ACER Study — Year 12 Curriculum Content and Achievement Standards

Specific comments from the AAMT

Preliminary notes

This paper discusses mathematics specific issues in the report. It begins with a short summary of the key points and observations.

The Summary is followed by sections that relate to the individual chapters in the Report, and generally follow that order. The exceptions are two sections in the Executive Summary (*Questions raised by this study* [pp. viii-ix] and *Going forward on the basis of this study* [pp. ix-x]). These summarise the authors' views without direct reference to any material that follows in the Report. Hence, whilst these are located at the beginning of the Report, it was felt most appropriate to deal with them immediately after these comments.

Summary of key points in this paper

1. The limitations of the desk audit methodology used for a large part of this work are such that the findings about content and standards in mathematics can only be viewed as indicative — much more detailed probing of the realities of what happens is needed.
2. The limitation to considering essential content and achievement standards of courses leading to university entrance in the physical sciences, engineering and mathematics (the 'gamma' courses) means that the mathematics courses undertaken by the vast majority of Year 12 students have not been considered. The Report therefore provides only a partial evidence base for any further work in mathematics.
3. The basis for conclusions about commonality of content in mathematics courses is not described. This is especially problematic as the findings in the Report are at odds with what is known about differences between mathematics courses in the jurisdictions.
4. The terms used to describe 'topics' in mathematics are very broad and open to interpretation. The findings about common content and what should be 'essential' therefore reflect quite varied interpretations of these terms.
5. The Report provides only a superficial treatment of the issues of achievement standards in mathematics, and the effects of the use of graphics calculators and other technologies in assessment.

Chapter 1 — Background and scope

Context (pp. 1-4)

The report notes that the study was based on the findings in *An Australian Certificate of Education: Exploring a way forward (*2006):

The first recommendation (of the ACE Report) is that 'curriculum essentials' be identified—initially in some nominated mathematics, English, science and social science/humanities subjects—to ensure that all Australian students have opportunities to engage with the fundamental knowledge, principles and ideas that make up those subjects. The second recommendation is that 'achievement standards' (described and illustrated levels of achievement) be developed to make students' results in these subjects more comparable across Australia.

In commenting on the first recommendation, the AAMT said at the time[1]:

The AAMT's support for this work comes with several caveats:

1. The members of the national mathematics panel[2] should have demonstrated expertise in relation to senior secondary school mathematics, and that at least one half of the members should be practising teachers nominated by the AAMT.
2. The time allocated for this work should be adequate to allow for genuine and thorough consultation with stakeholders. The process should demonstrate that feedback has been considered and provide a rationale for decisions. There should be at least 6 months for the actual consultation, plus sufficient time for the preparation of the final recommended 'essentials'.
3. The task for the national mathematics panel is essentially analysing *what is* in order to identify *what should be the core* for mathematics in the proposed certificate. The process is part of designing a certificate for the future. Hence, the panel should undertake its work with a forward-looking perspective that is informed by an appreciation of the role and nature of mathematics in the knowledge age and students' lives. The AAMT would not support an outcome that does not reflect this perspective, and the needs of **all** students.
4. The AAMT notes and strongly agrees with the commitment (p.62) that (studies at Year 12 level) *'would be available to all senior secondary school students'*…All jurisdictions have a range of mathematics courses available in the senior years. This range recognises that students have different backgrounds, needs and aspirations in terms of their mathematics in the final years at school and provides courses reflect these parameters. What this range allows is for all students to have access to an appropriate mathematics course up to the completion of their schooling.
5. It will also be necessary, in the context of 'differentiated' mathematics subjects, to have some sort of over-arching statement of the core values and intentions of the mathematics discipline. This statement would provide the high level purpose for, and the consistency and coherence between, the individual subjects. It would be a good place to enshrine the forward-looking perspective outlined in 3 above in a way that directly influences the detail within the subjects. Reaching consensus on such a statement will be a challenge for the mathematics community, but is a critical and much needed evaluation of purpose…Attention needs to be drawn to the nature of mathematics as an enabling subject for all other subjects and including VET – particularly considering the wide variety of pathways available and the fact that many jurisdictions have now legislated for compulsory schooling to year 12.
6. The AAMT endorses the statement on p. 69 (of the consultation paper) that *'the core should be more than the "lowest common denominator" of curriculum content'*. The focus on 'common' throughout the recommendations is understandable, but it needs to be noted that 'common' doesn't imply best practice/desirable/aspirational — these are also key metrics in identifying the core…For mathematics, at least, 'procedural' knowledge such as application, communication and problem solving — the essentials of **doing** mathematics — would necessarily be part of the core.

