Declines in High School Mathematics and Science Participation: Evidence of Students' and Future Teachers' Disengagement with Maths

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Abstract

Recent national analyses have shown declines in the number of high school students studying maths and science and there is concern over participation in STEM education. We report on mathematics and science subject combination choices made by students in the New South Wales (NSW) Higher School Certificate (HSC) between 2001 and 2013 and show a substantial decline in the proportion of students undertaking at least one maths and one science subject. We identify a decline in intermediate (2 unit) mathematics as central to the decline in maths and science combinations and explore this in two further analyses: examining HSC maths participation in general; and among students receiving offers for university Initial Teacher Education (ITE). Between 2001 and 2013 the proportion of students going on to study HSC without any maths tripled (from 3.2 to 9.7%), a small increase is seen in elementary level General maths (from 28.9 to 31.9), while intermediate, 2 unit maths, declined (16.8 to 11.4) and advanced, extension courses, remained stable. For students receiving ITE university offers between 2001 and 2013 there was: a tripling in the proportion with no mathematics at HSC (4.8 to 15.6%); with a large and growing majority in General maths (55.1 to 64.5%); and halving of 2 Unit (30.6 to 14.2%) and extension courses (9.5 to 5.46%). Together these analyses raise serious concerns for maths and numeracy standards and for STEM education and industry. In particular, the declining participation rates among prospective teachers are deeply concerning, with the potential to create a vicious cycle of declining engagement with maths in New South Wales schools.

Introduction

As the most basic indicator of educational progress, participation numbers are important. In competing economies they are often used as an index of educational strength and they are a strong predictor of the future educational achievement of a country. Recent attention on Australia's declining attainments and rankings in international educational assessments has raised concerns about the educational wellbeing and economic competitiveness of our nation. In particular maths and science have been areas of grave concern (Australian Academy of Science, 2009; Office of the Chief Scientist, 2014). Given the high standards Australia has achieved in education (universal participation to Year 10; top quartile status on international assessments of 15 year olds) it would be easy to assume that focus should be on attainment not participation. However, data presented here, and more historically, suggest that in some key curricular areas, like science and mathematics, careful attention should also be paid to participation rates at senior high school and the policies that govern them.

In contrast to most developed nations, Australia does not have mandatory requirements for upper secondary subject areas, with the exception of English, and participation levels in different subjects vary. While national curricula and assessment programs now mandate nationally uniform math and science to year ten, participation in these subjects in senior high school and therefore also later at university, is influenced by: diverse state and territory education policies, personal choice and variations in educational opportunity.

Recently there have been reports that subject choices at senior high school may be driven by students strategizing or "gaming" the Higher School Certificate (HSC) system in order to optimize their tertiary entrance rank while minimizing time and effort requirements (McNeilage, 2013a). While such approaches may be of benefit to individuals in terms of university entry hurdles, they are not ideal for ensuring appropriate preparation and the assumed knowledge required for completion of university studies. This situation has emerged with the disappearance of formal university prerequisites over the last 15 years and tertiary educators are voicing concern regarding students' preparedness for university studies (McNeilage, 2013b). Shifts in participation in upper high school subjects also cause more general concern regarding Australia's educational standard in what are considered universal core curricula – reading, maths and science literacy.

Australia's recent performance in the 2012 OECD PISA assessments of mathematics, science and reading literacy among 15 year olds highlighted declines in international competitiveness on these educational outcomes and also statistically significant declines in scores since 2000 (Thomson, 2013). Yet while the PISA attainments in maths and science are disappointing, they are assessed at 15 years of age when participation in mathematics and science study is required by the Australian national curriculum. We might assume that Australia's attainment standards and international competitiveness in maths and science would be weaker post-16 where neither of these subjects is nationally mandated. Australia sits apart from most of the developed world in that at post-16, mathematics and science education is elective. Despite the introduction of the national curriculum, which includes maths curriculum for the final two years of high school (Years 11 and 12, ages 16-18 years), there is currently no mandating of maths, or science, study for these years. Across Australia students are given choice in the subjects that they participate in for high school certificates and graduation. In New South Wales (NSW) students can choose from 43 courses, plus an additional 62 language courses. Maths is not a requirement in New South Wales, Victoria and Western Australia; although it is required in South Australia, and to a small extent in Queensland and the Northern Territory. Nationally there is also no requirement for science study in senior secondary school. In New South Wales the requirement to choose at least one maths or science course for HSC was removed in 2001. As a result there is a need to monitor participation in maths and science in upper secondary school. A change in participation in these years is likely to impact upon national attainment in mathematical and scientific literacy.

