



Draft Senior Secondary Australian Curriculum Mathematics

**Consultation Report
September 2012**

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Published by
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Internet: www.boardofstudies.nsw.edu.au

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1 Executive summary

Introduction

The current structure of the curriculum for the senior years and the current levels of courses within the curriculum do not provide suitable choices of senior mathematics study for all students. The discrete nature of General Mathematics and Mathematical Methods remains a fundamental flaw in the structure of the curriculum.

It remains the case that the two non-calculus-based courses, Essential Mathematics and General Mathematics, are not set at appropriate levels to best serve the needs of the broad range of students wishing to study these courses. The two calculus-based courses, Mathematical Methods and Specialist Mathematics, will not be sufficient to meet the needs of the range of students wishing to study a calculus-based course. A significant number of respondents felt that the calculus-based course structure should be revised in order to accommodate an arrangement paralleling the current ‘three-unit model’ in NSW.

Respondents were of the view that students capable of studying Specialist Mathematics should not be required to commit to the study of the highest-level course, and therefore to at least 400 hours of Stage 6 mathematics study, at the commencement of Year 11.

Respondents commented that the courses lack coherence. There is a lack of purpose in the course descriptions with regard to the selection of specific content. Also, there is a lack of clarity in the documents, including in relation to the depth of understanding expected or required. The sequencing of content within the courses is inappropriate.

The place of technology in the curriculum is seen by respondents as a significant issue. Expectations regarding the use of technology need to be much more explicit, with careful consideration of related access and equity issues. Respondents also felt that the use – or not – of technology impacts on the level of student understanding to be achieved, the time it takes to cover a topic area, and the assessment of the topic area.

Respondents noted that effective implementation of the curriculum will require extensive professional development support for teachers. This was seen as particularly important in relation to the teaching of statistics, but also for ‘new’ topic areas such as matrices and networks.

Key matters

- The course material prescribed for the proposed subjects, except in the case of Essential Mathematics, does not represent appropriate sets of content for the delivery of the intent described in the rationales.
- The presentation of the draft curriculum content developed for the Australian curriculum as a suite of subjects has confused respondents and inhibited quality-focused feedback on the appropriateness of the content as the basis of viable and suitable courses of study to be developed by individual jurisdictions for their senior students.
- The General Mathematics and Mathematical Methods courses are a central component of the proposed curriculum and are of a similar level of difficulty. They have been designed to have minimal content overlap. This has contributed to each course offering an unbalanced development of the Foundation – Year 10 curriculum and will make it very difficult for students to change courses from Mathematical Methods to General Mathematics. If students at this ability level were to devote a third of their total studies to mathematics in both Year 11 and Year 12 by choosing both subjects, the combined content in some areas, particularly in statistics and probability, would be quite excessive.

- The unitised structure of the proposed curriculum has not proved successful in the development of a suite of subjects, each of which is of appropriate balance, sequencing and level of difficulty.
- For students who are very proficient in mathematics, the proposed curriculum mandates that they study more than one of the proposed subjects from the beginning of Year 11 to the end of Year 12 if they are to obtain a strong grounding in senior mathematics and so have access to a sufficiently broad range of career options. The imposition of two mathematics courses plus one or more science courses in Years 11 and 12 to meet reasonable expectations of preparation for entry into science, engineering or IT programs at tertiary level will restrict student subject choice significantly.
- The proposed curriculum is not a satisfactory basis for an appropriate Australia-wide senior mathematics curriculum. Replacing the present senior curriculum in NSW with a curriculum that does not include a strong middle-level calculus course, as is Mathematics Extension 1 in NSW, will significantly reduce the number of students studying advanced level mathematics.
- The proposed Mathematical Methods subject is too difficult for students wishing to study only an introductory calculus-based course, but represents insufficient preparation for the study of mathematics at university level. The proposed Specialist Mathematics subject is a succession of largely disconnected topics beginning in Year 11. Many students cannot judge their mathematical ability well enough to choose the highest-level course at this point. The subject is too difficult for many able students, while being of insufficient challenge for many of the most able students. It is not appropriate to propose that a Mathematics Extension 1 course could be readily constructed out of the Specialist Mathematics content, as this would clearly result in a course in which the content was not unified.
- The reasons for the selection or omission of different content within the proposed curriculum are unclear. The many additional topics in discrete mathematics and statistics, in particular, appear out of place in the curriculum.
- The proposed senior curriculum does not meet the needs of all students, from those with learning difficulties through to very gifted students. Essential Mathematics is not an appropriate course of study for students with learning difficulties; it is unclear which students General Mathematics is intended to target; and Specialist Mathematics taken in conjunction with Mathematical Methods does not provide the appropriate degree of difficulty, challenge and preparation for very able students.
- There is a lack of flexibility in the senior curriculum to enable students to move between subjects. The nature, structure and sequencing of the proposed subjects mean that many more students will study the lowest-level subject, Essential Mathematics. This subject will not provide sufficient challenge for many students. Also, the proposed senior mathematics subjects do not represent an appropriate scope of learning for students. There was a strong view that there is too much emphasis on graph theory, networks and statistics at the expense of other areas, such as calculus and geometry, and that it is difficult to make judgements about the range of topic areas when the technological requirements are not specifically stated. It was also felt that many students are likely to see the Mathematical Methods and Specialist Mathematics subjects as two courses of different natures rather than as an integrated whole.
- While it is acknowledged that it may be difficult to incorporate general capabilities and cross-curriculum priorities authentically in particular subjects, there has not been appropriate attention to their inclusion in the proposed senior curriculum. It is clear, in particular, that the role and applications of information and communication technology (ICT) need to be made more explicit in the subject content.