The Report — and more particularly the methodologies used — are clear evidence that the parameters outlined by the AAMT in 1 and 2 above have yet to be realised.

The 'forward-looking perspective' identified in 3 does not appear to have been part of the thinking at all, as the methodology has focussed on common content in existing curriculum documents.

The comments in 4 are reflected in the Report insofar as there is a commitment to some broad differentiation of subjects.

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[1] AAMT response to ACE Questionnaire.

[2] The Consultation paper to which these comments responded suggested a series of 'panels' to undertake this work.

The matter in 5 is not canvassed at all, yet it would be essential to have such an over-arching statement to provide the rationale and coherence for mathematics in the midst of all the commonality of content.

The focus on content in the Report would seem to have ignored the aspects of mathematics the AAMT has argued as being essential in 6.

Caveats (pp. 5-8)

It is useful that the Report identifies several of the 'limitations of the methodology'. A number of these indicate that the findings need to be viewed as 'preliminary' (at best):

Caveat 2 acknowledges the superficiality of the work — the approach 'does not necessarily provide a complete understanding of the conceptual depth required of students' (p. 6). A much more complete study that looks beyond documents to the experience of teachers and students is needed, including an examination of assessment tasks required to be completed by students. That the methodology has necessitated looking at existing documents is identified in **Caveat 4**. Implicit in the statement that 'the study omits reference to some work under development' (p. 6) is the fact that this very work is the most up-to-date response of a jurisdiction(s) to the challenges for senior secondary schooling into the 21^{st} century. Achieving a forward-looking response would be likely to be informed by reference to this sort of work.

Caveat 6 concludes with the statement that 'in studying achievement standards, in pursuit of optimal comparability across states and territories, only the highest-level mathematics subjects were considered' (p. 7). It is appreciated that using the subjects with the highest commonality (ie the gamma subjects) was a pragmatic decision to strengthen the findings that could be reported. However, this approach:

- Gives the unfortunate and unhelpful message that these are the most (only?) important mathematics in Year 12;
- Could be taken to imply that other mathematics subjects (alpha and beta) are subsets of the gamma subjects — which is not the case;
- Might be taken to suggest that these are the subjects with the highest candidature — which they are not.

Caveat 8 again reinforces the limitations of the desk audit methodology used.

Chapter 2 — Curriculum content: What is common?

Mathematics mapping (pp. 21-24)

The statement on page 22 that 'In New South Wales the courses are already combined: the beta course includes the alpha course and the gamma course includes the beta course' is incorrect insofar as the beta course is distinct from the alpha course — the one is *not* included in the other. Further, the table (unlabelled) at the top of p. 23 is misleading. It implies that it is only in NSW that students on the gamma trajectory undertake a 'double mathematics' course. In fact, in most jurisdictions students on the gamma pathway undertake two full subjects in combination (eg in WA these students always take Calculus and Applicable Mathematics). Barrington and Brown (2005) were similarly misleading on this matter

— reliance on this as a secondary source is regrettable.

Table 3M (p. 24) provides the list of topics the Report has identified. These are a few words to summarise an area of mathematics. This is a common enough shorthand, but the diversity of what might be done within any one topic within a subject(s) is enormous. These findings can therefore only be taken as a very coarse indication of commonality. It is also puzzling to note a range of topics that seem to be commonly done around the country are omitted (trigonometry; equations); that the Binomial Theorem and Polynomials are connected (it is very likely that all jurisdictions do something on Polynomials, but not necessarily in conjunction with the Binomial Theorem).

The concatenation of 'problem solving', 'justification' and 'communication' into a single category in Table 4M (p. 24) is hard to understand, given that these are important among the key aspects of 'doing' mathematics. Indeed, Table 4M identifies a very small number of 'skills'. This emphasizes the coarseness of the analysis. Further, the table gives the impression that there are only two sorts of 'skills' explicit in mathematics (unlike English and History which have many more).