Maths is a cross-disciplinary pillar that enhances university performance across all the sciences (Sadler & Tai, 2007; National Research Council, 2013) and therefore examination of high school maths and science combinations is important to university and industry STEM programs. Back in the 1980s Barry Walsh and Warren Mann produced the final STEP (Secondary-Tertiary Education Planning) report, which examined the flow of students from high school to university in Victoria in the late 1970s, with particular focus on students' preparation for further study in Engineering or Science. Their analysis included summary data on mathematics and science subject combinations taken by male and female students as they progressed from Year 11 to Year 12. Their findings, showing declining maths/science

participation rates, 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. Mack (1986;1989) also examined the pattern of maths/science subject combinations taken by males and females at the NSW HSC, however monitoring of participation rates in the years since has focused on examining participation in separate subjects.

The renewed recent concerns regarding the future viability of science and mathematics based professions in Australia have been highlighted in the recent report to the Prime Minister by the Chief Scientist (Office of the Chief Scientist, 2012). In particular there have been concerns over a decline in maths participation and attainment in Australia (Australian Academy of Science, 2009). This stimulated us to utilise the STEP approach to examine science/maths combinations, 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 and for individual science subjects. Science and engineering degrees, and others, have requirements for both maths and science study at university and senior secondary school preparation for these degrees is important for the maintenance of standards within them. In particular, the level at which Year 11 and 12 mathematics has been studied by those entering these degrees is critical, since some reasonable familiarity with the concepts, techniques and skills needed to understand algebra and calculus remains a necessary prerequisite for successful pursuit of STEM degree programs.

Analysis of participation in maths and science combinations, 2001-2013, forms the core of the research presented here. Preliminary findings for the period 2001-2011 however, reported briefly elsewhere (Mack & Walsh, 2013; Mack, Wilson & Walsh, 2013) have been updated with 2012 and 2013 data. These analyses naturally identified two areas for further study, including: first, trends in students' choice of maths level within NSW; and, second, analysis of participation in maths among those students entering Initial Teacher Education (ITE). Neither of these trends had been examined in recent years and so these additional analyses are also presented here. They address some of the queries arising from the low levels of maths and science combinations found with the STEP approach. They also address several gaps in the literature surrounding what might be termed the "maths and science crisis" (Waldhuter, 2012).

The examination of maths and science combinations between 2001 and 2013 revealed that much of the decline was found among girls and stemmed from a gradual drift away from intermediate maths (NSW 2 Unit Mathematics course) toward elementary (NSW General Maths) courses or no maths study. These shifts and the impact they have upon science participation are not entirely apparent in the national participation reports on maths and require further analysis. Thus a second analysis presents participation in the different NSW HSC maths courses over the years 2001 to 2013.

A third analysis is conducted to examine maths participation among prospective teachers. Drawing on Darling-Hammond's (1990; 2012) important work on how teacher quality impacts on the challenges to mathematics and science education, we also undertook additional analyses to explore the maths HSC study among students receiving NSW university offers to study Initial Teacher Education (ITE). Darling-Hammond has both conducted and reviewed studies which clearly illustrate how teacher background, content knowledge and certification are directly related to students' learning outcomes (Darling-

Hammond, 2012). Teaching cohorts are therefore an important focus and their educational background plays an important part in their development into effective teachers.

In Australia the national curriculum requires numeracy to be taught by non-mathematics specialist teachers across curriculum areas up until year 10 (15 years); including requirements for teachers to "provide learning experiences and opportunities that support the application of students' general mathematical knowledge and skills" (ACARA, 2014). In addition, while there are expectations that maths and science subjects are taught by specialists in Years 7 to 12, shortages in specialised maths teachers have meant that around 40 percent of these classes are taught without a qualified mathematics teacher (AMSI, 2014). However we know little about non-specialist teachers' level of engagement with and knowledge of mathematics. Their choice to study maths at HSC level may be considered a proxy measure of their educational engagement with maths; one which is likely to impact upon maths and STEM curriculum in schools.

Methodology

In this secondary data analysis we update previous reports on maths and science combinations (Mack & Walsh, 2013; Wilson, Mack, & Walsh, 2013) to include 2012 and 2013 data and we explore deeper into how these trends relate to maths participation among the NSW student cohort. Given the concerning nature of these trends it is important to consider how maths engagement, as reflected by elective maths study in the HSC, might also be related to teacher engagement and capacity. Consequently we consider the HSC backgrounds of prospective teachers and whether they studied maths. Thus we present three analyses of data: 1) participation in maths and science combinations; 2) participation in maths courses; and 3) participation in maths courses among students receiving offers to study ITE at NSW universities.

This study is restricted to NSW HSC data. 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 degree programs, there is at present no national data base which provides data on the set of subjects chosen by students for high school graduation certificates. In NSW, existing arrangements between the NSW government and the Universities Admissions Centre (UAC) permit analysis of the HSC cohort data. This enables us to examine participation rates in relation to: the year 8 age cohort, in relation to the HSC cohort, the ATAR eligible cohort and specific subgroups, including ITE offers. These different approaches are explained below and as results are presented.

