



Report on the MANSW 2013 Secondary Mathematics Teacher Survey

Some background information

About calculus: In Years 11 and 12, students can elect to study mathematical topics collectively called 'calculus'. The study of calculus provides access to future study in the sciences, engineering and economics, amongst many other career options. Without calculus, students will find study in these areas challenging. In recent years many students have been required to undertake university bridging courses which attempt to deliver the necessary content in a short time span.

About the senior high school mathematics courses: During the years 2001 to 2013, Year 12 NSW students chose one of the following:

- **No mathematics**, or
- **General Mathematics** – a two unit course that does not include calculus topics, or
- **Mathematics (2 Unit) only** – a two unit calculus course, or
- **Mathematics (2 Unit) plus Extension 1** – three units of calculus, or
- **Mathematics (2 Unit) plus Extension 1 plus Extension 2** – four units of calculus.

The Mathematics (2 Unit) course is designed for students who have achieved the majority of the Year 7 to 10 Mathematics outcomes. High achievers in Years 7 to 10 are encouraged by their teacher to consider taking the additional Extension 1 course in Year 11 and Year 12, with an option to pursue Extension 2 in Year 12 where appropriate.

The NSW calculus courses were published in 1983, with minor modifications made in 2001 to accommodate the requirements of the 'New HSC'.

General Mathematics was first examined in 2001

Commencing with the 2014 Year 12 cohort, students have two choices within the General Mathematics course, allowing them to select between two levels of difficulty.

- Mathematics General 2 (HSC examination and ATAR contribution)
- Mathematics General 1 (No HSC examination or ATAR contribution)

Definitions:

Out-of-field teacher of mathematics: A qualified primary teacher (K-6) or high school teacher who is teaching mathematics in a high school without formal qualification to teach high school mathematics.

Second-career teacher: A qualified secondary mathematics teacher who has come to teaching after a previous career outside of the education sector.

Stage 5: Years 9 and 10.

Stage 6: Years 11 and 12.

STEM: Science, Technology, Engineering and Mathematics.

BOSTES: Board of Studies, Teaching and Educational Standards (formerly NSW Board of Studies and NSW Institute of Teachers)



Executive Summary

During December 2013, the Mathematical Association of New South Wales (MANSW) conducted an online survey of secondary mathematics teachers across NSW. The survey contained thirteen questions focused on student participation in senior mathematics courses, student access to qualified mathematics teachers and teacher views on the NSW Stage 6 (Year 11 and 12) courses. Specific attention was paid to the Mathematics (2 Unit), Mathematics Extension 1 and Mathematics Extension 2 courses, collectively referred to as the *calculus courses*. 1084 teachers from regional and metropolitan schools completed the survey, representing an estimated 18% of NSW secondary mathematics teachers. The survey findings presented below are supplemented with analysis of HSC and ATAR data.

1. Student participation in the calculus courses

RESEARCH FINDING 1.1	In 2013, NSW schools produced almost 20 000 calculus students. <i>Based on analysis of NSW Board of Studies data.</i>
SURVEY FINDING 1.2	49% of Year 12 students in metropolitan Sydney and 24% in NSW regional schools are enrolled in a calculus course.
SURVEY FINDING 1.3	Only 2% of students in NSW regional schools enrol in Mathematics Extension 2 compared to 11% in Sydney metropolitan schools. For Mathematics Extension 1, the figures are 7% in regional schools and 17% in Sydney metropolitan schools.
SURVEY FINDING 1.4	Only 15% of students in regional schools study Mathematics (2 Unit), compared with 21% of students in metropolitan Sydney.
RESEARCH FINDING 1.5	The NSW education system produces approximately 3 000 fewer calculus-trained students per year than it did in 2001. This represents a drop of 13% over 12 years. The majority of the decline in calculus trained students is in the Mathematics (2 Unit) only cohort, with a decline of 18% since 2001. Student enrolment in Extension 1 and Extension 2 have been more stable over the period. <i>Based on analysis of NSW Board of Studies data.</i>



Questions raised by these findings:

- The university sector has raised concern about the lack of qualified students entering university study that requires calculus proficiency. Where do the 20 000 calculus students per year go after leaving high school?
- What needs to be done to support regional schools to raise participation in all the calculus based courses?
- What further data on regional participation is available from the NSW Board of Studies?

Factors influencing student participation in the calculus courses

SURVEY FINDING 1.6	51% of respondents believe that a substantial number of mathematically able students in their school are selecting a senior mathematics course below their capability. Only 34% disagreed.
SURVEY FINDING 1.7	565 teachers supplied 1187 reasons for students choosing a mathematics course below their capability. The most frequent reasons given were: <ul style="list-style-type: none"> ○ A desire to optimise HSC and ATAR results, ○ The level of difficulty and time demands of Mathematics (2 Unit), ○ Students are attracted to other HSC courses and lack interest, motivation and confidence in mathematics.
RESEARCH FINDING 1.8	<p>In 2013, a General Mathematics student on the 90th percentile scored a higher ATAR contribution than the median Mathematics 2U student.</p> <p>A mathematically capable student who chose General Mathematics when they could have done Mathematics 2U is likely to gain an extra 10 ATAR points by making this choice, whilst also benefiting from a lighter workload, allowing for more focus on other HSC subjects.</p> <p><i>Based on analysis of the University Admissions Centre (UAC) 2013 Report Table A3.</i></p>
SURVEY FINDING 1.9	83% of respondents agreed that universities should reintroduce HSC Mathematics prerequisites for undergraduate university courses that have significant mathematical content.



