SMC&PA Submission 248
Received: 13 May 2013

To: Education and Innovation Committee: Assessment of Senior Mathematics, Chemistry and Physics in Queensland schools

From: Michael Barra
[redacted]

Terms of reference

1. That the Education and Innovation Committee inquire into and report on the assessment methods used in Senior Mathematics, Chemistry and Physics in Queensland schools.
2. That, in undertaking this inquiry, the committee should consider the following issues:
   - Ensuring assessment processes are supported by teachers
   - Student participation levels
   - The ability of assessment processes to support valid and reliable judgments of student outcomes.

I have been a teacher in Queensland secondary schools since 1982, teaching in both State and Independent schools. Over this time, I have become a specialist Mathematics teacher and have always taught one, or a combination of, senior Mathematics subjects. In my later years, I was a Mathematics coordinator of a department with six teachers. As part of my ongoing professional learning, I have taken on the role of Mathematics A panel member, Mathematics B panel member and Panel Chair Mathematics C during this period. In 2010, I accepted the position of Education Officer: Mathematics with Brisbane [redacted]. In this role, I have offered support and guidance to Mathematics Coordinators and teachers of Mathematics from Prep to Year 10 on matters related to the Australian Curriculum: Mathematics, provided consultative advice on the development of the Australian F – 10 curriculum, and was a member of the Advisory Panel: ACARA Senior Years Mathematics curriculum.

The following assessment *of* learning processes that teachers are required to complete and that could be considered as part of this inquiry include:

- Developing an assessment plan (this becomes a component of a school's work program)
- Developing and administering school-based assessment items
- Making judgments of student learning based on standards that reflect the General Objectives of the syllabus
- Ranking students based on the five levels of achievement
- Compiling and submitting student folios of work for the purpose of external moderation at monitoring, verification, post-verification, and random sampling (if required)
- Considering and/or heeding advice provided by subject panelists.

The first two points will be addressed when considering Issue 1: *processes supported by teachers*, the remaining when considering Issue 3: *judgments of student outcomes*.

Ensuring assessment processes are supported by teacher

Processes inherent in Queensland's school-based externally moderated assessment system allows teachers in schools the *flexibility* to develop school-specific learning, teaching, and assessment plans that reflects the interests and needs of students based on the 2008 QSA Mathematics B syllabus and the 2008 Mathematics C syllabus. Flexibility, and the six underlying principles of exit assessment as stated in the syllabi (continuous assessment / balance / mandatory aspects of the syllabus / significant aspects of the course of study / selective updating / fullest and latest information) should continue to underpin future assessment processes.

It is evident that practices based on some of these processes vary from school to school. For example, when developing a school assessment plan, a decision on the number of assessment items (minimum of 5 to a maximum of 10) needs to be made at the school level. While common practice across many schools is six items in Year 11 and six items in Year 12, this is not always the case, nor is it a requirement. Variation in the number of items does not necessarily result in inequitable or inconsistent outcomes. What is valued is that teachers in schools have the ability to gather evidence of student learning in ways that are in the best interests of students. If teachers in some schools are deemed to be over-assessing, then they should be encouraged to review their practices.

The development of school-based assessment items is an expectation of the current system. The advantage of this is that teachers in schools can ensure a strong alignment with learning and teaching, and assessment. Practice has found that the development of items can be onerous and time-consuming. Further support from QSA staff and greater opportunities for teacher collaboration across schools in all sectors to assist in development of tasks would be welcomed.

Assessment practices must also allow students to demonstrate their learning in a variety of ways as this is in their best interest. In both Mathematics subjects under review, the requirement is *that assessment techniques other than supervised tests must be included at least twice each year and should contribute significantly to the decision making-processes* (QSA syllabus). The techniques commonly used to satisfy this requirement are either *Extended modelling and problem-solving tasks* (EMPS) or *Reports*. These techniques allow students to demonstrate and apply their knowledge in contexts that are not possible under examination conditions and to demonstrate competencies necessary for the 21st workplace. For example, these techniques may require students to:

- work with others and in teams
- plan and organise activities
- collect, analyse and organise data
- use technology such as data loggers, motion detectors, Excel spreadsheets
- communicate ideas and information through a presentation.