- The connections and progression of learning from the new curriculum for Year 10 into the proposed senior curriculum need to be strengthened. Students who do not study the content for 10A in Year 10 will not have the prerequisites for studying Mathematical Methods and Specialist Mathematics and will be forced to choose Essential Mathematics and General Mathematics.
- Insufficient information is provided in relation to the possible pathways of study from Years 10 and 10A, the characteristics of students suitable for each senior course, and the options available to students who have completed each course.
- The subjects are currently not named to reflect the content and intent of the courses appropriately. Also, no Australian curriculum subject should have the same or a similar name to an existing or recent course in one or more jurisdictions.
- Significant professional learning and support will be required in order for teachers to adequately teach the proposed curriculum in its current form. To date, there has been no indication from the Australian Government as to how this professional learning and support will be provided.

Recommendations to ACARA

- Further consideration, particularly in the cases of General Mathematics, Mathematical Methods and Specialist Mathematics, needs to be given to the alignment between the subject rationales and the respective sets of content prescribed for the subjects.
- Given that individual jurisdictions are responsible for arranging the curriculum content developed for the Australian curriculum into courses of study for their students, the final content should not be presented as a suite of subjects.
- While the totality of the content and the appropriateness of structures for its hierarchy need to be reconsidered, the similarity of difficulty level and the minimal content overlap of the proposed General Mathematics and Mathematical Methods subjects need particular reconsideration.
- In order to develop focused and coherent senior mathematics courses, a rationale for the selection of specific content and the exclusion of other content is required.
- In aiming to achieve appropriate balance, sequencing and level of difficulty in the further development of the proposed curriculum, the appropriateness of a unitised structure needs careful investigation.
- In order to cater for the full range of students wishing to undertake the study of calculus-based mathematics in Stage 6 and the broad range of their aspirations, an appropriately coherent set of content needs to be developed that allows the construction of a rigorous and unified ‘middle’ calculus-based course of study.
- Further work needs to be undertaken in relation to the appropriate incorporation of the general capabilities and cross-curriculum priorities across the proposed senior curriculum. In particular, the expected role of ICT needs to be identified and applications of ICT need to be included explicitly.
- Further ‘overview’ information needs to be provided for the proposed curriculum, including in relation to the possible pathways of study from Years 10 and 10A, the characteristics of students suitable for each senior course, and the options available to students who have completed each course.
- The proposed subjects need to be renamed to reflect the content and intent of the courses appropriately and so as not to have the same or a similar name to an existing or recent course in one or more jurisdictions.

2 Background information

The Australian Curriculum, Assessment and Reporting Authority (ACARA) released the draft senior secondary Australian curriculum for the English, Mathematics, Science and History learning areas for national consultation from 10 May until 20 July 2012.

ACARA has an established timeline that includes further curriculum refinement to follow the consultation period. It is anticipated that the final senior secondary Australian curriculum for English, Mathematics, Science and History, including content and achievement standards, will be ready for publication following Ministerial endorsement in December 2012.

The focus of the Board's consultation was on the draft senior secondary Australian curriculum content. This consultation was part of a process for developing the NSW approach to integrating the Australian curriculum content into NSW syllabuses. The Board of Studies consulted with teachers, stakeholders and the public through focus group meetings in metropolitan and regional centres and through an online survey. The Board will provide ACARA with formal NSW feedback about the quality and suitability of the curriculum.

At this stage, there is no timetable for implementation of the senior secondary Australian curriculum in NSW.