Questions raised by these findings:

- Why does it matter?
 - The composition of the General Mathematics candidature is not well aligned with the content and intent of the course. A substantial percentage of students doing this course should be doing something more challenging.
 - Students for whom General Mathematics is the appropriate course are being crowded-out from getting high HSC results.
 - Lower student numbers in the calculus courses will have short and long term negative impact on the teaching population and Australia’s global competitiveness.
- What can be done to encourage students to take an appropriately challenging level of mathematics course?

2. Student access to qualified mathematics teachers

Over the last three decades, there has been an ongoing shortage of qualified secondary mathematics teachers. There have been measures during this time to retrain primary teachers and secondary teachers from other subjects as secondary mathematics teachers, but this has not made a significant impact on the shortage. As a result, schools are calling upon **out-of-field** teachers to teach some mathematics lessons. An out-of-field teacher is a qualified primary teacher (K-6) or high school teacher who is teaching mathematics without formal qualification to teach high school mathematics. The MANSW survey sought to determine the degree to which out-of-field teachers are being called upon to teach mathematics lessons to Years 7 to 9.

MANSW believes that every mathematics lesson for Years 7 to 12 should be delivered by a qualified secondary mathematics teacher. However, this is not always possible. As such, MANSW believes that a reasonable expectation is that at least 80% of Year 7 to 10 lessons are taught by qualified secondary mathematics teachers (i.e. typically 4 out of 5 classes in a Year cohort). Anything less than this should be considered unacceptable.

SURVEY FINDING 2.1	<p>In the Sydney metropolitan region, 30% of respondents reported a Year 7 figure below the MANSW minimum expectation (80% of lessons delivered by qualified secondary mathematics teachers).</p> <p>In regional areas 51% of respondents reported a Year 7 figure below the MANSW minimum expectation.</p> <p>In regional areas 37% of respondents reported a Year 9 figure below the MANSW minimum expectation.</p>
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SURVEY FINDING 2.2	53% of respondents agreed there should be an option for out-of-field teachers to be retrained so that they are qualified to teach Mathematics 7 to 10. Only 16% of respondents disagreed.
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Questions raised by these findings:

- What can be done to support out-of-field teachers of mathematics and what support do they require?

3. Teacher feedback on the senior secondary mathematics courses

Teachers were asked about the courses available and the choices students are making. Questions relevant to the design of future senior secondary mathematics courses were also asked.

SURVEY FINDING 3.1	Only 42% of respondents state that the current Stage 6 course offerings meet the needs of their students. In regional areas the corresponding figure is 36%.
SURVEY FINDING 3.2	53% of respondents state that NSW students should be able to use technology in examinations similar to that in other Australian jurisdictions and the International Baccalaureate. Only 18% of respondents disagreed.

In Conclusion

The results of the **MANSW 2013 Secondary Mathematics Teacher Survey** are discussed in greater detail in the full report. In the spirit of providing 'quality mathematics education for all', the important issues raised by the 1084 respondents warrant urgent attention by MANSW and the broader community. MANSW's recommendations are listed on the following page.

Readers are invited to make confidential written responses to MANSW regarding this report using the following link to an online form:

<http://tinyurl.com/2013manswsurvey>



Recommendation 1.1:

MANSW recommends an extensive review of the ATAR system that is currently used for university entrance, particularly with respect to the contribution of the current NSW Board of Studies, Teaching and Educational Standards (BOSTES) mathematics courses in the ATAR calculation.

Recommendation 1.2:

MANSW recommends that universities reintroduce clearly expressed prerequisites for undergraduate courses that have significant mathematical requirements.

Recommendation 2.1:

MANSW recommends that NSW BOSTES conducts an extensive review of the current NSW Stage 6 Mathematics suite of courses, with a view to creating new courses based on the ACARA Year 11 and 12 courses, as well as a timeline for their implementation.

Recommendation 2.2:

MANSW recommends that decisions about the compulsory use of technology in HSC Mathematics Examinations be made prior to the commencement of the construction of new Stage 6 mathematics courses.

Recommendation 2.3:

MANSW recommends that the NSW BOSTES makes immediate changes to the format and degree of difficulty of the Mathematics (2 Unit) HSC Examination, so that the distribution of raw HSC Examination marks is much more closely aligned to the distribution of mapped HSC marks published by the Board.

Recommendation 3.1:

MANSW recommends that urgent and ongoing measures be introduced and funded to support out-of-field teachers, especially in regional areas.

