

MATHEMATICS AND SCIENCE COMBINATIONS NSW HSC 2001-2011 BY GENDER

As an analysis of mathematics/science subject combination choices made by NSW HSC students 2001-2011, this study examines the proportions of the corresponding Year 8 cohort sizes electing to study maths/science subject combinations for the HSC.

John Mack and Barry Walsh

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Dedicated to the memory of Joan Bielski AO (1923-2012)



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SUMMARY

Analysis of mathematics/science subject combination choices made by NSW HSC students 2001-2011 show that although there appear to be very small declines in the various maths/science combinations possible, overall there has been a substantial decline in the proportion of students undertaking at least one maths and one science subject in the HSC. In 2001 some 19.7% of boys and 16.8% of girls from the corresponding Year 8 cohort went on to study a math/science combination in the HSC. However, in 2011 only 18.6% of boys and 13.8% of girls went on to study maths/science in the HSC. This is a considerable decline in an era when participation in Years 11 and 12 education is high and increasing. In addition, there are disturbing increases in the proportion of ATAR-eligible students choosing no units of mathematics in Year 12, especially so for the female student subgroup.

BACKGROUND

In 1980, Barry Walsh and Warren Mann produced the final¹ STEP (Secondary-Tertiary Education Planning) Report, which examined the flow of students from high school towards university in Victoria in the late 1970s. Their analysis included the provision of data, by gender, on mathematics and science subject combinations taken by students as they progressed from Year 11 to Year 12, with particular reference to those providing a suitable basis for the further study of Engineering or Science at university. They focused on the future implications of the data on admissions policies for Victorian universities. Their findings caused an immediate re-examination of the Victorian secondary curriculum, aimed at increasing the proportions of suitably qualified high school graduates well-prepared for entry into tertiary courses in the above-mentioned fields.

In the 1980s John Mack examined the pattern of maths/science subject combinations taken by males and females at the NSW HSC and published his findings in *Reflections* ².

The renewed recent concerns regarding the future viability of science and mathematics based professions in Australia, as evidenced for example by the recent report³ to the Prime Minister by the Chief Scientist, has stimulated us to return to this aspect of the situation, because in our view the use of subject combination data is a more satisfactory basis for expressing concern or making predictions about this matter than using enrolments in various levels of mathematics at school exit level or similar enrolment figures for individual science subjects. In particular, the level at which Years 11-12 mathematics has been studied by those studying science subjects is critical, since some reasonable familiarity with the concepts, techniques and skills needed to understand algebra and calculus remains a necessary prerequisite for the immediate successful pursuit of degree programs in Engineering and most areas of Science.

The tables presented below use Year 8 cohort sizes by gender as the base for comparison. We do so because until there was a common transition year from Primary to Secondary education across Australia, Year 8 was the first common year at secondary level. More importantly, our study is restricted to NSW for a very simple reason. While it is easy to obtain national data on the whole Year 8 cohort, and also on the total national enrolments of recent school leavers in say Engineering degree programs, there is at present no national data base which provides data on the set of subjects chosen by each exiting school student who might subsequently have enrolled in such a program. In NSW, existing arrangements between the NSW government and the Universities Admissions Centre permit analysis of whole of cohort HSC data for research purposes such as that carried out here. With much additional work, it would be possible to track this information across secondary-tertiary transition and thus obtain exact data on the precise preparation level of each student entering each degree program, but at present there is no way this can be done nationally. We hope that the Chief Scientist might commission such a study nationwide, thus obtaining a national profile of the entering cohort for each field of study.

DATA PRESENTATION

We first tabulate our data and will then comment on what has been displayed.

Note that the Year 8 Cohort Number is in fact the number relevant to the year when most of the given HSC Year were in Year 8. Note also that, for mathematics, we follow the terminology used in the well-known studies by Barrington and Brown⁴: for NSW, ‘Advanced’ means 3unit/Extension1 or 4unit/Extension2, while ‘Intermediate’ means Mathematics 2unit. These are the calculus-based mathematics courses in the NSW HSC. The NSW General Maths course, which does not include calculus, is not considered.