Use of calculators (p. 24-25)

The Terms of Reference for this study include:

Specifically for Mathematics, the study will identify the extent to which graphics or algebra calculators are used and compare assessments and examinations in the various jurisdictions in terms of the technical fluency and conceptual understanding expected of students by reference to whether calculators are permitted or not.

This section adequately addresses the first aspect of this ('identify the extent') in relation to curriculum documents only. What happens in practice could not and is not addressed, given the desk audit methodology.

The second component (comparing 'technical fluency' and 'conceptual understanding' in relation to the use of calculators in assessment or not) is not addressed at all. Even given the constraints of using a desk audit methodology it should have been possible to gain some insights from public materials such as examination papers and examiners' reports.

Commonality in Mathematics (p. 25)

The figures on commonality reported in this section do not appear to be supported by any discussion of how they have been estimated. In the absence of such evidence it is difficult to reconcile the statement that 'there are only small differences between jurisdictions in courses designed to lead to university study' (ie the stated 10% of differences between gamma courses) with what is known about the differences between these courses. Comparing NSW with WA, for example, we find that there is essentially no serious probability and statistics in NSW whereas these areas feature strongly in WA; the reverse is true in relation to Euclidean geometry; there is no exploitation of graphics calculators in NSW; and no formal proof in WA. These do not appear to be differences 'at the margin', yet we have no way of knowing how the figures were determined.

These estimates of commonality are likely to be drawn on in further discussions and gain media attention. Given the lack of transparency in how they were determined, and, indeed, some indications that would question the numbers, it would be unwise to use them as evidence that 27 mathematics courses are not needed.

General observations after the mapping exercise (pp. 32-33)

This section contains several statements of opinion.

…some definitions of, and rationales for, mathematics have almost nothing in the definitions or rationales to suggest mathematics apart from the use of the name. (p. 32)

This is an epistemological viewpoint that would be vigorously argued by the dedicated professionals responsible for these statements.

At the level of prescription (the 'intended' curriculum) and taking language used to describe curricula at face value, it is more probable than not that there are differences in what is studied (the 'experienced' curriculum). (p. 32)

There is no evidence for this statement of probability, and there can be none in the absence of looking at actual classrooms and students' experiences.

Chapter 3 — Curriculum content: What is essential?

Essentialness (pp. 37-38)

The process used for this component of the study leaves a great deal to be desired:

- The ad hoc selection of reviewers based on recommendations from the Advisory Committee;
- Isolated work (filling in tables) that was *expected* to be done quickly;
- The brevity of the 'topics' on the tables allowed for vastly different interpretations.

The earlier discussion noted that the decision to focus on the gamma courses only is understandable. It does, however, leave open the question that is probably uppermost in the minds of many people — 'What mathematics should young Australians know and be able to do and use to enable them to be effective citizens and workers in the 21st century?' Until and unless this question can be satisfactorily answered it will be difficult to contend that there is any sense a 'core curriculum' for Year 12.

Survey of reviewers (pp. 39-40)

The discussion about the perspectives that the different groups bring to the task of identifying what is 'essential' seems somewhat simplistic (p. 39). The idea is reasonable, but the identification and blending of perspectives will really only come out when these sorts of people sit down and work together.

Footnote 23 states (p. 39)

It is assumed that the rationale for the subject will indicate the group of students for whom the subject is designed. If this is the case then we can refer to **all** students taking the subject.

This approach creates issues in interpretation in mathematics unless the qualification is clearly made, and is supported in the subject documentation. There is a strong commitment to mathematics for all students, and a need to impress the importance of mathematics to young people and the wider community. What this footnote suggests is that the 'all' is relevant to a particular subject.

Comments from reviewers in mathematics (see Appendix 1, pp. 112-113)

Many of these comments indicated that the reviewers found it hard to determine 'essentialness' without being clear about depth, approach, purpose etc., all of which are moot in the context of a few words to define a 'topic'.

Mathematics topic ratings (p. 61-64)

The inconsistency between the topics in Table 3M (mapping) and Figs 1M and 2M is irksome and unnecessary in a report of this kind.