The NSW consultation consisted of:

- focus group meetings at:
 - Offices of the Board of Studies on 21 June 2012 (Sydney FG)
 - Wollongong on 25 June 2012 (Wollongong FG)
 - Newcastle on 26 June 2012 (Newcastle FG)
 - Offices of the Board of Studies on 28 June 2012 (Stakeholder FG)
- an online survey on the Board of Studies website from 8 June to 27 July 2012
- written submissions received from:
 - the NSW Department of Education and Communities (DEC)
 - the Mathematical Association of NSW (MANSW)
 - three individuals (Submissions 1–3)
 - the UNSW Group (Submission 4).

Professional associations and schooling sectors conducted a range of activities during the consultation period to inform feedback to the Board.

3 Analysis

3.1 Rationale

Overall comments

Feedback indicated that the respective rationales for the four proposed Australian curriculum subjects provided reasonable explanations of the individual purposes of the subjects in the curriculum. However, it was also felt that, except in the case of Essential Mathematics, the course material prescribed for the subjects does not represent appropriate sets of content for the delivery of the intent described in the rationales.

Summary of feedback	Source(s)
<p>Essential Mathematics</p> <ul style="list-style-type: none"> The rationale for the Essential Mathematics subject is suitable. The rationale for the Essential Mathematics course is sensible. 	<p>MANSW Survey (×1)</p>
<p>General Mathematics</p> <ul style="list-style-type: none"> The General Mathematics course could be more hands-on, with further resources for lower-ability students. The General Mathematics course meets the purpose of satisfying students who may go to university but do not need calculus. Ironically, this course seems to have less focus on statistics than some of the other courses, but it is likely that students who take the course may need statistics the most. 	<p>Survey (×1) Survey (×1)</p>
<p>Mathematical Methods</p> <ul style="list-style-type: none"> The rationale for the Mathematical Methods course is sensible, but the course does not develop systematically over the four units of the course. 	<p>Survey (×1)</p>
<p>Specialist Mathematics</p> <ul style="list-style-type: none"> The rationale for the Specialist Mathematics course is reasonable, but it does not adequately justify the lack of calculus and the emphasis on statistics and graph theory. This course appears to be designed for the best mathematics students, who are most likely to complete courses such as engineering; therefore, a greater emphasis on calculus is needed. 	<p>Survey (×1)</p>

3.2 Aims

Overall comments

Overall, feedback indicated that the aims of the four subjects provide appropriate statements of the individual purposes of the subjects. However, the view was also expressed that the aims for Essential Mathematics could be developed further in terms of student ‘confidence and competence in applying mathematics’.

Summary of feedback	Source(s)
<p>Essential Mathematics</p> <ul style="list-style-type: none"> The document states that ‘The emphasis of Essential Mathematics is to provide students with the mathematical knowledge, skills and understanding to solve problems in real contexts for a range of workplace, personal, further learning and community settings’. Therefore, students should develop competence in applying mathematics, but also confidence as users of mathematics in everyday real-life situations. The aims need to include: ‘Students will develop confidence as well as competence in applying mathematics to everyday real-life situations.’ The aims are suitable; however, it is not clear what type of technology students are to choose and use. 	<p>MANSW</p> <p>Survey (×1)</p>
<p>General Mathematics</p> <ul style="list-style-type: none"> The aims need to reflect the relevance of mathematics to enhance student engagement in the General Mathematics course. 	<p>Survey (×1)</p>
<p>Mathematical Methods</p> <ul style="list-style-type: none"> The aims for the Mathematical Methods course represent a reasonable summary. 	<p>Survey (×1)</p>
<p>Specialist Mathematics</p> <ul style="list-style-type: none"> The aims for the Specialist Mathematics course adequately summarise the intentions of the course. 	<p>Survey (×1)</p>

3.3 Organisation of content

Overall comments

Summary of feedback	Source(s)
<ul style="list-style-type: none"> The unitised structure within the course content produces challenges for sequencing and for flexibility in the senior years. 	Sydney FG, Newcastle FG, Wollongong FG, Stakeholder FG, DEC
<ul style="list-style-type: none"> The organisation of the curriculum material under subject titles has created confusion for teachers. For example, General Mathematics and Mathematical Methods are mutually exclusive and are similar in their level of difficulty. This is problematic and is not explained adequately in the documentation. 	Sydney FG, Newcastle FG, Stakeholder FG, DEC, MANSW
<ul style="list-style-type: none"> The provision of two parallel but mutually exclusive courses, General Mathematics and Mathematical Methods, will create logistical issues for schools. The proposed curriculum does not provide for the study of some aspects of mathematics, such as calculus in greater depth. A number of optional topics should be provided for schools to choose from in order to build their own course covering two, three or four units. 	Sydney FG, Newcastle FG, Wollongong FG, Stakeholder FG, MANSW
<ul style="list-style-type: none"> The option for students to take two mathematics courses in both Year 11 and Year 12 is supported. However, the number of students wishing to devote a third of their total studies to mathematics in both Year 11 and Year 12 is unclear. A three-unit course in both Year 11 and Year 12 may provide a viable alternative. 	Sydney FG, MANSW
<ul style="list-style-type: none"> The three topics within the General Mathematics course contain an appropriate amount of content for the time allocated and should be maintained. 	MANSW
<ul style="list-style-type: none"> The treatment of the second derivative needs should appear earlier in the Mathematical Methods course through a reduction in the amount of statistics. Applications of calculus and statistics should be included as the last element of the course. 	Sydney FG, MANSW, Submission 2
<ul style="list-style-type: none"> The General Mathematics and Mathematical Methods courses are a central component of the proposed curriculum and have been designed to have minimal content overlap. However, this has contributed to each course offering an unbalanced development of the Foundation – Year 10 curriculum. If taken together, the combined statistics and probability component is excessive. 	Sydney FG, Newcastle FG, Submissions 1 and 2
<ul style="list-style-type: none"> The continuity of development and the sequencing of topics need improvement in some areas and courses. 	Sydney FG, Newcastle FG, Stakeholder FG, Submission 2