Students benefit from and value the opportunity to demonstrate their learning in a variety of ways and any review of current processes should ensure that techniques other than supervised tests are a requirement of future assessment plans.

Recommendations to ensure assessment process are supported by teachers:

- position student learning as paramount and central to the assessment processes, not ranking students for further study
- allow for flexibility
- insist on a strong alignment between the learning and teaching with assessment
- allow for the use of context-specific tasks designed to meet the needs and interests of the student group
- recognise local, social, and cultural contexts and resource availability
- not narrow curriculum opportunities because of the need to teach to externally generated exams.

Student participation levels

Data already tabled to the committee by QSA should be the source for analysing participation levels. There is no evidence to suggest that the current assessment practices have impacted on student participation levels.

Queensland data shows general consistency in enrolments compared to two studies (one from NSW and one from Victoria) included in Appendix 1.

The ability of assessment processes to support valid and reliable judgments of student outcomes

The syllabi detail *Standards associated with exit criteria* that reflect the General Objectives. In the Mathematics courses they are: Knowledge and procedures (KAP); Modelling and problem solving (MAPS); Communication and justification (CAJ). These are written to reflect the General Objectives of the courses rather than couched in mathematical content-specific language. Consequently this has led to variation in interpretation and different expectations of learning. This could be overcome by rewriting the standards to reflect content, particularly in the KAP criterion, and by offering further professional learning opportunities for teachers around the intent and use of standards.

In order to ensure valid and reliable judgments of student outcomes, teachers in our department enacted a number of practices. These included the:

- development of task-specific criteria sheets for every assessment item. An example is included in Appendix 2. This meant that the success criteria were made clear and explicit to the students prior to them commencing a task and they could clearly identify where they were successful and where improvement was needed after judgments were made. Students acknowledged this was more constructive feedback than being awarded a percentage grade. It should be noted that there is no QSA documentation that prohibits the use of percentages and I am aware that some teachers continue to use this practice. I have no objection to using grades provided they align with the curriculum standards

- practices to ensure authenticity of work. These included submission of work at various stages through the report writing process; completion of some EMPS tasks under examination conditions; the use of open-ended tasks; interviews with students
- cohort marking
- collaborative practices for ranking students.

As a team, we felt confident in our ability to interpret the standards, make reliable and valid judgments of student outcomes and rank students for the purposes of verification and the generation of Subject Achievement Indicators (SAIs). Underpinning this was our teacher professionalism for we believed teachers are in the best position to make judgments of student learning.

Recommendations to ensure ongoing valid and reliable judgments of student outcomes:

- Ongoing support for teachers to understand the intent of the syllabus and best assessment practices
- Rewriting the *Standards* to reflect the mathematical content as well as the General Objectives
- QSA personnel to provide exemplar assessment items for teacher use
- Further support and training for subject panel members to ensure consistency of advice and judgments.

Overall Recommendations

This Parliamentary Inquiry is specific in terms of its scope. It is restricted to the assessment methods in Mathematics B, Mathematics C, Chemistry and Physics. A much broader review of Overall Position (OP) and Tertiary Entrance processes and procedures is currently under review and the issues before this inquiry should form part of the wider review.

Appendix 1: Participation in NSW and Victoria (two studies).

Source 1

Declining participation in post-compulsory secondary school mathematics: students' views of and solutions to the problem. Murray, S., 2011.
http://www.tandfonline.com/doi/full/10.1080/14794802.2011.624731#tabModule

Over the past decade, there has been a marked and statistically significant decline in participation in senior secondary mathematics. In 2001, 83% of girls and 88% of boys who sat for the New South Wales Higher School Certificate examinations (the examinations held at the end of secondary schooling) were studying some kind of mathematics. By 2010 those figures had fallen to 68% and 78% for girls and boys respectively (Board of Studies New South Wales 2010).