1) HSC participation in maths and science combinations

We report on the proportions of Year 8 cohorts that go on to study various math and science combinations for the HSC over a twelve year period 2001-2013. Detailed tables of participation numbers and proportions are available for 2001-2011 in the technical paper (Mack & Walsh, 2013) and trends up until 2011 have been reported earlier (Wilson et al., 2013).

For a measure of overall educational participation we use Year 8 cohort numbers as the reference for the calculation of the proportion of participation; because this represents the first common year at secondary school across Australia's states and territories. This approach is conventional in studies of secondary school participation. We also follow the terminology used in the well-known studies by Barrington and Brown (2007) 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. We examine these mathematics courses in combination with HSC Physics, Chemistry and Biology courses. While participation in Earth and Environmental Sciences was also examined the numbers were so low they are not reported here. The NSW General Maths course, which does not include calculus, is not considered in the maths and science combinations.

An important methodological point to note is that the overall proportion of participation (in relation to the Year 8 cohort) needs to be interpreted within the context of rising HSC participation. The proportion of Year 8 students going on to study for HSC has increased over the period examined; from 68.7% in 2001 to 74.4% in 2013. Some of this increase is related to shifts in legislation in several states. Assuming that maths and science maintain their position as core curriculum in upper secondary education among this growing cohort of students, the 5.7% increase in HSC participation rates might leave us to expect that there would also be increasing participation rates in math/science combinations at HSC. It may be, however, that the additional students retained in education for the HSC are less academically inclined so that growth of 5.7% in maths and science may not be realised. However, growth in senior secondary education is based, among other things, upon the premise that upper secondary schooling is important preparation for labour markets with increasing educational requirements (Lamb & Markussen, 2011); given that math and science figure substantively within those requirements we might expect some increase in participation among these subjects as a return on growing investment in upper secondary education.

2) HSC participation in maths

We report the proportions of participation in the various HSC mathematics courses over a thirteen year period 2001-2013. As with the maths and science combinations these participation rates are calculated as the proportion of students in Year 8 who go on to study maths at HSC. This analysis includes the participation rates in General Maths (classed by Barrington and Brown (2007) as 'Elementary') and also the proportions of students studying no maths. As with the maths/science combinations, because of the growth in senior secondary participation over this time period, there is an expectation that maths participation rates will have increased. If maths study has been retained as a central part of the growth in senior secondary education we would expect 5.7% growth in these maths participation rates.

Furthermore, we also explore the proportions in each maths course (and in no maths) among the ATAR eligible cohort. These are prospective university students who must have completed at least two units of English study and at least eight other units (with no more than 2 units in vocation education courses) in their HSC to meet the requirements to apply for university entrance.

3) HSC participation in maths among prospective teachers

This analysis draws on the NSW HSC and UAC data to identify those students who have applied and been made offers for entry to ITE degrees. Here, we focus on just two years: 2003 (N=2,458) and 2013 (N= 4,613). These cohorts are spread across 15 universities in NSW and across 110 different education degree codes in early childhood, primary, secondary and adult education programmes.

Results and Discussion

As these are analyses of the total populations of various NSW cohorts the findings comprise of descriptive table and graphs; inferential statistics are not necessary. Findings are presented in for the three analyses outlined above.

HSC participation in maths and science combinations

Overall participation rates for male and female students who complete HSC with maths (intermediate or advanced) and at least one science subject are presented in Figure 1. The gender disparity is highly apparent, as is a gradual downward trend over the thirteen year period – although a recent rise in participation amongst boys since 2009 is also evident. Boys' total participation in at least one maths and at least one science subject in 2001 was 19.7% and in 2013 18.7%; not a substantial shift. Girls' total participation in 2001 was 16.8% and in 2013 this dropped to 13.9%. The decline among girls is most evident up to 2009; thereafter rates are more stable, albeit at low levels of around 14%.

A gradual decline is also evident in total participation rates: in 2001 36.5% of the corresponding Year 8 cohort went on to study maths plus at least one science, in 2013 this figure was 32.6%. This 3.9% decline is equivalent to approximately 350 students; a substantial number when we consider national goals to increase maths and science participation at university.