Summary of feedback	Source(s)
<ul style="list-style-type: none"> • The proposed curriculum may mandate that students study more than one of the proposed subjects from the beginning of Year 11 to the end of Year 12 if a strong and balanced grounding in mathematics follows and extends the Foundation – Year 10 curriculum. 	Submission 2
<ul style="list-style-type: none"> • There is a wide range of career options available to school students who are competent or very proficient in mathematics. The imposition of two mathematics courses plus one or more science courses in Years 11 and 12 in order to meet reasonable expectations of preparation for entry into science, engineering or IT programs at the tertiary level may restrict student subject choices. 	
<ul style="list-style-type: none"> • The draft Australian curriculum is not a satisfactory basis for an Australia-wide senior secondary mathematics curriculum. Replacing the present senior secondary mathematics curriculum with a reduced middle-level calculus course may significantly reduce the number of students studying advanced level mathematics. 	Sydney FG, Newcastle FG, Submissions 2 and 3
<ul style="list-style-type: none"> • The proposed Specialist Mathematics subject is a succession of largely disconnected topics beginning in Year 11. Many students cannot judge their mathematical ability well enough to choose between two and four units of mathematics and teachers cannot advise them effectively at this point. Specialist Mathematics is too hard for much of the present candidature of the NSW three-unit course, and provides insufficient challenge for many of the present NSW four-unit candidates. 	Sydney FG, Newcastle FG, Submissions 1 and 3
<ul style="list-style-type: none"> • Mathematical Methods is too difficult for the present candidature of the NSW two-unit ‘Mathematics’ course. It remains insufficient preparation for the current NSW university mathematics courses. 	Sydney FG, Newcastle FG, Submission 3
<ul style="list-style-type: none"> • Any proposal to develop an Extension 1 course out of the Specialist Mathematics content would result in a course in which the content would not be unified. 	Sydney FG, Submissions 1 and 3
<ul style="list-style-type: none"> • The unit structure and content of the proposed Essential Mathematics subject is satisfactory. 	Survey (×1)
<ul style="list-style-type: none"> • The unit structure of the General Mathematics subject is better compared to that of the other subjects. However, lower-ability students will have considerable difficulty with the content of General Mathematics. 	Survey (×2)
<ul style="list-style-type: none"> • The idea of units is reasonable, but the proposed Mathematical Methods and Specialist Mathematics subjects have resulted in an artificial and non-sensible division of the content. For example, the spread of calculus across the units in Mathematical Methods is not appropriate. It would be very difficult to teach some of these units in a logical way. 	Survey (×2), Stakeholder FG