Source 2

How inclusive is year 12 mathematics? Helme, S. & Teese, R., 2012
http://www.curriculum.edu.au/leader/how_inclusive_is_year_12_mathematics,34446.html?issueID=12524

Recent Victorian data shows a significant decline in enrolment rates in the more demanding year 12 mathematics subjects. In 2011 enrolments in Mathematical Methods and Specialist Mathematics were, respectively, 17 per cent and 38 per cent lower than in 2001 (Dunn 2012). A worrying concern from a gender perspective is that enrolment rates in both these subjects have slipped more for girls than for boys, which means that an already significant gender gap is becoming wider.

Appendix 2: Example of an Examination criteria sheet: KAP criterion

Knowledge and procedures **11 MATHS B CRITERIA SHEET – End Semester Two**

A	B	C	D	E
In routine and non-routine simple tasks through to routine complex tasks and in life-related and abstract situations, the student work has the following characteristics: • accurate recall, access, selection and use of mathematical definitions, rules and procedures and their application • demonstration of number, spatial sense and algebraic facility • appropriate selection and accurate use of technology. **Indicators include those for B and:** • use the sine and cosine rules to solve triangles in cases with a degree of complexity • determine all transformation parameters from given data • differentiate a complex polynomial function requiring the use of both chain and product rules • determine algebraically the gradient of a complex function at a point. There may be two major errors or omissions or a small number of minor errors or omissions in the indicators stated in standards A to E.	In routine or non-routine simple tasks through to routine complex tasks and in either ***life-related or abstract situations***, the student work has the following characteristics: • accurate recall, access, selection and use of mathematical definitions, rules and procedures and their application • demonstration of number, spatial sense and algebraic facility • appropriate selection and accurate use of technology. **Indicators include those for C and:** • use the concept of the unit circle to evaluate the sin, cos or tan of a standard angle • demonstrate knowledge of transformations of trig functions (phase shift and period) • identify the period of a trig function • differentiate functions that require the use of index laws • differentiate using the chain rule • find the turning point of a function • calculate, using calculus, an instantaneous velocity from a displacement function. There may be two major errors or omissions or a small number of minor errors or omissions in the indicators stated in standards B to E.	In routine, simple life-related or abstract situations, the student work has the following characteristics: • recall, access, selection and use of mathematical definitions, rules and procedures and their application • demonstration of number, spatial sense and algebraic facility • selection and use of technology. **Indicators include those for D and:** • use the sine and/or cosine rules to solve triangles in simple cases • convert degrees to radians • demonstrate knowledge of transformations of trig functions (amplitude and vertical translation) • obtain the value of a trig function using a determined input value • calculate an average rate of change • differentiate simple polynomials • use technology to find the gradient of a function at a point • substitute values correctly into a function • recall the definition of velocity as a rate of change of displacement. There may be no more than three major errors or omissions or a small number of minor errors or omissions in the indicators stated in standards C to E.	In routine or simple tasks, the student work has the following characteristics: • use of stated rules and use of procedures in simple situations • demonstration of number, spatial sense and/or algebraic facility in routine or simple situations • some use of technology. **Indicators include those for E and**: • recall and use trigonometric ratios • recall the sine or cosine rule • convert a radian measure to degrees • display some knowledge of the transformations of functions • use a given rule for differentiating a polynomial term • make some progress with the differentiation of a polynomial. There may be one major error or omission or a small number of minor errors or omissions in the indicators stated in standards D and E.	The student work has the following characteristics: • some statements of relevant mathematical fact • some use of technology. **Indicators include**: • some statements of relevant mathematical fact related to: - trig ratios - periodic functions - a rate of change - differentiation.

Exam: Wednesday 28th October (Next week) **Periods 1 & 2**
Be ready to enter your room at 08:30 am with all of your required materials.