Table 1: below gives the background information on the NSW HSC- and ATAR-eligible candidature sizes 2001-2011 in total and by gender .(We use ATAR as the generic acronym for TER/UAI/ATAR).

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Corresponding Yr 8 (00)	837	845	839	845	844	854	874	879	894	880	878
Corresponding Yr 8 (00) males	427	431	428	431	428	435	445	450	445	449	446
Corresponding Yr 8 (00) females	410	414	411	414	416	419	429	433	424	431	432
HSC (00)	575	595	598	606	599	604	611	619	623	638	647
HSC (00) males	270 47%	282 47%	285 48%	289 48%	283 47%	286 47%	289 47%	293 47%	296 48%	306 48%	307 47%
HSC(00) females	305 53%	313 53%	313 52%	317 52%	317 53%	318 53%	322 53%	326 53%	326 52%	333 52%	340 53%
ATAR(00)	498	516	517	520	515	507	510	520	524	542	549
ATAR(00) males	233 47%	243 47%	245 47%	247 48%	241 47%	237 47%	237 47%	241 46%	244 47%	256 47%	256 47%
ATAR(00) females	265 53%	274 53%	273 53%	273 52%	274 53%	271 53%	273 54%	279 54%	280 53%	286 53%	293 53%

Table 1

Table 2 below shows NSW HSC maths and science subject combination data 2001-2011 for males who chose an Intermediate mathematics course for their HSC and exactly one of the subjects biology, chemistry or physics. Note that numbers for Earth and Environmental Science are too small to be included separately in this and later Tables.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yr 8 (00)	427	431	428	431	428	435	445	450	445	449	446
Any one science	2652 6.2%	2610 6.1%	2681 6.3%	2464 5.7%	2354 5.5%	2318 5.3%	2290 5.1%	2185 4.9%	2006 4.5%	2185 4.9%	2038 4.6%
B	917 2.1%	792 1.8%	744 1.7%	680 1.6%	668 1.6%	664 1.5%	683 1.5%	614 1.4%	567 1.3%	626 1.4%	593 1.3%
C	380 0.8%	336 0.9%	388 0.9%	395 0.9%	424 1.1%	379 0.9%	367 0.8%	341 0.8%	328 0.7%	320 0.7%	343 0.8%
P	1280 3.0%	1399 3.2%	1482 3.5%	1318 3.1%	1203 3.1%	1230 2.8%	1205 2.7%	1171 2.6%	1070 2.4%	1183 2.6%	1063 2.4%

Table 2

Table 3 below shows NSW HSC maths and science subject combination data 2001-2011 for females who chose an Intermediate mathematics course for their HSC and exactly one of the subjects biology, chemistry or physics.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	410	414	411	414	416	419	429	433	424	431	432
Any one science	2751 6.7%	2563 6.2%	2393 5.8%	2234 5.4%	2229 5.4%	2060 4.9%	2015 4.7%	1898 4.4%	1881 4.4%	1793 4.2%	1758 4.1%
B	1953 4.8%	1693 4.1%	1586 3.9%	1454 3.5%	1475 3.5%	1323 3.2%	1321 3.1%	1236 2.9%	1215 2.9%	1168 2.7%	1158 2.7%
C	496 1.2%	539 1.3%	449 1.1%	462 1.1%	477 1.1%	480 1.1%	440 1.0%	413 1.0%	406 1.0%	369 0.9%	384 0.9%
P	216 0.5%	256 0.6%	275 0.7%	257 0.6%	242 0.6%	208 0.5%	221 0.5%	215 0.5%	218 0.5%	205 0.5%	194 0.4%