3.4 Content descriptions

Overall comments

Summary of feedback	Source(s)
<ul style="list-style-type: none"> The introduction of many additional topics in discrete mathematics and statistics, in particular, is out of place in the Australian senior curriculum. The reasons for the selection or omission of different content are unclear. In order to develop focused and coherent senior mathematics courses, a rationale for selecting specific content and excluding other content is required. 	DEC
<ul style="list-style-type: none"> More detail is required to indicate the depth and breadth of treatment of the topics listed in each course. Many of the content points are open to interpretation by the teacher. The big ideas in mathematics are not sufficiently evident in the curriculum. 	MANSW
<ul style="list-style-type: none"> Our members generally recognise that there are more university courses utilising statistics than there are courses relying on calculus. They therefore approve the inclusion of statistics in the senior school curriculum. However, many members expressed the view that too much statistics has been included to be taught in the time available. This is at the expense of other topics – in particular, calculus. 	MANSW
<ul style="list-style-type: none"> The number of indicative hours assumed per semester is not stated in the draft senior curriculum. This makes it difficult to assess whether the amount of content in each course is appropriate. 	MANSW
<ul style="list-style-type: none"> Technology applications should be explicitly mentioned throughout the document. There is a need to provide specific examples of how spreadsheets can be incorporated. 	MANSW
<ul style="list-style-type: none"> I have found it very difficult to identify the starting point for any of the courses, except Essential Mathematics. It is absolutely essential that material from Years 9 and 10 be revised in Year 11. 	Submission 1
<ul style="list-style-type: none"> I recommend taking out a lot of the statistics. There are several reasons for this. Students tend to find statistics very boring and many teachers know little or no statistics. However, my main reason is philosophical. Then it is a judgement of whether it is worthwhile. Presumably, the unexpectedly large coverage of statistics must be due to pressure from professional statisticians, who are not involved in teaching high school students. 	Submission 1
<ul style="list-style-type: none"> Notation and terminology should be consistent and reflect best practice. A review is needed of the terminology and notation used in the drafts to ensure that these are in accord with common usage and, wherever possible, unambiguous in their use. I am, in particular, concerned with the use of the words ‘graphs’ and ‘matrices’, which appear frequently in these drafts. 	Submission 2
<ul style="list-style-type: none"> Calculus is not developed coherently in the ACARA drafts. Not only is the geometry deficient, but the placement of ideas is unsuitable for school. For example, integration should be done first with algebraic functions before the complexities of exponential and trigonometric functions are introduced. 	Submission 3

Summary of feedback	Source(s)
<ul style="list-style-type: none"> Calculus is not sufficiently developed in ACARA’s drafts for Mathematical Methods and Specialist Mathematics and is not applied in a coherent manner to problems, despite continual mentions of its ‘applications’. There are other incoherencies in the drafts. For example, without a prior study of geometric sequences, it is not appropriate to be teaching the complex patterns of the Pascal triangle or the mathematics of exponential growth and decay. Graph theory is disconnected from other topics and does not belong in a school course. ‘Matrices and Systems of Equations’ will, despite good intentions, only be taught and understood as a sequence of lengthy and meaningless calculations. 	<p>Submission 3</p> <p>Submission 3</p>
<p>Essential Mathematics</p> <ul style="list-style-type: none"> The course content shows little development from the Australian curriculum Mathematics F–10 content for Years 8–10. Rather than selecting mathematics applicable to the areas of students’ interest, such as independent living, the contexts appear to be fitted to the earlier years’ mathematics content. The content descriptions do not really represent the knowledge, skills and understanding that students should develop when studying Essential Mathematics. Essential Mathematics is a reasonable course for the target group of students. It would benefit from including at least one other context in which each unit could be taught. This course is suited for those students who learn mathematics at a slower rate and have not fully mastered the content of the Australian curriculum Mathematics K–10. However, a reworking of Units 1 and 2 in order to better integrate them and the inclusion of Earning Money in one of the units are recommended. Positive features of Essential Mathematics include the focus on using mathematics to make sense of the world and the practical real-life applications. Throughout the documentation for Essential Mathematics and General Mathematics, both the mathematical content and the context in which this is to be applied should be more clearly specified. I have looked at the syllabus, including some of the details, and I am impressed. The aims should be able to be met by this syllabus. 	<p>DEC</p> <p>Survey (×1)</p> <p>Survey (×1)</p> <p>MANSW</p> <p>MANSW</p> <p>MANSW</p> <p>Submission 1</p> <p>Submission 1</p>

Summary of feedback	Source(s)
<p>General Mathematics</p> <ul style="list-style-type: none"> • The depth of treatment of the content is not always clear. • The inclusion of the Matrices topic in General Mathematics needs to be reconsidered. It appears that they are here to allow students to solve systems of equations, but students do not actually solve systems of equations elsewhere in General Mathematics. The so-called Matrices topic should be either dropped or repositioned and reworked (matrix arithmetic is there for what purpose?). • Many of the topics in General Mathematics show a progression from knowledge and skills through to real-world applications and mathematical modelling, giving a ‘sense of purpose’ for each topic. • There is not enough pre-calculus material. There are some very poorly chosen topics in the course. • The content descriptions do not represent the knowledge, skills and understanding that students should develop when studying General Mathematics. As previously mentioned, graph theory and networks seem to be a major feature, whereas statistics might be more useful. 	<p>DEC</p> <p>MANSW, Submission 2</p> <p>MANSW</p> <p>Submission 1</p> <p>Survey (×1)</p>
<p>Mathematical Methods</p> <ul style="list-style-type: none"> • The draft content still covers too many topics at the expense of depth of treatment. • Many of our members welcome the presence of statistics in this course, but feel that the quantity of statistics needs to be reduced. The topics Discrete Random Variables, Binomial Theorem and Bernoulli Distribution are too difficult for these students in Year 11 and the statistics topics in the General Mathematics course would be more useful and appropriate for many of the students doing this course. • Overall, this is a bland course lacking in the applications of mathematics to the real world and to science, finance and commerce that are usually employed to give students a purpose for the study of calculus, functions and trigonometry at this level. If necessary, the amount of content should be reduced to allow time for applications of the mathematics in Mathematical Methods to be included. • The depth of treatment of topics in Mathematical Methods should be more clearly specified. Teachers require more than lists of dot points of content. • More applications of algebra, functions and graphs need to be included in Mathematical Methods and time allowed for mathematical modelling, if necessary by the removal of content. Emphasise that the statistical topics should be taught through real-world contexts and the use of suitable real data. • Consider reducing the amount of statistics to allow for relevant and useful applications of both calculus and the statistics that is retained. 	<p>DEC</p> <p>MANSW</p> <p>MANSW</p> <p>MANSW</p> <p>MANSW</p> <p>MANSW</p>