Recommendation 3.2:

MANSW recommends a review of the systems currently in place for qualified teachers to retrain as qualified secondary mathematics teachers and proposes two different types of retraining courses:

- Type A is for teachers who want to be qualified as a teacher of Mathematics 7 to 10. The focus of this course should be on strategies for teaching mathematical concepts, especially to students who experience difficulty in Stages 3, 4 and 5.
- Type B is for teachers who want to be fully qualified 7 to 12 mathematics teachers.

Recommendation 4:

MANSW recommends that urgent and ongoing measures be introduced and funded to support students, especially in regional areas, who are undertaking the higher levels of mathematics. This could take the form of online lessons available cost-free to students and teachers in all schools.



About MANSW

The *Mathematical Association of New South Wales* (MANSW) is a professional association of mathematics educators that is dedicated to improving the quality of mathematics teaching and learning throughout New South Wales. The association is affiliated with the *Australian Association of Mathematics Teachers* (AAMT) and the *Professional Teachers' Council NSW* (PTC).

MANSW membership covers mathematics educators from Kindergarten through to tertiary level. The association provides support for teachers of mathematics from Kindergarten to Year 12 in both government and non-government schools. MANSW encourages participation from tertiary educators in mathematics and mathematics education. The activities of the association are managed by a voluntary executive committee supported by two professional officers, two project officers, an administrative officer and a financial controller.

The association provides:

- professional development for teachers
- quality resources for teachers and students
- opportunities for the exchange of ideas,
- activities to enrich student learning,
- a representative voice for mathematics educators.

About the MANSW 2013 Secondary Mathematics Teacher Survey

During December 2013, the Mathematical Association of New South Wales (MANSW) conducted an online survey of secondary mathematics teachers in NSW. The survey contained thirteen questions focused on student participation in Stage 6 mathematics courses, teacher resourcing of mathematics classes and teacher views on the Stage 6 mathematics courses.

Key motivations for conducting the survey included:

- Increasing concern about the level of mathematical experience that students are bringing to university,
- Concern that some students are choosing senior mathematics courses well below their capability,
- Reports of difficulty staffing mathematics lessons with fully qualified secondary mathematics teachers.

The respondents

1084 secondary mathematics teachers completed the survey, representing an estimated 18% of NSW secondary mathematics teachers. MANSW believes this survey to be the largest of its kind.

- 95% of respondents are qualified secondary mathematics teachers, 5% are out-of-field teachers.
- 55% of respondents teach in regional NSW (outside the metropolitan Sydney area).
- 20% of respondents are second-career teachers.
- 18% of the respondents have experience teaching senior mathematics courses in other jurisdictions or teaching the International Baccalaureate mathematics courses.

See Appendix A for the full details of the survey questionnaire and the participants.



1. Student participation in calculus courses

1.1 How many calculus students graduate from NSW secondary schools?

The NSW Board of Studies publishes annual data on HSC course participation. Table 1 shows a summary of 2012 data. Raw data have been processed to remove duplicate counting of Extension 1 and Extension 2 students in other courses.

	No HSC maths	General Mathematics	2 units of calculus	3 units of calculus	4 units of calculus
Total students	9 669	31 713	11 232	5 471	3 454
% of Students	15%	52%	18%	9%	6%
			All calculus courses: 33%		
<i>Source: NSW Board of Studies</i>					

RESEARCH FINDING 1.1

In 2013, NSW schools produced almost 20 000 calculus students.
Based on analysis of NSW Board of Studies data.

1.2 Is there a difference between metropolitan and regional areas?

The MANSW survey sought to gain further information on student participation in the senior mathematics courses. Table 2 summarises the survey response to the MANSW Survey Question 3:

	2 units of calculus	3 units of calculus	4 units of calculus	Calculus Students
Sydney Metropolitan responses	21%	17%	11%	49%
Regional responses	15%	7%	2%	24%
Total responses	17%	11%	6%	34%
<i>Source: MANSW 2013 Secondary mathematics teacher survey, Question 3</i>				



Comparing this data to the Board of Studies data (Table 1) suggests the MANSW survey data accurately report the population data for the calculus courses.

The MANSW survey revealed disturbing findings in regional areas, with very low participation in the extension courses and a significantly lower enrolment in Mathematics (2U) only.

SURVEY FINDING 1.2	49% of Year 12 students in metropolitan Sydney and 24% in NSW regional schools are enrolled in a calculus course.
SURVEY FINDING 1.3	Only 2% of students in NSW regional schools enrol in Mathematics Extension 2 compared to 11% in Sydney metropolitan schools. For Mathematics Extension 1, the figures are 7% in regional schools and 17% in Sydney metropolitan schools.
SURVEY FINDING 1.4	Only 15% of students in regional schools study Mathematics (2 Unit), compared with 21% of students in metropolitan Sydney.

1.3 What is the long term trend?

Table 3 provides a summary of the Board of Studies data on student participation in senior mathematics.

Due to variation in student participation over the years, the averages over two five year periods are compared. See Appendix B for a year-by-year analysis.