Table 3

Table 4 below shows NSW HSC maths and science subject combination data 2001-2011 for males who chose an Advanced mathematics course for their HSC and exactly one of the subjects biology, chemistry or physics.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	427	431	428	431	428	435	445	450	445	449	446
Any one science	1965 4.6%	2147 5.0%	2089 4.9%	2108 4.9%	1949 4.6%	1770 4.1%	1686 3.8%	1691 3.8%	1682 3.8%	1823 4.1%	1649 3.7%
B	128 0.3%	137 0.3%	120 0.3%	151 0.4%	151 0.4%	146 0.3%	123 0.3%	134 0.3%	122 0.3%	143 0.3%	144 0.3%
C	343 0.8%	375 0.9%	396 0.9%	405 0.9%	478 1.1%	458 1.1%	437 1.0%	442 1.0%	414 0.9%	414 0.9%	407 0.9%
P	1483 3.5%	1627 3.8%	1565 3.7%	1543 3.6%	1317 3.1%	1161 2.7%	1119 2.5%	1109 2.5%	1136 2.6%	1257 2.8%	1094 2.5%

Table 4

Table 5 below shows NSW HSC maths and science subject combination data 2001-2011 for females who chose an Advanced mathematics course for their HSC and exactly one of the subjects biology, chemistry or physics.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	410	414	411	414	416	419	429	433	424	431	432
Any one science	1221 3.0%	1307 3.2%	1408 3.4%	1395 3.4%	1419 3.4%	1303 3.4%	1238 2.9%	1213 2.8%	1273 3.0%	1324 3.1%	1227 2.8%
B	296 0.7%	306 0.7%	316 0.8%	314 0.8%	281 0.7%	314 0.7%	320 0.7%	305 0.7%	306 0.7%	308 0.7%	304 0.7%
C	534 1.3%	576 1.4%	586 1.4%	609 1.5%	706 1.7%	643 1.5%	594 1.4%	604 1.4%	585 1.4%	643 1.5%	611 1.4%
P	392 1.0%	412 1.0%	492 1.2%	463 1.1%	423 1.0%	342 0.8%	321 0.7%	296 0.7%	373 0.9%	367 0.9%	306 0.7%

Table 5

Table 6 below shows NSW HSC maths and science subject combination data 2001-2011 for males who chose an Advanced mathematics course for their HSC and at least two science subjects.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yr 8 (00)	427	431	428	431	428	435	445	450	445	449	446
2 or more	2386 5.6%	2294 5.3%	2358 5.5%	2629 6.1%	2460 5.7%	2516 5.8%	2453 5.5%	2462 5.5%	2382 5.4%	2632 5.9%	2776 6.2%
C+P	2009 4.7%	1899 4.4%	1957 4.6%	2099 4.9%	1924 4.5%	1877 4.3%	1802 4.0%	1738 3.9%	1683 3.8%	1899 4.2%	1969 4.4%
B+C+P	105 0.2%	145 0.3%	150 0.3%	219 0.5%	215 0.5%	251 0.6%	262 0.6%	321 0.7%	279 0.6%	282 0.6%	333 0.7%
B+(C or P)*	272 0.6%	250 0.6%	251 0.6%	311 0.7%	321 0.7%	388 0.9%	389 0.9%	403 0.9%	420 0.9%	451 1.0%	474 1.1%
Note * One in three males chooses the Physics option here											

Table 6

Table 7 below shows NSW HSC maths and science subject combination data 2001-2011 for females who chose an Advanced mathematics course for their HSC and at least two science subjects.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	410	414	411	414	416	419	429	433	424	431	432
2 or more	1535 3.7%	1511 3.6%	1483 3.6%	1688 4.1%	1597 3.8%	1615 3.9%	1476 3.4%	1464 3.4%	1476 3.5%	1488 3.5%	1523 3.5%
C + P	951 2.3%	890 2.1%	841 2.0%	970 2.3%	869 2.1%	778 1.9%	706 1.6%	641 1.5%	698 1.6%	645 1.5%	656 1.5%
B+C+P	129 0.3%	121 0.3%	155 0.4%	170 0.4%	177 0.4%	189 0.5%	202 0.5%	181 0.4%	182 0.4%	168 0.4%	196 0.5%
B+(C or P)*	455 1.1%	500 1.2%	487 1.2%	548 1.3%	551 1.3%	648 1.5%	568 1.3%	642 1.5%	596 1.4%	675 1.5%	671 1.6%
Note * One in ten females chooses the Physics option here											