Summary of feedback	Source(s)
<ul style="list-style-type: none"> • In Mathematical Methods, make clear in the content of the calculus topics that applied problem-solving is required, including the skills of modelling that are needed to analyse a problem and construct relevant representations. 	MANSW
<ul style="list-style-type: none"> • The statistics is too hard and the problem with the huge quantity of statistics is not just that it is hard, but also that it has squeezed out a lot of material that is more central. 	Submission 1
<ul style="list-style-type: none"> • I do not believe that 25% of the syllabus should be statistics. This is especially the case for the Mathematical Methods subject. Ten percent probability and statistics would be a good target. One mantra repeated by Wildberger several times in his document is ‘Teach it properly or not at all’. This applies not only to topics in the calculus-based courses, but also to topics in the General Mathematics syllabus. 	Submission 1
<ul style="list-style-type: none"> • The current version of the subject should simply be discarded. I would discard all the statistics. I would have a substantial amount of algebra, including arithmetical and geometrical series, probability and the binomial theorem. The second topic to be covered would be geometry, including a lot of coordinate geometry and some Euclidean geometry. The third topic would be trigonometry, done properly, and certainly including the $\sin(A+B)$ formulas so that the calculus treatment of trigonometrical functions can be done properly as well. 	Submission 1
<ul style="list-style-type: none"> • The statistics and probability content is extensive and appears to require rapid treatment towards relatively deep and narrow endpoints. 	Submission 2
<ul style="list-style-type: none"> • There is no Euclidean geometry in the Mathematical Methods draft, and very little coordinate geometry. Moreover, geometric ideas play little part in the development of calculus. These attitudes of the drafts are in sharp contrast to the extensive and imaginative role of geometry throughout NSW mathematics secondary syllabuses. 	Submission 3
<ul style="list-style-type: none"> • School students learn mathematics best when they can see it, they solve problems best when they can see the algebra and arithmetic displayed on a diagram, and they learn proof when that proof is visible on the diagram. Without geometry, mathematics can lose its meaning for most school students and become instead a dreary pushing of symbols around on a page. 	
<ul style="list-style-type: none"> • The content descriptions do not really represent the knowledge, skills and understanding that students should develop when studying Mathematical Methods. This course is the minimum course that students can take if they need calculus at university. It would therefore be better to include more emphasis on the study of calculus and less on the areas of discrete random variables and statistics. Additionally, the depth of treatment of some content areas is unclear. 	Survey (×1)

Summary of feedback	Source(s)
<p>Specialist Mathematics</p> <ul style="list-style-type: none"> • The content described as Specialist Mathematics does not always appear to be well considered. The Specialist Mathematics content needs further consideration in terms of balance, as it appears to over-represent discrete mathematics, and also needs more depth of treatment. There is little content reflecting a ‘first principles’ approach to mathematics, something that would be expected in a specialist course. • It was suggested to me that a three-unit course could be constructed simply by selecting half of the topics in Specialist Mathematics and adding them to Mathematical Methods. There are several problems with this suggestion. • One of the very real strengths of the current four-unit syllabus is that the topics are tightly linked to the three-unit course, and in that sense it is a true extension course. Why should NSW move away from a very successful four-unit course to an inferior product? • The vectors topics in the Specialist Mathematics course are a good feature. • No. I would like to see the removal of graph theory and statistics, a reduction in the study of matrices and vectors, and the inclusion of more calculus. • The number of topics to be covered will make this a difficult course. There is concern that geometry is included in this course, but not at all in Mathematical Methods. • The content in Specialist Mathematics (especially in statistics) needs to be reduced, but emphasise the skills in proof and problem-solving that students will be expected to develop. • The depth of treatment of topics in Specialist Mathematics should be more clearly specified. 	<p>DEC</p> <p>Submission 1</p> <p>Submission 1</p> <p>Submission 2</p> <p>Survey (×1)</p> <p>MANSW</p> <p>MANSW</p>