Table 3: Trends in student participation in Year 12 mathematics					
	General Mathematics	2 units of calculus	3 units of calculus	4 units of calculus	Total number of calculus students
Average number of students 2001-2005	29 901	13 798	6 349	3 145	23 293
Average number of students 2009-2013	31 424	11 306	5 524	3 347	20 176
% change	+5%	-18%	-13%	+6%	-13%
<p><i>Note: The New HSC was introduced in 2001, bringing significant change in student subject selections, especially in subjects other than Mathematics.</i></p> <p><i>Source: Board of Studies</i></p>					



RESEARCH FINDING 1.5	<p>The NSW education system produces approximately 3 000 fewer calculus-trained students per year than it did in 2001. This represents a drop of 13% over 12 years. The majority of the decline in calculus trained students is in the Mathematics (2 Unit) only cohort, with a decline of 18% since 2001. Student enrolment in Extension 1 and Extension 2 have been more stable over the period.</p> <p><i>Based on analysis of NSW Board of Studies data.</i></p>
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Are students selecting courses below their capability?

Question 5 of the MANSW survey asked teachers for their view on the statement:

“In recent years a **substantial** percentage of mathematically able students in my school have chosen to do no maths or General Mathematics for the HSC, even though they were capable of doing something more challenging”.

SURVEY FINDING 1.6	51% of respondents believe that a substantial number of mathematically able students in their school are selecting a senior mathematics course below their capability. Only 34% disagreed.
SURVEY FINDING 1.7	565 teachers supplied 1187 reasons for students choosing a mathematics course below their capability. The most frequent reasons given were: <ul style="list-style-type: none">○ A desire to optimise HSC and ATAR results,○ The level of difficulty and time demands of Mathematics (2 Unit),○ Students are attracted to other HSC courses and lack interest, motivation and confidence in mathematics.



The 565 teachers who stated that students were selecting below their capability were given the opportunity to list reasons. The following is a summary of their responses:

Table 4: Teachers' reasons for students selecting mathematics courses below their capabilities		
CODE	REASON	FREQUENCY
1	Reasons relating to the structure of HSC results and university entry	362
1.1	Mathematically able students are trying to maximise their ATAR by scoring highly in General Maths.	214
1.2	Students and schools want Band 6s. Compared to Mathematics (2 unit) they can get higher results in General Mathematics with less effort.	65
1.3	No university prerequisites for undergraduate courses requiring mathematical prowess. Bridging courses are available.	74
1.4	Maths is not compulsory for Years 11 and 12.	9
2	Reasons relating to the nature of the NSW Mathematics courses	537
2.1	Mathematics (2unit) is too difficult and/or takes too much time/effort /work compared to other 2 unit subjects (including General Maths).	239
2.2	Students don't like / enjoy maths. They are not interested / confident. They appear disengaged / unmotivated.	149
2.3	The Mathematics (2 unit) HSC Exam is too difficult.	47
2.4	Students doing '2 unit only' need to compete with Extension 1 students for Band 6s in 2 unit.	14
2.5	The suite of Stage 6 Mathematics courses is not meeting the needs of students.	27
2.6	Students had inadequate mathematical experiences in K to 10 and/or insufficient preparation for Year 11.	61
3	Reasons relating to external forces	271
3.1	Subjects other than mathematics are more appealing / relevant / useful / interesting / important for their future.	220
3.2	Advice from teachers / careers advisers and other obstacles discourage students from doing Mathematics (2 Unit).	40
3.3	Societal / parental influences	11
4	Other reasons	17
	TOTAL	1187



Some comments from individual teachers:

“Students are more focused on how each subject affects their ATAR. They feel that they can gain better marks in their ATAR by doing an easier course with not as much time or effort required in comparison to the Mathematics (2 unit) course. Students doing the harder 2 unit course feel they have not been adequately compensated in recent years with better scaling of their marks in relation to the General students. They have to work much harder, complete a more difficult course and devote more time to their Maths when doing the 2 unit course or Extension Maths and some aren't prepared to do this for what they perceive as little benefit in their ATAR. They also see the Maths exams as more challenging than other subjects (some students crying after Maths exams). Those doing Mathematics (2 unit) feel their exam is more about sorting out Extension 1 students, rather than letting them show what they know. Many students doing this year's Mathematics (2 unit) exam were devastated after the exam as they worked so hard to be confronted by an exam that gave them little chance to show what they knew. This filters back to younger students who would then rather do the easier General course.”

“The gap between Mathematics and General Mathematics is enormous. In my previous school, the numbers above would have been very different. This year I taught a class of students who had all begun the Extension 1 course and moved to Mathematics 2 unit. Many of them had much greater success and this allowed more time to concentrate on other subjects. In my previous school, we would have students getting results like 14% in Mathematics and after moving to General Maths, they would top the cohort. They did not have to spend 3 hours a night completing work for General Maths (this is the time they were spending completing 2 Unit) and allowed much greater time to be spent on other subjects. This was far more beneficial for them overall. I feel this is a real shame as these particular students would have studied Mathematics to Stage 5.3 and would have been capable Mathematicians. Although I feel reasoning and understanding is important, I feel the shift from 80/20 Component A and B to 50/50 Knowledge v Understanding has meant that the level of understanding required to complete almost ALL questions in HSC examinations, makes it almost impossible for some students to even begin a question.”

