



**AAMT Response to the Draft Senior Secondary
*Australian Curriculum: Mathematics***

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1. EXECUTIVE SUMMARY

The key finding from AAMT's engagement with members and others on the Draft Senior Years Mathematics Curriculum is that the contents and expectations of Mathematical Methods must be accessible to, and achievable by, students who do not currently elect to undertake 'higher level' mathematics studies in their senior secondary years – this is essential if the nation is to increase the numbers of young people able and willing to take STEM career trajectories.

Other important findings include:

1. The subjects all contain, to a varying degree, too much content. This is especially true of Mathematical Methods and Specialist Mathematics.
2. A more measured approach to Statistics content is required, again particularly in the context of Mathematical Methods and Specialist Mathematics.
3. Essential Mathematics and General Mathematics will need to be supported and monitored in the implementation phase to ensure the needs of students are being met.
4. The Achievement Standards need to be given thorough attention in the light of the issues that were encountered with these in finalisation of the F-10 Australian Curriculum: Mathematics.
5. A number of issues around implementation and 'teachability' need to be considered in finalising the curriculum.

2. BACKGROUND

The mathematics curricula that are currently in place around the country are different in many ways including arrangement, layout, level of detail, and responses to key issues in the teaching and learning of mathematics. State and territory perspectives on work under development such as the Senior Years Mathematics Curriculum are at times contradictory, given that they are based on the heritage and background of the respondent.

The construction of national feedback from the AAMT is a challenging task. We do not try to weigh these views to come to an "AAMT stance" on matters of detail. Rather, our focus is on highlighting and discussing common concerns and, where practical, recommending ways to improve the Draft.

3. IMPLEMENTATION RESPONSIBILITY TO REST SOLELY WITH THE JURISDICTIONS

The ACARA Board has made clear the status of these subjects. Jurisdictions will incorporate them into their existing curriculum structures and assessment processes. Hence the question for AAMT and others to address in this consultation is the actual contents of the subjects, and their 'quality' as a suite of subjects.

However, the diversity of practices and arrangements across the jurisdictions has meant that many of the AAMT's respondents have raised issues around structure that are outside the scope of this consultation. Most noticeable among those have been the representations around NSW being able to maintain the Extension 1 pathway that is highly valued by many teachers in NSW. This is a structural matter – essentially how the NSW Board of Studies 'packages' these subjects within their curriculum offerings. AAMT has been assured by ACARA that maintenance of this kind of pathway is both feasible and practical.

There are 'packaging' issues in other jurisdictions that have emerged during this consultation. It is clear that, once the contents of the actual subjects are settled by ACARA and approved by ministers, the authorities in each of the jurisdictions will have a subsequent period during which their planning for implementation (ie 'packaging') will need to involve extensive further local consultation.

AAMT believes it is regrettable that the implementation phase for the Australian Curriculum, first in F-10 and now for the senior years, is not progressing with far greater collaboration between the jurisdictions. There is evidence that many of the potential benefits from having common curriculum in place across the country are not being realised due to this lack of collaboration and coherence. Curriculum *development* has been managed on a national basis; curriculum *implementation* should be handled similarly.

4. OVERARCHING QUESTIONS

Is the proposed structure of subjects 'fit for purpose'?

Overall

The senior years mathematics subjects on offer in the states and territories need to be appropriate for the various cohorts of students. Each of the subjects identifies, in broad terms, the cohort of students for which it is seen as appropriate.

Respondents have questioned whether the suite of subjects will provide appropriate mathematics for two, possibly overlapping, groups of students – those with poor grounding in mathematics from F-10, and those whose aspirations include vocational training with some mathematical content (trades in particular).

The size of the first group has been suggested as significant by people in some jurisdictions. It would seem the only structural solution for them would be for the jurisdiction to design a subject to meet their needs. However, the overlap between the contents of Essential Mathematics and the F-10 Australian Curriculum: Mathematics may mean that jurisdictions are not able to develop a subject to meet these students' needs (perhaps loosely defined as 'numeracy completion') that is sufficiently distinct from Essential Mathematics to be acceptable under current agreements.