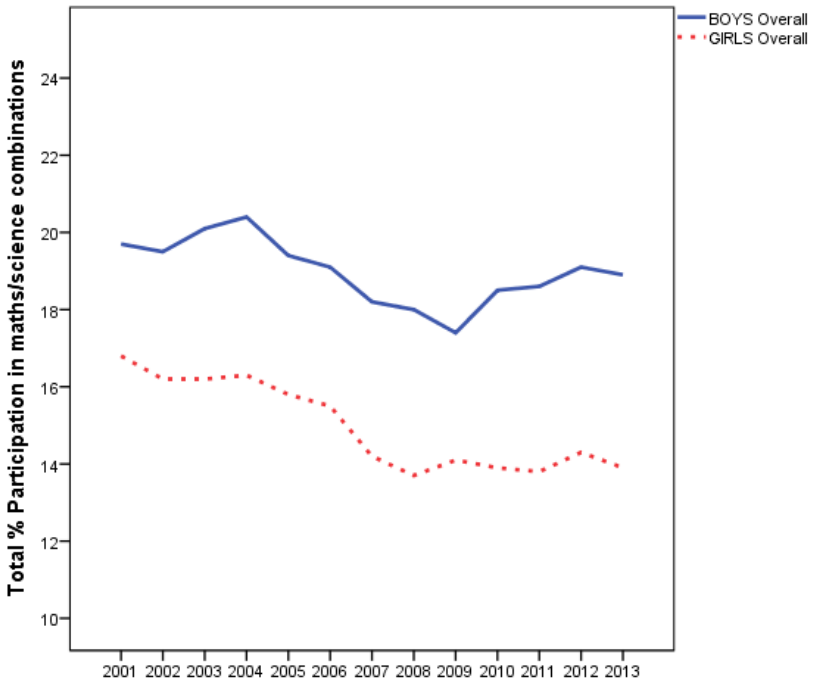


Figure 1: Total participation in HSC maths and science by gender 2001-2013.

The trends for four different science/math combinations are examined separately for boys and girls in Figure 2; including: 1) Intermediate maths + one science; 2) Advanced maths + one science; 3) Intermediate maths + two or more sciences; and 4) Advanced maths + two or more sciences.