“There is such a huge difference between the general maths and the 2 unit course. Many of my students ask why there isn't a 1.5 unit maths course as they can't believe the difference in the courses when they drop 2 unit and come to gen maths. There NEEDS to be a decent 2 unit course that is just a step or 2 above general maths instead of the difference being such a ridiculous one. Otherwise we will continue to have many capable students taking the "easy" Gen maths route or simply drop maths altogether. This is one of my biggest frustrations as a maths teacher!!”

“Many students are capable of undertaking a calculus based course but they are not particularly interested in Maths and so prefer to study General Mathematics which is an easier option and takes up less of their time. Some students start studying 2 unit Maths but find that their assessment results are not as high as their friends studying General Maths who spend less time studying/completing homework for Maths.”



Supplementary Analysis: ATAR 2013 Scaling of Mathematics Courses

<p>RESEARCH FINDING 1.8</p>	<p>In 2013, a General Mathematics student on the 90th percentile scored a higher ATAR contribution than the median Mathematics 2U student.</p> <p>A mathematically capable student who chose General Mathematics when they could have done Mathematics 2U is likely to gain an extra 10 ATAR points by making this choice, whilst also benefiting from a lighter workload, allowing for more focus on other HSC subjects.</p> <p><i>Based on analysis of the University Admissions Centre (UAC) 2013 Report Table A3.</i></p>
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Table 5: Extract from the UAC 2013 Scaling Report – Table A3

Table A3 Descriptive statistics and selected percentiles for HSC marks and scaled marks by course (continued)

Course	Number	Type of mark	Mean	SD	Max. mark	P99	P90	P75	P50	P25
Industrial Technology	5,365	HSC	36.2	6.4	50.0	48.0	44.0	40.5	36.5	32.0
		scaled	16.9	9.7	40.6	38.0	31.0	24.0	15.8	8.9
Information Processes & Technology	2,984	HSC	37.3	6.3	49.0	47.5	45.0	42.0	38.0	33.5
		scaled	21.8	11.0	48.2	44.8	36.6	30.1	21.7	12.9
Legal Studies	9,851	HSC	37.7	6.3	49.0	47.5	45.0	42.5	38.5	33.5
		scaled	25.5	10.8	50.0	46.1	39.6	33.8	26.0	17.2
General Mathematics	32,376	HSC	33.9	6.9	49.5	47.0	43.0	38.5	33.5	30.0
		scaled	21.5	10.1	45.7	41.4	35.4	29.6	21.3	13.2
Mathematics	16,463	HSC	38.9	6.2	50.0	48.0	46.0	43.5	39.5	35.0
		scaled	31.1	9.1	50.0	45.8	41.4	37.9	32.7	25.8

Scenario: Student A and Student B are mathematically capable students. They have completed Year 10 with good results. They may not have completed the most advanced Stage 5 topics, but they have essentially achieved the majority of the Year 10 (Stage 5.2 / 5.3) outcomes.

Student A chooses General Mathematics. We can reasonably expect Student A could be on the 90th percentile of the General Mathematics cohort and score a Band 5 – the majority of the content is revision of Year 7-10 content, with some new applications and extensions. Student A’s ATAR contribution will be approximately 35.4/50 or 70.8 ATAR points. Because Student A is essentially revising material already learnt in Years 7 to 10, they have more time available to study their other HSC courses, further benefiting their overall ATAR.

Student B chooses to do Mathematics 2U only. If Student B works hard, they will master most of the content of the 2U course. In their exam however, they will be competing with nearly 6 000 Extension 1 students who are demonstrably stronger than most 2U students. Given that Extension 1 students



are typically stronger than 2U only students, an average 2U only student will be well below the 50th percentile. Their ATAR contribution will thus be around 30 out of 50, or 60 ATAR points. In addition, compared to Student A, Student B has completed a much more demanding and time-consuming mathematics course, with less time available for studying other subjects.

Student A is demonstrably making the wise ATAR choice to study General Mathematics, and Student B is paying a heavy price for choosing a more challenging and time-consuming subject.

Source: UAC 2013 Scaling Report Table A3

Is the absence of university prerequisites affecting student choices?

The MANSW survey sought to understand how strongly mathematics teachers perceived the influence of university prerequisites on student choice of senior mathematics course.

SURVEY FINDING 1.9

83% of respondents agreed that universities should reintroduce HSC Mathematics prerequisites for undergraduate university courses that have significant mathematical content.



2. Student access to qualified mathematics teachers.

Respondents were asked to estimate the percentage of lessons taught by teachers without formal qualification to teach secondary mathematics.