The second group – students anticipating entering trade or other training – would probably have their needs best met by some other sub-set of the content of Essential Mathematics (perhaps with the addition of some content from General Mathematics). This content would need to be treated and extended in appropriate ways. Again, jurisdictions may not be able to create such a subject as separate from the approved Essential Mathematics.

It is acknowledged that the Rationale for Essential Mathematics includes the statement:

"It is intended that the content of the Essential Mathematics subject is taught within a context that is relevant to the needs of the particular student cohort. The skills and understandings developed throughout the subject will be further enhanced and reinforced through presentation in an area of interest to the students."

If a 'structural' solution of generating 'versions' of the content of Essential Mathematics matched to the needs of these cohorts is not possible, a great deal of effort in implementation will need to be invested in ensuring that the teaching of the common Essential Mathematics subject actually reflects these intentions for these cohorts.

Insufficient retention of capable students into 'higher level' mathematics subjects is an established issue in this country. Students with this mathematical background form the pool of those who can take STEM career trajectories. As a nation we need to

increase this pool. This matter is increasingly coming to the attention of governments through policy and programs.

In the context of these draft subjects, Mathematical Methods is the key one into which we should be attracting students in order to address the identified shortfall of students in higher level mathematics.

There is a sense among many that the current version of Mathematical Methods is broadly acceptable. This is probably based on the fact that the contents generally match current subjects in the jurisdictions (with the exception of the focus on statistics for those in NSW). An alternative view is that continuing as we have been will perpetuate the view among many students that higher level mathematics – in this case Mathematical Methods – is ‘too hard’ and ‘too crowded’ for them to contemplate.

Taking this second view would require substantial revision of (ie cutting of content in) Mathematical Methods. This could still be consistent with the Rationale by allowing for a focus on Calculus and Statistics to be realised, albeit with at a slower pace designed to build greater understanding as an effective basis for further study of mathematics. There would be consequent implications for the content of Specialist Mathematics.

Within subjects

The comments above highlight challenges for Essential Mathematics insofar as maintaining fidelity with its Rationale. In terms of Mathematical Methods, there is clear connection between the contents and the Rationale, with this able to be maintained if content is adjusted as suggested above.

General Mathematics sets out to meet the needs of those “students who want to extend their mathematical skills beyond Year 10 level but whose future studies or employment pathways do not require knowledge of calculus.” Its combination of discrete mathematics and a range of other non-calculus topics makes the subject stand apart somewhat from most current offerings in the states and territories. There are questions about the extent to which the subject will be appealing to the targetted cohort.

Specialist Mathematics is designed to be taken in addition to Mathematical Methods. It is therefore intended for study by our best and brightest mathematics students. The aim that “(s)tudents of Specialist Mathematics will be able to appreciate the true nature of mathematics, its beauty and its functionality” is compromised in the minds of a significant number of teachers and others by what they see as a lack of coherence, and, again, the overall amount of material included.

Are the contents appropriate?

International benchmarking

In a recent paper that reflected on the strong performance of east Asian students in international comparative assessments, Frederick Leung from Hong Kong concluded that “(i)n learning from other countries, one must first evaluate the cultural values and educational context in one’s own country before deciding on how much can be learned from other countries.” (Leung, F. K. S. (2012) *What Can and Should We Learn from International Studies of Mathematics Achievement?* Proceedings of 35th Annual Conference of MERGA, pp 34-60. NIE, Singapore.).

Clearly there are aspects of curriculum design and content in places like Singapore and the like that have been considered in developing these subjects, particularly Mathematical Methods and Specialist Mathematics. Leung’s advice, as an insider, is salutary. Simply adopting those approaches is unlikely to be effective. They need to be critically appraised and used in ways that ensure that Australian curriculum reflects our culture and educational context.

In the light of this, it would seem that the current subjects reflect an appropriate approach to benchmarking against curriculums for other countries – there is a distinct Australian ‘flavour’.

