrolments between 1990 and 1998. In examining Table 3 for 1990 it can be seen that:

- There were more science enrolments than mathematics enrolments for both males and females;
- The number of Year 12 students was comparable to the total mathematics and science enrolments;
- The number of computing enrolments represented only approximately one eighth of the total Year 12 enrolment; and
- The number of female Year 12 students was greater than that for female mathematics and science enrolments.

This scenario changed quite dramatically during the 1990's to the extent that in 1998:

- The number of mathematics enrolments for both males and females exceeded those for science;
- The number of computing enrolments has increased by nearly 150%, representing approximately one quarter of the total Year 12 enrolments. Whilst in 1990 the percentage of males and females was nearly equal, this had changed to approximately 60% for males and 40% for females in 1998;
- The total number of mathematics enrolments exceeded both Year 12 students' enrolments and science enrolments; and
- Male and female science enrolments both decreased after 1990, whereas for mathematics they both increased.

Implications of Trends

Three interrelated enrolment trends have clearly emerged within Australia with respect to mathematics enrolments and Year 12 student numbers. These are the:

- Increased retention of students from Year 8 to Year 12.
- Higher levels of retention of females to Year 12 than for males.
- Increased participation of females in mathematics courses.
- Overall drift away by students from taking higher-level mathematics subjects.

Thus the Year 12 school population in more recent times is comprised of students with a wider range of academic ability, career aspirations and interest than those in previous years.

It also emerges from the examination of the mathematics enrolment data that the level of student participation in school mathematics varies considerably between the States and the Territories, as does the range of subject offerings in mathematics, particularly for SAS mathematics. Queensland has a higher participation rate in mathematics (and science) than elsewhere in Australia when compared to Year 12 populations. This is evidenced by the extent SAS mathematics subjects are available in the States and the Territories. Nevertheless it would appear that the provision of SAS mathematics subjects has not altogether been a solution to attracting more students to do mathematics in Year 11 and 12. Indeed the tradition of offering conventional school mathematics curricula in preparation for university study has prevailed and remains relatively popular.

In order to achieve a greater level of participation in school mathematics for both males and females, a number of previously identified problems and issues in the provision of mathematics at Year 11 and 12 needs to be addressed. These are as follows:

- The recruitment and retention of qualified and well trained mathematics teachers.
  The provision of incentives and opportunities for the ongoing professional development of mathematics teachers, both for context and method.

- The development and introduction of more creative approaches to the teaching of mathematics in schools. The use of the Internet is an obvious teaching resource which remains to be widely utilized for mathematics education.
- The development and implementation of mathematics curricula that challenge and motivate students in the study of mathematics.
- The breaking down of the influence of the university sector in mathematics syllabus content both for PES and SAS subjects. Currently there remains a tendency to "load" curricula with too much content, facts and figures, whereas what is required is a more conceptual, enquiring mode of mathematics education.
- The greater involvement of industry, commerce and "end-users" of the products of secondary education to help ensure that curricula choices available to students are relevant to careers and preparation for the workforce.

Until problems such as the above are addressed, it can be anticipated that the current status and appeal of mathematics education to students will remain unchanged.

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