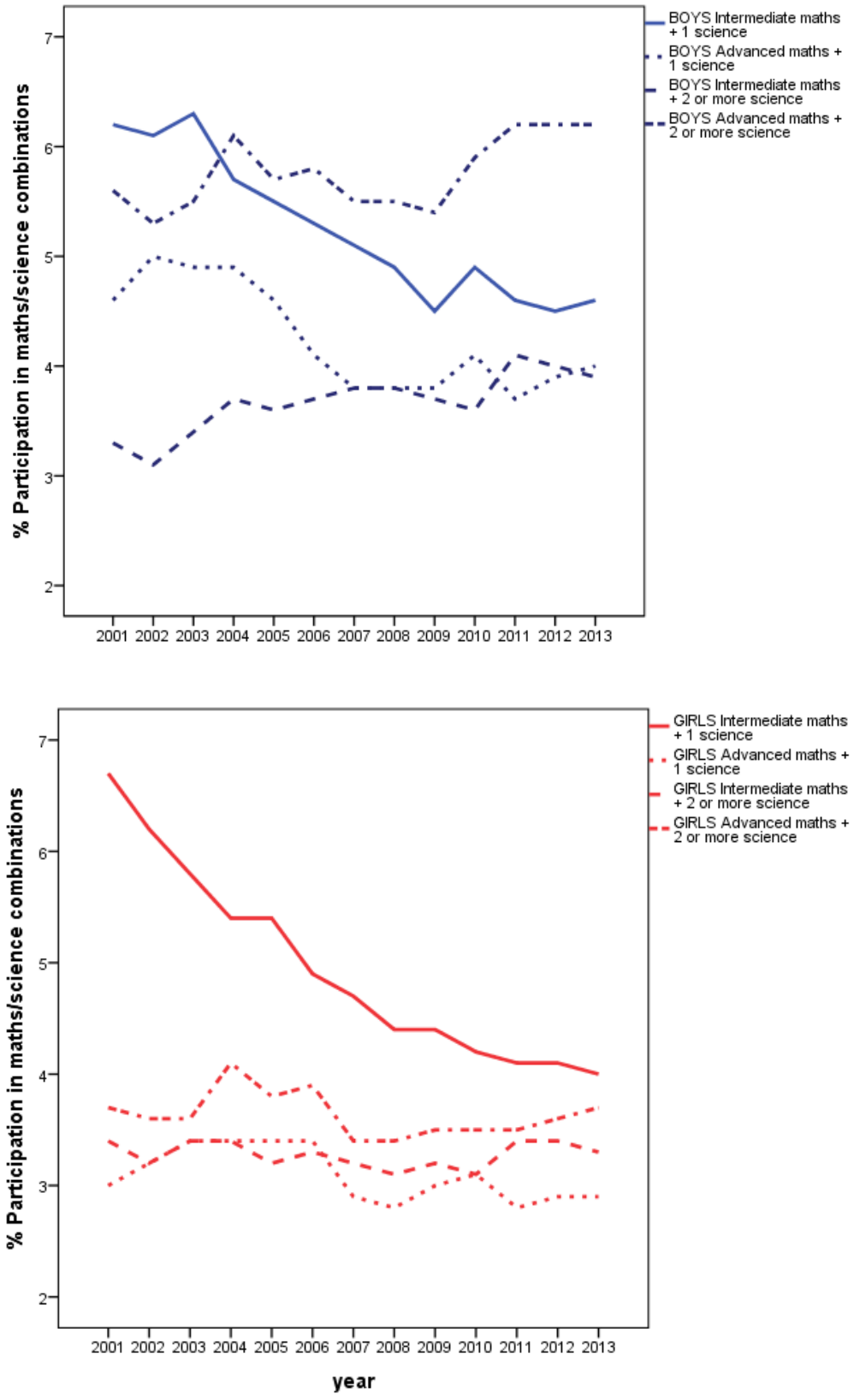


Figure 2: Participation in science and maths combinations by gender 2001-2013

For both boys and girls there is a decline in the proportions taking a math and single science combinations. The most substantial decline is for girls taking intermediate maths and a single science. This number has dwindled from 6.7 percent in 2001 to 4.0 in 2013. Participation in

maths plus two or more sciences is more stable; with a discernible rise in boys' participation in intermediate or advanced maths and two or more sciences since 2009.

Only very small proportions of girls go on to study and maths and science combinations, with total girls' participation in 2013 of 13.9%. If we compare this contemporary data with that produced by Mack (1986; 1989) in the1980s it is clear that the gender gap has not been redressed. .

It is evident from Figure 2 that much of the decline in girls' participation is observed in the numbers in intermediate maths and science combinations. This may be substantially explained by falling participation in intermediate math as girls' participation fell from 24.78 % in 2001 and to 17.85% by 2011. Thus, participation in maths is examined separately in the next analysis.

However, before we focus more on maths it is important to point out that science participation is at low levels. If we consider only the 24,738 ATAR eligible students of 2013 some 54,642 did not complete any science study for HSC. This is a staggering 45% of the NSW cohort that is expected to apply for university study. These figures are particularly low when we benchmark them against countries which are strong performers on international assessments of education. Countries like South Korea and Japan, have exceedingly high participation rates in science; where science (and mathematics) is mandatory study even for those students who choose the 'humanities' rather than the 'natural science' stream for high school graduation. In Finland, consistently the highest performing country in scientific literacy, maths is required but science is not mandated for high school graduation, nevertheless science makes up half of the subject choices within the "Reaali" exam – which is one of the four core exams, of which students are required to take three (Sahlberg, 2011).

HSC participation in maths

The trends in maths participation in the HSC between 2001 and 2013 are presented in Figures 2 and 3. Figure 2 shows the trends in participation rates as a proportion of the students in Year 8 who go on to study these courses for HSC. Figure 3 shows the total participation in the number of students undertaking these courses in the NSW HSC. The data for these graphs is provided in supplementary material, Table 1.

The total participation proportions in Figure 2 show that, despite increasing HSC participation over the period, there has been a decline in Intermediate (2Unit) mathematics (from 16.8 in 2001 to 11.4% in 2013) while Advanced (Extension 1&2 courses) maths has remained stable (at around 10%). At the same time there has been a rise in the proportions undertaking no maths (from 3.2 in 2001 to 9.7% in 2013) and a rise in those taking the lowest level of maths – elementary, General Maths (28.9 to 31.9%). Similar trends among elementary, intermediate and advanced mathematics levels are seen nationally using different metrics (Falkiner, 2012).

Figure 3 shows that increasing numbers of students are completing the HSC and the total number of students in some courses has risen; in Extension 2 and in General Maths for example. However these figures can be difficult to interpret as they are influenced by birth cohort, immigration and also upper secondary participation rates. Thus growth in numbers is not equivalent to a rise in proportionate participation. Overall however the trend in cohort numbers is upward and, despite this, it is strikingly clear that there is a decline in 2 Unit Maths; with some 4,193 fewer students taking this subject in 2013 than in 2001. It is also

evident that in 2001 some 2,701 students did not study maths and by 2013 this had risen to 8,368.

These trends are also evident among those students completing HSC study so as to be eligible for university entrance. In 2013 85% of HSC eligible students were also eligible for an ATAR. Examining the ATAR eligible cohort we see the same rise in no maths and General Maths, declines in 2 Unit maths and fairly stable participation in Extension maths.