Table 4a: Year 7 lessons taught by a qualified mathematics teacher			
	% of Responses		
	Overall	Sydney Metro	Regional
60% or less	17%	10%	23%
61% to 80%	24%	20%	28%
More than 80%	59%	70%	49%

Table 4b: Year 9 lessons taught by a qualified mathematics teacher			
	% of Responses		
	Overall	Sydney Metro	Regional
60% or less	9%	5%	13%
61% to 80%	19%	13%	24%
More than 80%	71%	82%	63%

MANSW believes that every mathematics lesson for Years 7 to 12 should be delivered by a qualified secondary mathematics teacher. However, this is not always possible. As such, MANSW believes that a reasonable expectation is that at least 80% of Year 7 to 10 lessons are taught by qualified secondary mathematics teachers (i.e. typically 4 out of 5 classes in a Year cohort). Anything less than this should be considered unacceptable.

SURVEY FINDING 2.1	<p>In the Sydney metropolitan region, 30% of respondents reported a Year 7 figure below the MANSW minimum expectation (80% of lessons delivered by qualified secondary mathematics teachers).</p> <p>In regional areas 51% of respondents reported a Year 7 figure below the MANSW minimum expectation.</p> <p>In regional areas 37% of respondents reported a Year 9 figure below the MANSW minimum expectation.</p>
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In order to formally retrain, out-of-field teachers are currently required to complete advanced university mathematics subjects (for example, solving differential equations), when their immediate need is pedagogical support for teaching mathematics to Year 7 and 8 students.

Respondents were asked for their views about options for the retraining of out-of-field teachers.

SURVEY FINDING 2.2	53% of respondents agreed there should be an option for out-of-field teachers to be retrained so that they are qualified to teach Mathematics 7 to 10. Only 16% of respondents disagreed.
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This is a vote of confidence from the mathematics teaching community that teachers trained in other Key Learning Areas and K to 6 are willing and able to teach Year 7 to 10 mathematics given adequate support and a realistic formal qualification.

3. Teacher feedback on the senior secondary mathematics courses

Is the current suite of Stage 6 Mathematics courses meeting student needs?

From 2014 onwards, Year 12 students have six options:

- 4 units of calculus
- 3 units of calculus
- 2 units of calculus
- Mathematics General 2
- Mathematics General 1
- No mathematics

The survey asked for teacher views on the Stage 6 mathematics courses available to their students.

SURVEY FINDING 3.1	Only 42% of respondents state that the current Stage 6 course offerings meet the needs of their students. In regional areas the corresponding figure is 36%.
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A 42% disapproval of the current suite of Stage 6 mathematics courses is a concern, given there are currently six different options available.



Use of technology in HSC Examinations

Respondents were also asked their views on the use of technology in HSC Examinations (see Table 6). In what appears to be a significant shift in opinion among the mathematics education community, there is now clear support for incorporating technology into the HSC Examinations. It should be noted that 20% of respondents have experience teaching mathematics in a jurisdiction where students are permitted to use handheld technology beyond a scientific calculator.

Table 6: Teacher views on using technology in HSC Examinations

“NSW students should be permitted to use the same technology during some or all of their HSC Mathematics Examinations that students use in other countries, states, territories and the International Baccalaureate”

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Taught only NSW BoS Stage 6	6%	10%	33%	33%	18%
Taught other Stage 6 courses	6%	12%	22%	35%	25%
Total	6%	10%	31%	33%	20%
	16%		31%	53%	

It appears the NSW mathematics community is ready for this discussion when considering the new Stage 6 courses. Refer to Appendix D for some preliminary notes for this discussion.

SURVEY FINDING 3.2	53% of respondents state that NSW students should be able to use technology in examinations similar to that in other Australian jurisdictions and the International Baccalaureate. Only 18% of respondents disagreed.
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A discussion and explicit decision of the role of technology in the HSC courses needs to occur *prior to* the writing of the new Stage 6 syllabuses. A dual “with-and-without” approach, which was previously the case in General Mathematics, is not equitable – giving significant advantage to those students with the technology.



Discussion Points

Student Participation in Calculus Based Courses

- The university system has raised concern about the lack of qualified students entering university degrees that requires calculus proficiency. Where do the 20,000 plus calculus students per year go after leaving high school?
- What needs to be done to support regional schools to raise participation in all the calculus based courses?
- What further data on regional participation is available from the NSW Board of Studies?
- The current ATAR system, in conjunction with the lack of university prerequisites, is discouraging capable students from taking the Mathematics (2 Unit) course.

Teacher Supply

- What can be done to support out-of-field teachers of mathematics?
- What sort of support will need to be provided to regional areas?

Stage 6 Courses

- Is anyone interviewing students to understand their course needs and choices?
- A proposed approach is to view the Stage 6 courses in terms of how they meet the need of the student body. See Appendix C for a proposed Student 'Mathematical Needs' Segmentation. Using this model, it is possible to ask if proposed courses meet the needs of all students.
- The ACARA General Mathematics course is significantly different to the NSW BoS General Mathematics course. Interestingly, the ACARA General Mathematics course would be suitable for those students currently capable of 2U who are choosing General: it is a challenging, non-calculus course with a significant statistics component beyond the level of Year 10 and some topics that will be new to students, such as matrices, networks and sequences.



Appendix A:

The MANSW 2013 Secondary Mathematics Teacher Survey

The survey contained the following 13 questions:

Question 1

In which region of NSW do you currently teach Mathematics?