3.5 Catering for the full range of students

Overall comments

The proposed senior curriculum does not meet the needs of all students, from those with learning difficulties through to very gifted students. Essential Mathematics is not an appropriate course of study for students with learning difficulties; it is unclear which students General Mathematics is intended to target; and Specialist Mathematics taken in conjunction with Mathematical Methods does not provide the appropriate degree of difficulty, challenge and preparation for very able students.

There is a lack of flexibility in the senior curriculum to enable students to move between subjects. The nature and structure of the proposed subjects mean that many more students will study the lowest-level subject, Essential Mathematics. This subject will not provide sufficient challenge for many students. Respondents also indicated that the proposed senior mathematics subjects do not represent an appropriate scope of learning for students. They expressed the view that there is too much emphasis on graph theory, networks and statistics at the expense of other areas, such as calculus and geometry, and that it is difficult to make judgements about the range of topic areas when the technological requirements are not specifically stated.

Summary of feedback	Source(s)
<ul style="list-style-type: none"> Concerns were raised about the apparent lack of flexibility in the senior curriculum provision to enable students to move between subjects and to allow schools to implement various delivery approaches. It would be a backward step if the proposed Australian senior curriculum provides less flexibility and less challenge for our high-achieving students. 	Sydney FG, Newcastle FG, Wollongong FG, DEC, MANSW
<ul style="list-style-type: none"> The proposed Australian senior mathematics curriculum should be redesigned to provide a more comprehensive suite of courses to meet the needs of the full range of student mathematical ability, from those students with learning difficulties through to very gifted students. The nature and structure of the suite of subjects will mean that many more students will study Essential Mathematics, which will not provide them with sufficient challenge. There is no appropriate course designed for students currently catered for by Stage 6 Life Skills. 	Sydney FG, Newcastle FG, Wollongong FG, MANSW
<ul style="list-style-type: none"> The needs of senior students intending to study quantitative disciplines at tertiary level, including engineering, are not addressed adequately in the Australian senior curriculum. This is a major concern, given the shortage in Australia of graduates in quantitative disciplines. 	Sydney FG, Newcastle FG, Stakeholder FG, MANSW, Submission 2
<ul style="list-style-type: none"> A ‘pathways’ diagram indicating the nature of the differentiation between the four subjects, the relationship between General Mathematics and Mathematical Methods, and the progression from K to 12 and post-school opportunities for work and further study is required. More clarity is needed surrounding access to post-school courses for General Mathematics and Mathematical Methods students. 	MANSW
<ul style="list-style-type: none"> The structure of the suite of senior mathematics subjects will reduce the proportion of the ATAR-eligible candidates completing higher-level courses in mathematics. This will restrict their access to some tertiary courses. 	Sydney FG, Wollongong FG, Submission 2

Summary of feedback	Source(s)
<ul style="list-style-type: none"> • The senior mathematics subjects do not represent an appropriate scope of learning for students. There is too much emphasis on graph theory, networks and statistics at the expense of other areas, such as calculus and geometry. As the technological requirements are not specifically stated, it is difficult to form judgements on topic areas. Generic comments about technology are not adequate. 	<p>Sydney FG, Newcastle FG, Wollongong FG, Stakeholder FG, Survey (×2)</p>
<ul style="list-style-type: none"> • The General Mathematics subject does not represent an appropriate set of mathematics learning for students. 	<p>Newcastle FG, Survey (×2)</p>
<ul style="list-style-type: none"> • The Mathematical Methods subject is not an appropriate course of study for many students needing a strong foundation in calculus prior to tertiary study. There is an unnecessary emphasis on statistics, and the course contains no geometry. 	<p>Sydney FG, Survey (×1)</p>

3.6 General capabilities and cross-curriculum priorities

Overall comments

Feedback indicated that there has not been appropriate attention to the inclusion of general capabilities and cross-curriculum priorities in the proposed senior curriculum. It was felt, in particular, that the role and applications of information and communication technology (ICT) need to be made more explicit in the subject content. However, respondents also acknowledged that it may be difficult to incorporate general capabilities and cross-curriculum priorities authentically in particular subjects. It was also stated that the cross-curriculum priorities, in particular, should not be forced or tokenistic.