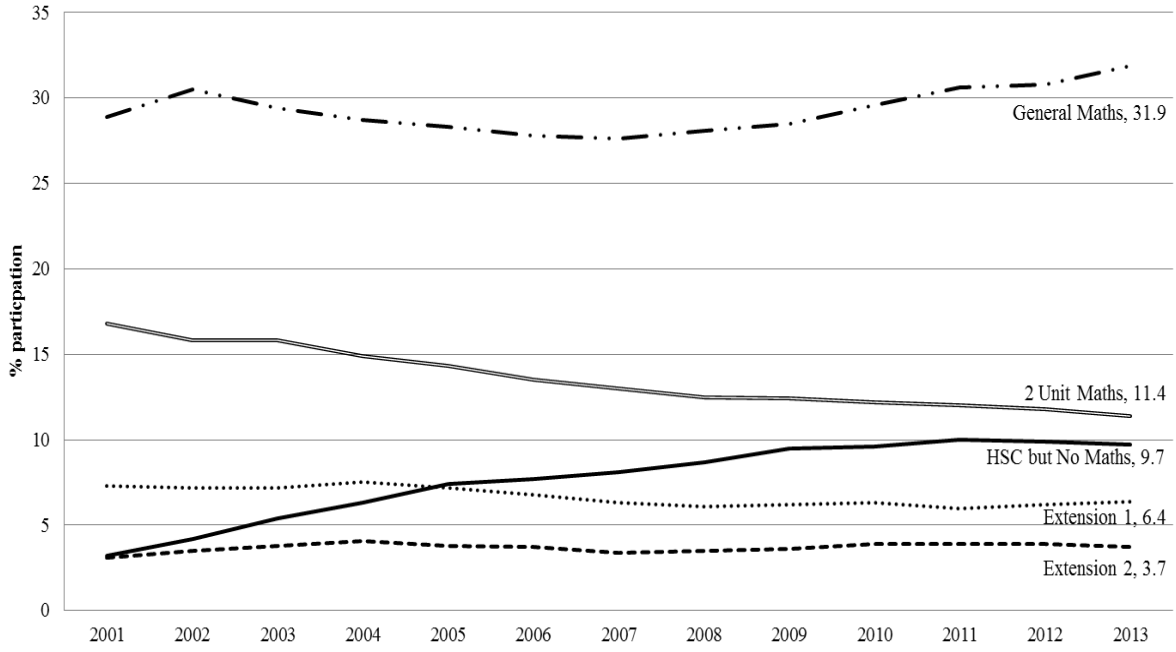


Figure 3: Participation in HSC mathematics courses 2001-2013 as a proportion of the relevant Year 8 cohort

Historically more students completed intermediate maths than did elementary maths until 1995. A tipping point occurred after 1994 and in 1995 some 37% of ATAR eligible students completed Maths in Society (Elementary level maths, predecessor of General Maths) and 35% completed 2 Unit Maths. By 2013 these proportions had changed so that 50% of ATAR eligible students did General Maths and only 18% did 2 Unit. With an additional 15% of students studying no maths at all, this means that of the 2013 cohort eligible to apply for university entrance by HSC, some 65% did elementary level or no maths.

National participation in intermediate and advanced maths is also declining. In 1995 the percentage of Year 12 students studying intermediate or advanced maths was at 41.5% by 2011 this had dropped to only 29.4% studied intermediate or advanced courses (Barrington, 2014). The move away from these levels of maths, seen in the NSW HSC data, is consistent with national trends.

Although some growth for General Maths is evident the growth is not proportional to the growth in senior secondary education over the period. Between 2001 and 2013 the proportion of Year 8 students going on to HSC study increased by 5.7%. Thus examining maths participation as a proportion of the Year 8 cohort, we would expect growth in maths of 5.7%. This is not evident in 2 Unit maths where there is a decline; nor in the extension courses where rates are stagnant. It is not even evident in the 'elementary' General Maths, where

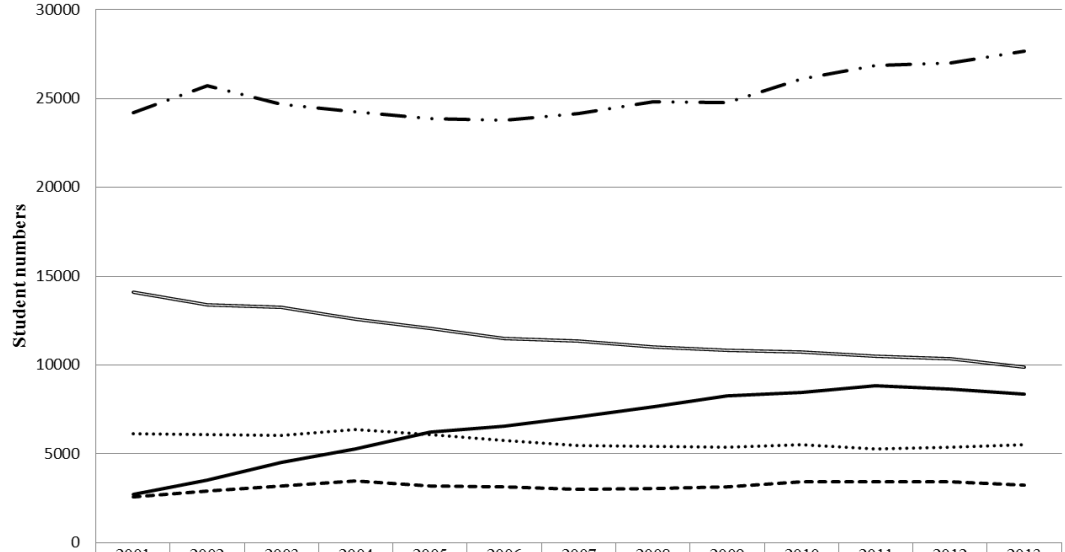
there is growth of just 3%. Thus we can conclude that the majority of the additional students retained in senior secondary education since 2001 are not studying maths.