Table 7

Table 8 below shows NSW HSC maths and science subject combination data 2001-2011 for males who chose an Intermediate mathematics course for their HSC and at least two science subjects.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	427	431	428	431	428	435	445	450	445	449	446
2 or more	1396 3.3%	1341 3.1%	1446 3.4%	1595 3.7%	1553 3.6%	1602 3.7%	1684 3.8%	1701 3.8%	1649 3.7%	1606 3.6%	1817 4.1%
C+P	779 1.8%	714 1.7%	786 1.8%	828 1.9%	780 1.8%	742 1.7%	773 1.7%	738 1.6%	724 1.6%	675 1.5%	760 1.7%
B+C+P	80 0.2%	88 0.2%	111 0.3%	152 0.4%	143 0.3%	186 0.4%	244 0.5%	235 0.5%	214 0.5%	225 0.5%	260 0.6%
B+(C or P)*	537 1.3%	539 1.3%	549 1.3%	615 1.4%	630 1.5%	674 1.5%	667 1.5%	728 1.6%	711 1.6%	706 1.6%	797 1.8%
Note* One in three males chooses the Physics option here											

Table 8

Table 9 below shows NSW HSC maths and science subject combination data 2001-2011 for females who chose an Intermediate mathematics course for their HSC and at least two science subjects.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Year8(00)	410	414	411	414	416	419	429	433	424	431	432
2 or more	1388 3.4%	1305 3.2%	1401 3.4%	1409 3.4%	1318 3.2%	1365 3.3%	1379 3.2%	1336 3.1%	1371 3.2%	1332 3.1%	1463 3.4%
C + P	337 0.8%	333 0.8%	294 0.7%	324 0.8%	294 0.7%	258 0.6%	231 0.5%	259 0.6%	205 0.5%	179 0.4%	214 0.5%
B+C+P	108 0.3%	86 0.2%	113 0.3%	139 0.3%	131 0.3%	133 0.3%	150 0.3%	160 0.4%	178 0.4%	166 0.4%	146 0.3%
B+(C or P)*	943 2.3%	986 2.4%	994 2.4%	946 2.3%	893 2.1%	974 2.3%	998 2.3%	917 2.1%	988 2.3%	987 2.3%	1103 2.6%
Note * One in ten females chooses the Physics option here											

Table 9

ANALYSIS OF THE DATA

There is reasonable stability in the size of the Year 8 cohorts examined above although the HSC candidature has increased. This reflects increasing participation in upper secondary education over the ten year period. Since 2001 the proportion of students going on to HSC has risen from 68.7% to 73.7%. This 5% increase in HSC participation rates might leave us to expect that there would be, if anything, an increase in the proportion of Year 8 students going on to study math/science combinations.

In fact what is shown is that there have been small incremental, downward trend changes in almost every table. While these changes are indeed very small, examination of the total proportions in maths and science combination in both 2001 and 2011 suggests a substantial decline overall among girls. Boys' total participation in at least one maths and one science subject in 2001 was 19.7% and in 2011 18.6%; not a substantial shift. Girls' total participation in 2001 was 16.8% and in 2011 this dropped to 13.8%

If we compare this contemporary data with that produced by Mack in the mid-1980s, an even more disappointing picture is evident. In the previous period, the number of females studying Advanced mathematics, Physics and Chemistry for their HSC was approximately 40% of the corresponding number of males. As the above Tables show, this proportion has not increased over the subsequent 25 years; in fact it has dwindled to only 34%. Today only 1.5% of girls go on to study this combination, while 4.4% of boys do.