Extent of Statistics content

There is some variability in the statistics content in current courses of study around the country. The current drafts reflect a greater emphasis on statistics in schooling in response to the increasingly data-rich world of the 21st century. In principle this is seen as an appropriate direction, with the extent of inclusion of statistics content the question to be resolved. There is a significant view that there is too much statistics content in the current drafts of both Mathematical Methods and Specialist Mathematics, in particular. Suggestions about how this can be addressed are included in a number of detailed submissions to ACARA.

‘New’ content

In addition to some of the more advanced topics in statistics, the inclusion of matrices, vectors and, particularly, graph theory in Specialist Mathematics are seen as ‘new’ content areas. There is a significant and widely held view that it would be better to have a more extensive coverage of traditional areas such as algebra, geometry, calculus, mechanics and perhaps conics than to include these newer topics. The argument is that the more traditional topics would provide better preparation for future study – counter to this is the express aim of Specialist Mathematics to expose students to the “nature of mathematics” that has led to the inclusion of some content from some significant areas of mathematics. Vectors and matrices complement each other and also link directly to Physics (as does mechanics), offering another incentive for students to opt for mathematics and science.

This is a tension that may be resolved when the total content of Specialist Mathematics – and particularly the statistics – is re-evaluated.

Contexts and applications

The substantial change in Essential Mathematics since the previous draft has been the move away from formally including the contexts as key organisers for the curriculum. This has resulted in a more traditional, content-based organisation of the subject that some have indicated is clearer and more user-friendly – others regret the passing of the overt focus on context and see this as an opportunity lost.

There remains a clear intention for the learning to be undertaken in context in Essential Mathematics, as outlined in the quote from the Rationale above. However, the content driven form of the current draft is seen by many to militate against this intention – effective support through the implementation phases will be required to ensure the students’ experience of the subject is as intended and not a collection of unconnected skills that are not embedded within meaningful contexts. Some argue that ACARA should aim to make it possible for particular jurisdictions to choose to write a syllabus based on the Essential Mathematics course, but directing teaching and learning in a thematic or project based style, while still covering the content.

5. THE SUBJECTS

AAMT is aware that a number of its state and territory affiliates have made extensive submissions that provide detailed feedback and suggestions on the contents of these draft subjects. No attempt is made to synthesise those organisations’ considered and well-grounded responses – AAMT understands that ACARA will carefully consider the points made in its review of the details of the subjects. Similarly, a number of

other groups and individuals have made submissions based on detailed analysis that warrant careful consideration by ACARA.

The reality of a consultation exercise like this is that contradictory advice – on just about every conceivable matter – will be provided. The following brief comments give an overview of the input received by AAMT.

Essential Mathematics

Overall assessment

The broad scope of the content of the draft Essential Mathematics is generally accepted as appropriate for a cohort of students in the senior years who want to complete their schooling with a good grasp of practical mathematics, and the confidence and skills to use their mathematics effectively. It is not clear that, in its implementation, the contents provided will be adaptable to the needs of a fairly diverse group of students for whom a subject along these lines is appropriate.

Outstanding issues

The key issue for many is disappointment that the focus on context and investigations seems less overt than it was in the first draft. Essential Mathematics as it now stands has a relatively familiar flavour in this regard. The emphasis on context and use of mathematics will now rest much more heavily on the teacher. This may be consistent with the ACARA line that the curriculum is about content, not teaching, but for many it seems an opportunity lost.

General Mathematics

Overall assessment

General Mathematics has received by far the least amount of feedback and comments. This is in contrast with the fact that, in many respects, it is the most innovative and interesting collection and sequencing of content of the four subjects. This has perhaps resulted in teachers and others really not knowing where it fits. Whilst a target cohort of students is clearly identified, there has been a diverse approach to meeting their needs in the jurisdictions – teachers have not had a student-centred frame of reference for reviewing the contents, only a ‘mathematical’ one. As a result there is, overall, cautious support for the current contents.