- Sydney Metropolitan
- Central Coast/Hunter
- Blue Mountains
- Illawarra/ Southern Highlands
- North Coast
- South Coast/Monaro/ACT
- New England
- North Western NSW
- Western NSW
- Riverina
- NA

Question 2a

A 'qualified secondary mathematics teacher' is someone with a mathematics teaching qualification for Year 7 to 12 that is recognised in NSW. This includes those who have completed a NSWIT-accredited re-training course. Please select one of the following:

- I am a 'qualified secondary mathematics teacher'. This was my first career.
- I had a career in a field other than teaching, then I completed a course to become a 'qualified secondary mathematics teacher'.
- I was initially a qualified secondary teacher from another KLA, then I completed a re-training course to become a 'qualified secondary mathematics teacher'
- I was initially a K to 6 teacher, then I completed a re-training course to become a 'qualified secondary mathematics teacher'.
- I am a qualified secondary teacher from another KLA who is in the process of completing a re-training course to become a 'qualified secondary mathematics teacher'.
- I am a qualified K to 6 teacher who is in the process of completing a re-training course to become a 'qualified secondary mathematics teacher'.
- I am a qualified secondary teacher from another KLA who is teaching secondary mathematics without any formal secondary mathematics teaching qualification.
- I am a qualified K to 6 teacher who is teaching secondary mathematics without any formal secondary mathematics teaching qualification.
- Other:

Question 2b(i)

In a typical year at your school, approximately what percentage of Year 7 mathematics lessons are taught by 'qualified secondary mathematics teachers': (please type numbers without percentage symbols)

Question 2b(ii)

In a typical year at your school, approximately what percentage of Year 8 mathematics lessons are taught by 'qualified secondary mathematics teachers': (please type numbers without percentage symbols)

Question 2b(iii)

In a typical year at your school, approximately what percentage of Year 9 mathematics lessons are taught by 'qualified secondary mathematics teachers': (please type numbers without percentage symbols)



Question 3a

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed 'no maths' for the HSC

Question 3b

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed a school-designed Content Endorsed Course such as Maths Applied for the HSC

Question 3c

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed General Mathematics for the HSC

Question 3d

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed Mathematics (2 unit) without Extension 1 for the HSC

Question 3e

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed Mathematics (2 unit) with Extension 1 only for the HSC

Question 3f

In your school, in recent years, approximately what percentage of students in the Year 12 cohorts completed Mathematics (2 unit) with Extension 1 and 2 for the HSC

Question 4

What percentage of the Year 11 2013 cohort at your school are currently undertaking the HSC Mathematics General 1 course for Year 12 2014?

Question 5a

In recent years, a substantial percentage of mathematically able students in my school have chosen to do no maths or General Mathematics for the HSC even though they were capable of doing something more challenging. (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 5b

If you selected 4 or 5 for Question 5a, list reasons



Question 6

I believe the amount of content in the new Preliminary Mathematics General Course is appropriate for the typical student for whom this course was designed (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 7

The new Mathematics General 1 course should have an HSC Examination (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 8

The new Mathematics General 1 course should have an ATAR contribution (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 9

The current suite of NSW Stage 6 Mathematics courses IS meeting the needs of students in Years 11 and 12. (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 10

NSW students should be permitted to use the same technology during some or all of their HSC Mathematics Examinations that students use in other countries, states, territories and the International Baccalaureate. (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 11

Have you taught mathematics to students in Year 11 and/or 12 in other countries, states, territories or the International Baccalaureate?

- Yes
 No

Question 12

NSW universities should re-introduce HSC Mathematics pre-requisites for undergraduate university courses that have significant mathematical content. (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

Question 13

In addition to the current re-training courses, NSW should introduce and recognise a re-training course that would enable qualified teachers from other KLAs and/or K to 6 to teach Mathematics in Years 7 to 10 only. (1=strongly disagree, 2=disagree, 3=unsure/unable to comment, 4=agree, 5=strongly agree)

MANSW believes the survey received responses from approximately 18% of secondary mathematics teachers in NSW.

Metropolitan Sydney	486	45%
Regional NSW	598	55%
Total	1084	100%

Data on type of school was not collected.

The goal was to collect data across all school systems.

Participants were required to supply an email address to participate.

The data was anonymised prior to analysis.



Appendix B: NSW Board of Studies data on student participation

In analysing Board of Studies data on HSC Mathematics courses, it is important to recognise that:

- Many students are counted twice in the data. Students doing the combined Mathematics + Extension 1 are counted twice (in the Mathematics 2 Unit and the Extension 1 data), and Extension 2 are counted twice (in the Extension 1 and the Extension 2 data). *For the purposes of analysing trends, two new sets of data are derived from the BOS data: 2 units of calculus, and 3 units of calculus. This data is given in the table below.*
- The Mathematics 2U figures are likely inflated by accelerated Year 11 students sitting the Mathematics 2U HSC in Year 11, and then going on to do Extension 1 and possibly Extension 2 in Year 12.
- The annual HSC student cohort has grown by approximately 20000 students in the previous 13 years. The regulations for school attendance have also changed.