This analysis then has documented a decrease in female participation in maths/science and an increasing gender disparity. Analysis of males appears less problematic – or does it? With a 5% proportionate increase in HSC candidature over the ten year period a substantial increase in male and female participation is expected since the proportions reported here relate to Year 8 cohort numbers. If more students are going on to HSC study then we might expect more to go on to maths/science study. This is not the case. It appears that increasing upper secondary participation does not extend to maths and science study. Thus it can be argued that the male participation figures are also disappointing.

There is a pressing need for measures that will produce an improvement in the numbers of school students exiting the HSC well-prepared for entering courses in Engineering and Science.

Girls without any HSC Mathematics

There is a more disturbing feature of HSC mathematics enrolments that is not shown in the above Tables but which emerges from an analysis of mathematics enrolments in Year 12.

Examining the HSC-eligible cohort first, then, in 2001, 9.5% presented no mathematics course for their HSC. One-third of these were male and two-thirds female. In 2011, this figure was 21.8%, with the same ratio of male to female students.

Restricting numbers to those in the ATAR-eligible NSW HSC cohort, then in 2001, 5.4% chose to study no mathematics for their HSC. By 2011, this figure had risen steadily to just over 16%, two-thirds of whom were females. In fact, 21.5%(6316) of the ATAR-eligible females completing their 2011 NSW HSC did not include any mathematics course in their HSC subjects, against a figure of 7.5% (1982) in 2001. (The respective data for boys is 9.8% (2505) in 2011 as against 3.1% (719) in 2001.)

If this trend continues, then we may expect a steadily reducing proportion of future HSC cohorts to be studying mathematics suitable for entry to many post-secondary courses, with an increasing number unprepared for entry to any university Engineering or Science course without preparatory classes in mathematics. This will especially be the case for a very substantial proportion of girls seeking eligibility for post-secondary study.

CONCLUSION

This analysis suggests there is an urgent need to address declining female participation and stagnated male participation in intermediate/advanced maths and science combinations of study. The proportion of girls studying these combination subjects has dwindled since 2001 and there is now a greater gender disparity in maths/sciences participation than there was in the 1980s. Increasing upper secondary participation rates are not reflected in increasing proportions of maths/science study. Proportions of males have stagnated while female proportions have declined; this reflects a failure to promote maths/science education within increasing upper secondary education.

Policies to redress this decline and narrow the gender disparity are needed. There is little hope for improvement in the number of exit-credentialed school-leavers properly prepared for post-secondary study in the fields of Engineering or Science, unless dramatic change at secondary education occurs.

A related and more serious result from this study is the trend for more girls to be leaving high school without having studied any mathematics for their HSC. This has developed particularly over the previous decade in NSW, some 20-30 years after Joan Bielski and others devoted much effort to persuading the NSW community to encourage more girls to pursue their studies in mathematics and science during schooling and to consider careers in Engineering and Science.

The Chief Scientist's³ recent report to the Prime Minister on how to encourage greater participation in mathematics, statistics and science, and the Government's response to it, are timely and demonstrate the level of attention needed if improvement is to be realised. The analysis presented here emphasises just how critical the situation has become.

Acknowledgements

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2. a) *H.S.C. Participation Rates*, Reflections Vol.11 (3), pp3-6 (1986).
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4. A description of the terminology and its relation to individual Year 12 mathematics courses in each State and Territory is given in Barrington, Frank: *Participation in Year 12 mathematics across Australia 1995-2004*. ICE-EM Publications in Education No. 2, AMSI, Melbourne University (2006).

[Barry Walsh in memoriam: Barry died unexpectedly on 9 January 2013. His original work on the STEP and SCOPE reports in Victoria, and later studies both here and in New Zealand, have been a continuing inspiration to those wishing to monitor and publicise the serious matters lying behind his work. I owe him much. John Mack]

Enquiries Contact: john.mack@sydney.edu.au