Outstanding issues

General Mathematics needs therefore to be seen as somewhat experimental. It should be supported to ‘find its place’ in the implementation, and monitored over the first few years. It is through this monitoring process that genuine evidence about its effectiveness and future shape will be gained. It was suggested that there be options offered in the early years of implementation, a strategy would sideline some topics in the course with only one or two to be opted for. After some time the options could be refined or perhaps collapsed into a core course.

Mathematical Methods

Overall assessment

Many of our respondents find much to like in the current Mathematical Methods, although it is seen to be quite full and ‘heavy’ with content. There is a general sense that the statistics content needs to be cut back somewhat, and this may go some way to easing the perceived content load. That said, there are many suggestions for changes in detail, emphasis and sequencing for ACARA to consider.

Some argue that more radical surgery is required to ensure that the subject is accessible and fulfilling for the sorts of numbers of students who should have a

grounding in calculus and statistics that enables them to take STEM career trajectories.

Outstanding issues

The mathematics curriculum for the senior years that is adopted from this process needs to be part of the solution to the issue of insufficient students taking higher level mathematics in the senior years of schooling. Mathematical Methods is the pivotal subject in this – there is a case for significantly recasting it.

Specialist Mathematics

Overall assessment

The extent and difficulty of the Statistics content in Specialist Mathematics is questioned by many, often in the context of the view that the subject contains too much content in any case.

There are two views about the underlying intention of Specialist Mathematics. One is that it needs to be about extending and drawing together the content of Mathematical Methods; the other is that whilst some of these sorts of elements is appropriate, but that Specialist Mathematics should also open up broader areas of mathematics for students. The current drafts sits in the second ‘camp’.

Outstanding issues

This schism is at its sharpest in relation to the Graph theory currently included. Many would argue that it should be replaced with, for example, material on Conics or Mechanics – content they describe as ‘more useful’. However that matter is decided, the bigger issue of whether giving our best and brightest mathematics students a more rounded sense of mathematics and what it means to do mathematics ought to be an important component of Specialist Mathematics – and, if so, how to achieve this – needs to be resolved. The use of options is another way to test out Graph Theory for its popularity in the early years, while reducing the content to a more manageable amount.

6. TEACHABILITY

The following are all important issues around teachability of this curriculum that essentially relate to implementation, not content. They are included here to alert those reviewing and revising the curriculum content in the event that they do have a bearing on content.

Articulation with F-10 and 10A

The structure of the current drafts does not explicitly extend the framework of the F-10 curriculum, either in terms of the content strands or the proficiencies. Given the need to attract students to mathematics in the senior years, the changes in structure will reinforce existing perceptions – particularly among students – that senior years mathematics is somehow different from the subject in the F-10 years; and by implication ‘harder’ and ‘not for me’.

Jurisdictions and schools are currently working through the implementation of the Australian Curriculum: Mathematics for F-10. The matter of how 10/10A content will be handled and for what numbers of students remains an unknown. Some indications are that local factors (time for mathematics; backgrounds of teachers) will significantly limit the number of students who will have access to 10A content.

However, the outline of Mathematical Methods indicates the following

“In studying Mathematical Methods, it is desirable that students complete topics from 10A.” and goes on to identify several Content Descriptions from 10A that are ‘highly desirable’.

Consequently, students who have not undertaken study of 10A content for whatever reason will be disadvantaged in Mathematical Methods. Either they will lack the background of others in their class, or their teacher will need to take time out from the already packed Mathematical Methods to cover this pre-requisite knowledge. In either case, it is likely that this will materially discourage those students caught up in this. They are just the students for whom we should be encouraging, through curriculum design and teaching practices, to engage and succeed with Mathematical Methods in order to increase the pool of students able to go on with further study and careers in STEM.

Monitoring 10/10A in practice – and particularly as a ‘gate-keeper’ to entry into and success with Mathematical Methods – is a critical issue in the short to medium term. The assumptions about prior knowledge that can be made for Mathematical Methods will need to be revisited in the light of those findings.

Small schools (mostly in non-metropolitan locations)

Concern has been expressed that small schools will have difficulty offering appropriate mathematics for all their students. In the first instance, numbers of students and classes may make it difficult to provide for those students for whom 10A mathematics is appropriate (ie it will not be feasible in the school’s timetable).