The identification of 'three discernible groups of topics' (p. 62) in mathematics seems to have been decided on a different basis from that used for Physics (p. 65). In particular, in physics 'essential' topics are strictly those with universal agreement; for mathematics some level of 'desirable' responses can still result in an 'essential' tag (for *Calculus Applications – Rates of change* to *Probability* in Fig. 2M). This sort of inconsistency needs to be addressed before the results and recommendations are further considered[3].

Chapter 4 — Achievement standards: Are they comparable

The Report describes a range of differences in approaches in the jurisdictions and indicates the difficulty of the task of comparing standards of student achievement. This is useful, but does not address the central task of comparing actual standards of student performance.

Given this, it is difficult to understand why attention has been narrowed to the highest grade in the already narrowed field of gamma courses. A more expansive scoping of the territory may be more useful when this work is actually undertaken, through access to student data and materials.

The use of the WA Grade Descriptors as the basis for Table MA1 (p. 79) is curious and misleading. These descriptors were developed some 20 years ago at a time when new courses were being introduced. Whilst they may still be included in the Curriculum Council documentation they are no longer used at all in any practical way — they in no way reflect what actually happens in WA. It is inappropriate to use them as the framework for national comparisons as has been done in this table. This is a good example of the problems with the desk audit methodology in a complex task such as this — findings run the very real risk of being out of touch with reality.

[3] There may be other similar instances in the reporting.

Summary statements (Executive Summary and Chapter 5 — Conlusions: What is? What should be? What next?)

Questions raised by this study (p. viii-ix)

The Report raises the question of efficiency in curriculum development:

> Given that at least 85 per cent of the curriculum in these subjects (physics and chemistry) is common across Australia, a question remains about the necessity and efficiency of developing curricula and their accompanying assessment processes for these subjects seven times in seven different jurisdictions (for use in eight jurisdictions)…
>
> A similar question can be asked about the need for 27 different TER mathematics courses across Australia. Different mathematics courses are required for students of different abilities and interests, but it is difficult to imagine that 27 different courses are necessary. (p. viii)

The assumption that underpins these questions is that the apparent duplication of effort is a waste of resources[4]. The counter argument is that the jurisdictions are much more in touch with their communities. Curriculum development on this distributed model seeks to meet local needs. Also, there is a level of 'competition' between the jurisdictions — they keep a close eye on each others' progress and will adapt approaches that help them respond to developments in the discipline, and projected needs of the workforce and the students themselves. This keeps the country in a state of constant curriculum renewal — it is not clear how a 'next generation' of curriculum could emerge in the context of a 'common curriculum'.

> In these subjects, and perhaps others such as Economics, it should be a straightforward matter to reach Australia-wide agreement on a core of essential curriculum content (including both subject matter and essential skills/understandings). (p. viii)

There is nothing inherently wrong with identifying and agreeing about 'a core of essential curriculum content'. We contend however that this needs to be done using a rigorous and inclusive process. Further, the core must be forward-looking. The current attraction to finding what is common in documents and turning it into the 'core' does not allow for this sort of orientation. The fact that content (and skills) are currently 'common' does not necessarily make this content 'right' (relevant; appropriate) for students into the 21st century.

Going forward on the basis of the study (pp. ix-x)

This section largely consists of the authors' opinions. Hence the use of the term 'should' is unfortunate.

The third dot point — 'express central concepts in language that is familiar to students' — suggests that some other non-central concepts can be expressed in unfamiliar language.

Minimising overlap (dot point 4) may not be possible in the case of differentiated mathematics subjects; in any case it would seem to be counter to the notions of interdisciplinary learning.

Dot points 5 and 7 are extremely difficult to understand.

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[4] It is interesting to note that the four public universities in WA alone have 31 separate first year mathematics courses. Is this seen as unnecessary duplication of effort and a waste of resources?

The comment that ‘a lack of clarity in curriculum documents sometimes arises from attempts to be inclusive and positive’ (p. ix) might be taken to mean that inclusivity and positive statements are not desirable attributes of such documents.

The future envisioned in the last paragraph on p. x represents a legitimate view of the world. It is a *non sequitur*, however, to suggest that creating this vision will necessarily address the questions (and by implication raise standards) as outlined in the fourth last paragraph on that page.