Summary of feedback	Source(s)
<ul style="list-style-type: none"> • General capabilities and cross-curriculum priority areas need to be included in the senior curriculum. • More explicit examples in the statistics sections using data relating to sustainability and other cross-curriculum areas should appear. • The role of technology and its applications needs to be made explicit throughout the document. Decisions by state authorities on the use of technology in external examinations will have an impact on the use of technology in teaching and learning throughout course delivery, and this could lead to significant differences between states. • General capabilities appear to be sensible for any course. However, it may be difficult to address them authentically in particular subjects. Cross-curriculum priorities appear tokenistic. 	<p>DEC</p> <p>MANSW</p> <p>Sydney FG, MANSW</p> <p>Survey (×2)</p>

3.7 Other comments

Summary of feedback	Source(s)
<p>Connections to K–10 curriculum</p> <ul style="list-style-type: none"> • The connections and progression of learning from the new curriculum for Year 10 into the proposed senior curriculum need to be strengthened. • A diagram should be provided to illustrate all possible pathways of study from Years 10 and 10A, through Year 11 to Year 12, including a brief outline of the mathematical content of each course, the characteristics of students suitable for each course, and the options available to students who have completed each course. • It is not clear whether the Australian curriculum for Foundation – Year 10 is a statement of what all students are expected to have learnt by the end of Year 10. There is overlap between the Proficiency strands in K–10 and the applications in Essential Mathematics. • Students who do not study the content for 10A in Year 10 will not have the prerequisites for studying Mathematical Methods and Specialist Mathematics and will be forced to choose Essential Mathematics and General Mathematics. • The Mathematical Methods subject has high algebra demands with no adequate preparation through the 10A content. Many of the topics in Mathematical Methods require knowledge, skills and understanding developed in 10A. The 10A course will attract a small candidature; therefore, some students who may otherwise have been successful at this level of study will be excluded from studying Mathematical Methods. • The three-strand design of the Australian Foundation – Year 10 curriculum has disappeared and subsequently there is discontinuity to the senior curriculum. It is not clear why these strands are no longer relevant at the senior level. • Within the current version of the curriculum, only the Essential Mathematics subject has the potential to represent a balanced and smooth continuation from Year 10. 	<p>Sydney FG, DEC</p> <p>MANSW</p> <p>MANSW</p> <p>Sydney FG, Newcastle FG, MANSW, Submission 2, Survey (×1)</p> <p>Newcastle FG, MANSW, Submission 2</p> <p>Submission 2</p> <p>Submission 2</p>
<p>Additional information on overview of senior curriculum</p> <ul style="list-style-type: none"> • Additional information needs to be provided in terms of an overview of the proposed senior mathematics curriculum. 	<p>DEC</p>
<p>Ease of transferability from one course to another</p> <ul style="list-style-type: none"> • The nature and sequencing of the content of the various subjects reduces the ease with which students will be able to transfer between the subjects. Many students are likely to see the Mathematical Methods and Specialist Mathematics subjects as two courses of different natures, rather than as an integrated whole. 	<p>Sydney FG, Newcastle FG, Wollongong FG, Submission 2</p>

Summary of feedback	Source(s)
<p>Names of courses</p> <ul style="list-style-type: none"> The subjects should be renamed to reflect the content and intent of the courses appropriately. For example, the name ‘Essential Mathematics’ implies that the subject should be studied by all students, and General Mathematics does not read as a ‘general’ course of study in mathematics, as there is little or no algebra, trigonometry or probability. To avoid confusion, no Australian curriculum subject should have the same or a similar name to an existing or recent course in one or more jurisdictions. 	Sydney FG, MANSW, Submission 1
<p>Professional development needs</p> <ul style="list-style-type: none"> Significant changes to the senior mathematics curriculum will place considerable pressure on schooling systems and sectors nationally. There has been no indication from the Australian Government regarding the provision of professional support for teachers, who will require considerable professional learning to adequately teach the proposed curriculum. 	Sydney FG, Newcastle FG, Wollongong FG, MANSW, Submission 1
<p>Investigations</p> <ul style="list-style-type: none"> There is strong support for the inclusion of Investigations in Essential Mathematics and there is agreement among our membership that Investigations should be included in all courses in the proposed curriculum. MANSW urges state curriculum authorities to include Investigations in external assessment components for the award of senior years credentials. 	MANSW
<p>Achievement Standards</p> <ul style="list-style-type: none"> Though the introduction of Achievement Standards in the proposed senior curriculum documents is welcomed, it appears odd that the terminology being used is inconsistent with the Proficiency strands in the Australian Foundation – Year 10 curriculum. Understanding, Fluency, Problem Solving and Reasoning should be made more explicit in the Achievement Standards for the proposed senior subjects. It is unclear whether the Achievement Standards specified for Level A will provide guidance in relation to depth of treatment and applications. Some are unrealistic in their descriptions. 	MANSW Submission 2