The identification of relatively distinct cohorts for each of the subjects suggests that students should have a choice between the four. Small schools will not have the capacity to do this, thus causing some students to make inappropriate, for them, choices of the mathematics to study. This is probably true in most jurisdictions under current arrangements – it is regrettable that this disadvantage for small schools is likely to continue.

Teacher knowledge and skills

The comments above about ‘new content’ are generally associated with a concern at the magnitude of teacher development required in order for teachers to be equipped with the background knowledge and skills to teach this new content. Clearly teachers will need to undertake professional learning of this kind in a timely way, and there is some nervousness that employers will actually be willing to provide the support (funding, time) required – the evidence from the implementation of the F-10 AC:M does not inspire confidence that this will be the case.

However, there is some evidence that teachers of mathematics can take on new content and actually enjoy learning and teaching mathematics that is new to them. When a significant amount of statistics was incorporated into senior years mathematics courses in SA some years ago, similar fears about teacher upskilling were expressed. The teachers there were obliged to learn the new content and did so – now teachers have confidence with the statistics in the SA courses, along with a sense of achievement.

Time for teaching

The content of the subjects in this draft should be able to be taught through 50-60 hours of class time. The 10 hours possible difference would seem to be significant in practice – are the subjects really able to be taught in 50 hours?

The second factor in ‘time for teaching’ relates to in-school allocations. Typically, mathematics teachers report that many other pursuits take time allocated to mathematics. Whilst they recognise that these are often educationally legitimate, teachers are frustrated by the associated decrease in effective teaching time for mathematics. These subjects seem to be quite tightly packed, and any shortfall in

time for teaching mathematics at the school level will have a significant impact on student learning. This would be less of an issue if the subjects were less 'full'.

Student mobility between subjects

The designers of these subjects have allowed for students to change directions at the end of the second unit (generally end of Year 11) and change from one pathway to another. This has been a feature of the curriculum structure in some jurisdictions. Some respondents expressed concern that these changes in pathway may not be practically possible in the current draft subjects without significant disadvantage for the students.

Achievement Standards

It is fair to say that AAMT has received little close analysis and comment on these components of the draft curriculums in this round of consultation. AAMT is aware that the Achievement Standards of the F-10 mathematics curriculum have been somewhat problematic. It would therefore be wise to be mindful of this experience as the senior years curriculum is finalised.

One of the generic comments about the draft senior years curriculums has been that the depth of coverage is not well defined in the description of content. Logically, the Achievement Standards are one place in which depth of coverage can be indicated – AAMT suggests that these components could be looked at and revised to help with this indication of depth, as appropriate.

A key issue in Achievement Standards is the 'achievability' of the highest level. Across the Achievement Standards in each of the subjects the A level under Concepts and Techniques seems to be achievable. Another issue is the distinction between levels. On this score it seems the current versions of Achievement Standards often relies on relatively subtle changes in language (eg in Essential Mathematics the dot point about use of technology uses 'appropriately and competently' at level B, becoming 'appropriately and skillfully' at level A). Identifying and interpreting these subtleties will be challenging in practice.

In relation to the Reasoning and Communication dimension, the Achievement Standards for Essential Mathematics and General Mathematics at level A would seem to be achievable by students. There are significant commonalities between the expectations for level A in Mathematical Methods and Specialist Mathematics, and this is appropriate. Moreover, level A in both includes some important emphases on doing mathematics in sophisticated ways. However, particularly for Mathematical Methods, it may be difficult for students to achieve at this level, given the packed (some say overfull) nature of the subject. Things like "comprehensive consideration of the validity and limitations of the use of any mathematical or statistical models" and "inter-relatedness of different representations of mathematical and statistical information" will require students to take time for deep reflection on the mathematics they are doing. The amount of content in the current version of Mathematical Methods could militate against students being able to achieve what are, arguably, important outcomes for school mathematics.

The comments about subtlety of language apply equally to the use of the Achievement Standards in this domain of Reasoning and Communication.