The trend toward elementary or no maths is most highly evident among females. Although the figures by gender were not available for the whole data series, we can report that among ATAR eligible students some 27.5% of females took 2 Unit maths in 2001 and by 2013 that had dwindled to just 16.3%.

International benchmarks in upper secondary maths participation make it clear that these proportions are extremely low and unlikely to put NSW in a competitive position in terms of post16 maths attainment. In Japan and South Korea participation is extremely high; with mandatory requirement to study maths (from a choice of syllabuses) until high school graduation (Wong, Koyama & Lee, 2014). In Singapore approximately 95% of students take mathematics at senior high school (Wong, et al. 2014). In Finland maths is one of the four compulsory exams, of which students must take at least three, for high school graduation with the *Abitur* (Sahlberg, 2011).

HSC participation in maths among prospective teachers

To explore if the trend away from intermediate and advanced math and toward elementary or no maths study also occurs among prospective teachers, we conducted a brief preliminary analysis, examining the years 2003 and 2013. Findings are seen in Figure 4, which shows a dramatic rise of students receiving ITE offers with elementary or no mathematics study at HSC. Data for Figure 4 are provided in supplementary materials, Table 2.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
HSC but No Maths	2701	3525	4535	5300	6218	6565	7082	7670	8277	8446	8821	8665	8368
General Maths	24218	25741	24682	24246	23873	23782	24135	24836	24794	26077	26867	26999	27640
2 Unit Maths	14085	13376	13263	12584	12081	11495	11333	11018	10814	10724	10493	10357	9892
Extension 1	6149	6071	6035	6369	6082	5767	5489	5406	5360	5522	5279	5390	5516
Extension 2	2600	2928	3220	3499	3207	3135	2997	3048	3157	3452	3437	3436	3226
Total	49782	51648	51736	51999	51461	50744	51036	51978	52402	54221	54897	54847	54642

Figure 4: Participation in HSC mathematics courses 2001-2013 in student numbers

For students receiving ITE undergraduate university offers between 2001 and 2013 there was: a tripling in the proportion with no mathematics at HSC (4.8 to 15.6%); with a large a growing majority in General maths (55.1 to 64.5%); and halving of 2 Unit (30.6 to 14.2%) and extension courses (9.5 to 5.46%). These trends are similar to those seen in the other

cohorts, except that the decline in two unit maths is steeper and a decline in advanced maths is also evident.