In the following table:

- '2 Units' denotes students who are doing Mathematics (2 Unit) only, without Extension 1
- '3 Units' denotes students who are doing Mathematics (2 Unit) and Extension 1, without Extension 2
- 'Calculus' denotes all students who are studying one or more of the calculus courses
- The underlined numbers are the lowest number for that course. The italicised numbers are the highest.

Year	4 units	3 units	2 Units	calculus	GM
2013	3198	5658	<u>10878</u>	<u>19734</u>	32883
2012	3454	5471	11229	20154	31702
2011	3441	5383	11181	20005	31633
2010	3470	5648	11504	20622	30992
2009	3170	5461	11736	20367	29911
2008	3090	5458	11789	20337	29977
2007	3010	5604	12157	20771	29437
2006	3149	5870	12254	21273	29248
2005	3242	6123	12883	22248	28673
2004	3514	6445	13306	23265	29376
2003	3432	6768	14270	24470	30849
2002	2960	6193	13948	23101	31233
2001	<u>2578</u>	6216	14585	23379	29375



Appendix C:

A proposed segmentation model for student mathematical needs.

The following is a suggested classification of the differing mathematical needs of Stage 6 students, based on their future career choices.

Description of students and their mathematical needs		Most appropriate course choice	
		NSW BoS Options (2014)	AC Senior Years Options
Numerate Citizens	Those who are waiting to turn 17 so they can leave school and join the workforce. They are probably not seeking an ATAR. Some will leave school prior to the HSC Examinations.	No mathematics Mathematics General 1 or 2	No mathematics AC Essential Mathematics
Future Vocational	Those who will finish Year 12 and will probably not be going directly from school to university. They might go to TAFE as part of some trade-related qualification. They may or may not qualify for and/or apply for an ATAR.	Mathematics General 1 Mathematics General 2	AC Essential Mathematics AC General Mathematics
Future Professionals (including teachers)	Those who will be going to university. They probably won't be doing anything that involves the use of calculus but they need to think and communicate analytically. The mathematics they are most likely to meet at university and in their working life is statistics.	Mathematics General 2 <i>[No calculus, basic statistics]</i> Mathematics 2U <i>[No statistics]</i>	AC General Mathematics <i>[Harder statistics, no calculus]</i>
Future STEM Specialists (including secondary mathematics teachers)	Those who need high-level mathematics because they are destined to do something like engineering, actuarial studies or any of the mathematical sciences. These students need calculus and statistics.	Mathematics 2U + Extension 1 + Extension 2 <i>[No statistics]</i>	AC Mathematical Methods + AC Specialist Mathematics (1 or 2 units) <i>[Statistics and calculus]</i>



Appendix D: The Use of Technology in Mathematics Examinations

- If technology is to be used, we need to be clear of the purposes:
 - We want more time available to teach and evaluate creative mathematical modelling, which reflects the mathematical practices of the real world,
 - We are not seeking to remove the need for some fundamental manual skills. A technology-free examination component is suggested.
- Equitable access to technology remains an issue. Experience shows that explicitly mandating technology, rather than making it optional, means schools address the equity issues, rather than opting out of the use of technology. In the past, schools have managed loan and/or resale programs to provide low-cost options for students to use graphics calculators and laptops. Other jurisdictions have been managing this issue for twenty years.
- A recommended framework for examining the use of the technology is Kutzler's "Indispensable Manual Calculation Skills in a CAS-Environment" – which provides a framework for helping decide which parts of a syllabus should be examined with technology support (T+), which elements students should be able to do without technology (T-) and which areas need to be negotiated (T?). See reference below.

References:

Descriptive statistics and selected percentiles for HSC marks and scaled marks by course (2013).

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http://www.matematicamente.it/staticfiles/approfondimenti/skills_ita/skills_ita.pdf on the 21st December 2013.

NSW Board of Studies (2013). *Student Entries by Sex — 2013 Higher School Certificate* Retrieved from http://www.boardofstudies.nsw.edu.au/ebos/static/EN_SX_2013_12.html on 22nd of December 2013.



Appendix E: Key Stakeholders

- Year 11 and Year 12 Students
- Parents of Year 11 and Year 12 Students
- NSW Federation of Parents and Citizens Associations
- Mathematics teachers K-12
- Mathematical Association of NSW (MANSW) members
- Australian Association of Mathematics Teachers (AAMT)
- Professional Teachers Council (PTC) NSW
- Board of Studies, Teaching and Educational Standards (BOSTES) (formerly NSW Board of Studies and NSW Institute of Teachers)
- ACARA
- University Admissions Centre
- Department of Education and Communities
- Association of Independent Schools of NSW
- Catholic Education Office
- State and Federal Ministers for Education
- NSW Board of Studies and NSW Institute of Teachers
- Universities
- NSW Teachers Federation
- Independent Education Union
- Media organisations
- Professional groups, such as engineers, accountants, actuaries, statisticians
- MERGA
- AMSI
- The Chief Scientist
- Australian Council of Deans of Science
- Australian Government Office for Teaching and Learning