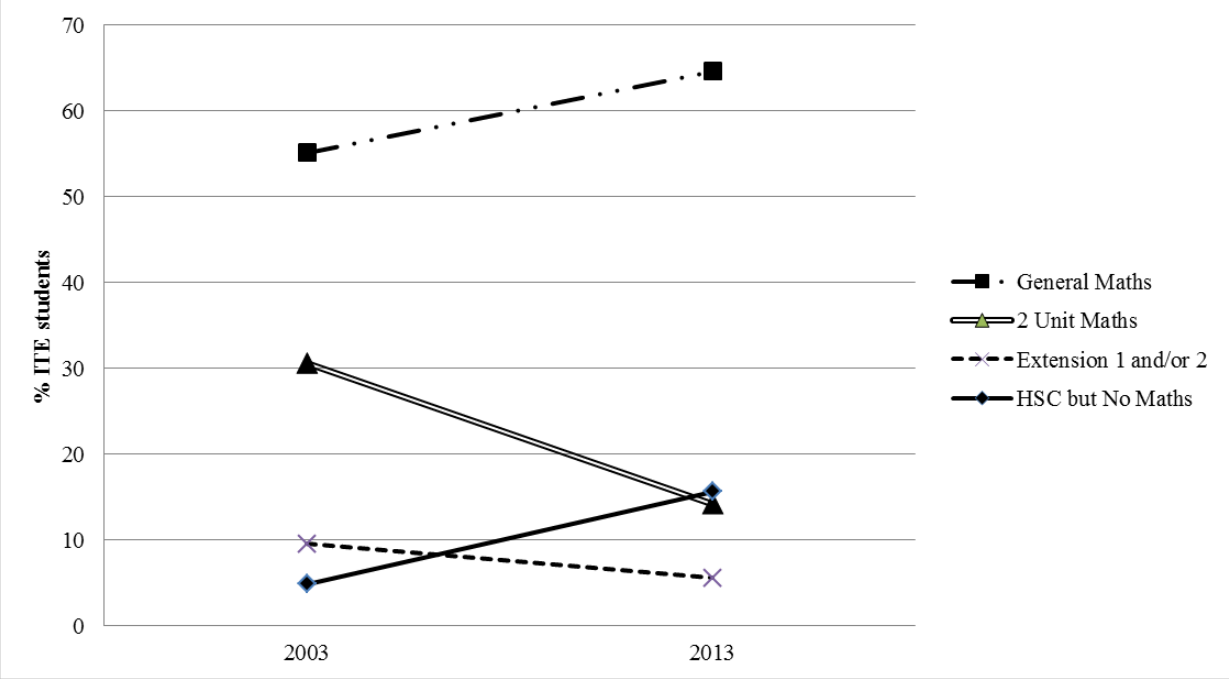


Figure 5: HSC mathematics background among 2003 and 2013 ITE University offers through UAC

NSW regulates that undergraduate trained primary teachers should have completed at least General or 2 Unit Maths:

> ***Prerequisites for admission:*** *Higher School Certificate English minimum Band 4 (Standard English, English as a Second Language or Advanced English) and Higher School Certificate General Mathematics minimum Band 4 or completion of Mathematics (2 Unit). Where you do not meet these entry requirements, a tertiary institution may offer concurrent study or appropriate bridging units and/or require satisfactory performance in approved tests in literacy and numeracy before graduation* (NSWIT, 2013).

The introduction of this requirement may account for some of the rise in General Maths, but does not explain the fall in 2 Unit Maths. Further research is needed to determine whether primary ITE students not meeting the HSC maths requirements undertake bridging courses or numeracy tests.

This is a preliminary analysis which aggregates the ITE students together and is limited to data from just two years. More detailed analyses will be required to examine: early childhood, primary, secondary (non-maths specialist) and secondary maths specialists separately; and, the attainments bands, as well as course choices, of these students.

However, despite the limitation of aggregated data, these figures show a concerning deterioration in the mathematical backgrounds of NSW teachers. Mathematical content knowledge is important to all teachers. This is especially so with the national Australian Curriculum, which requires numeracy teaching across curriculum areas. Furthermore, we know that substantial proportions of teachers teaching maths in secondary schools (40% in Years 7-10 and 25% in 11-12) do so without specialised training in maths (McKenzie, Kos,

Walker & Hong, 2008; AMSI, 2014). The participation figures we report here may also be interpreted as reflections of prospective teachers' engagement with mathematical study. They reflect how maths is valued, or devalued, as part of preparation for teaching and so too reflect how maths is valued within education as a whole.

Conclusion

We report on declining participation rates in maths and science combination between 2001 and 2013. The findings of stagnant boys' participation and declining girls' participation reflect maths and science subjects' failure to participate in the growth in the HSC. Thus it can be argued that the both the female and male participation figures are disappointing and reflect real declines.

Much of the decline of participation in maths and science combinations is due to shifts in the proportions of students taking maths courses and to an increase in the proportion of students studying no mathematics at HSC. Across cohorts (Year 8 age cohorts, ATAR eligible, ITE) we observe a shift away from intermediate, 2 Unit, maths and modest growth in elementary maths. Disturbingly, there is a tripling of the proportions of students studying no maths for HSC in all cohorts. These trends in participation rates are a reflection of students' and schools' educational engagement with mathematics in an upper secondary system in which choice is a key driver.

The finding that these trends are observed among prospective teachers is deeply concerning. In fact, among students with offers to study ITE there was also a halving of the proportions studying intermediate and advanced maths – trends not seen in other cohorts. The increasingly low levels of mathematical study amongst prospective teachers have the potential to create an internal cycle of diminishing maths and science in schools; as the teachers who are currently exiting are replaced by teachers whose knowledge in maths is lower. Such a cycle can lead to a society with an insufficient knowledge base in maths and science. This knowledge base forms the foundations for technological and economic development and is required to maintain the current standard of living. Levels of participation and attainment in mathematics and science education must be lifted if Australia is to compete with international economies whose benchmarks in education already surpass our current standards. If participation rates continue to fall we are committing future generations to a decline in educational and economic standards and to an ever reducing capacity to redress them. It is indeed a slippery slope.

There is an urgent need for policy to redress these declines. In particular, there is need for strong mathematics and science standards among prospective teachers. The introduction of the new NSW HSC in 2001 removed the longstanding requirement for students to study at least one mathematics or science subject. The removal of this requirement and the increase in alternative subject choices over the ten year period must be seen as contributing factors in the declining rates of math and science study. The current system of choice in HSC study has unwittingly produced a system which is dynamic and subject to a wide range of influences – high-stakes pressures, student 'gaming', pragmatic choices regarding workload, parental pressures, variations in school provision, a lack of university prerequisites and so on. Within this system it is clear that mathematics is struggling to compete. Thus, our findings only add to:

> *"the [growing] evidence that Australian mathematics and mathematics education are in serious trouble"* (Australian Academy of Science, 2009, p.1).

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