SMC&PA Submission 106
Received: 10 May 2013

To: The Parliamentary Education and Innovation Committee
eic@parliament.qld.gov.au

From:

Associate Professor Anthony Roberts
School of Mathematics and Physics
University of Queensland
Queensland 4066

Current Position:	Teaching and Research Academic, Mathematics, UQ (2005-)
Past Positions:	Postdoctoral fellow at Oxford University Fulbright fellow at Princeton University Teaching and Research Academic, Griffith University Teaching and Research Academic, Queensland University of Technology
Education:	Senior, Townsville State High School, 1984-1985 (Maths I/II) BSc (1st class Hons), University of Queensland (University Medal) PhD, Australian National University

I have taught and assessed mathematics at all University levels at Brisbane's three main tertiary institutions. I am an applied mathematician, working in the area of materials science, including modeling and designing prototype bone implants.

Submission on Mathematics B

The main motivation for my submission is that the skills of many Queensland mathematics B graduates are insufficient to study the subject at a first year University level. This in turn jeopardises the ability of our University graduates in science, mathematics and engineering to reach an international standard, and support Australia's aspirations to maintain its ability for scientific and technological innovation.

The subject content as outlined in the Mathematics B curriculum appears to be reasonable, but the standards at which it is learned and assessed does not. The criterion referenced assessment and written assignments contained in the current syllabus appear to significantly distract excellent high school teachers from focusing on more important mathematical topics and content.

Assessment types

Extended modelling and problem solving task (Section 6.4.1, Mathematics B, Senior Syllabus)

Although this appears to be a useful and worthy task for students, there are a number of practical reasons why it should not be part of assessment in high school mathematics.

1. It is a difficult task to set a meaningful and authentic problem for a teacher with a typical Bachelor level education in mathematics. The two tasks (one at a private school, and the other presented by an "expert" teacher) that I have come across to satisfy the assessment requirements for this topic were not correct from a modelling perspective and some mathematical content was incorrect or inappropriate. The

students would not have significantly benefited from the exercise. I would regard topics from statistics to be an exception, as simple studies using the average, standard-deviation, or probabilities of unusual events can be presented at an appropriate and beneficial level. Standard mathematical modelling applications, such as motion-under-gravity, maximization of area etc. should still be taught and assessed in conventional ways.

2. The synthesis of information, mathematical modelling and interpretation is probably too difficult a task for students at the same time that they are struggling with the mathematical content. This high-level synthesis and analysis is not reached at University mathematics until 2nd year, or more likely 3rd year studies. As noted, an exception to this generalisation would be topics drawn from basic statistics.
3. Focussing on written contextual assignments can detract from, and certainly diminishes time for study of other more important mathematical content. My experience as a University lecturer is that many students demonstrate weak basic algebraic and calculus skills. Moreover, I have detected no evident benefit from the written assessment that carries forward to University studies. Writing skills should be taught and assessed in English – the curriculum does not ask for quantitative results to be taught and assessed in English. There are other subjects, such as physics and chemistry, where modeling and interpretation of scientific data can be more appropriately taught.

In summary, while I agree with the aspirations of the "Extended modelling and problem solving task", I believe that is difficult to execute well by both teachers and students alike, and that students time could be more beneficially concentrated on core mathematical skills.

Assessment processes

Comment on Section 6.7 of the Mathematics B, Senior Syllabus.

I find the criteria for awarding grade in the syllabus to be very difficult to follow, and question if they are valuable for student education and outcomes. From my experience the lack of proficiency exhibited by students in their basic calculus and algebra skills is highly problematic. Perhaps this is not surprising given that that the criteria contained in the syllabus do *not* mention proficiency.

To illustrate the complexity in the criteria I have tried to distil the subtle and problematic difference in standards for level A and B students:

Knowledge and procedures

> Of about 80 words describing four characteristics, a Standard B student is only differentiated by being able to apply definitions for "routine **or** non-routine simple tasks" and perform calculations in "life related **or** abstract" situations rather than the "routine **and** non-routine simple tasks" in "life related **and** abstract" situations expected of an A student. This attempt to separate out students seems artificial; chosen to provide different criteria, rather than a sensible standard.

Modelling and Problem Solving

> There is one meaningful (and laudible) differentiation in this section: Level A students should be able to carry out non-routine complex tasks whereas the level B student need not. On the other hand, a student is able to obtain a B grade without

being able to evaluate the validity of "mathematical arguments ", which seems inappropriate.

Communication and Justification

Dot points 1-4 are identical apart from the "and/or" difference mentioned above. The single difference in dot-points 5 and 6 is that a student must be more concise than a B student, and must in assessment be able to provide "justification of the reasonableness of results". It is not clear how the latter point would be consistently measured across multiple assessment items. Moreover, if a student cannot spot unreasonable results - should they be at B standard?

As a mathematics lecturer I would find it very time consuming, if not impossible, to craft assessment which would reliably differentiate students along many of the lines given above. For example, I would not expect there to be students who were excellent at life-related problems and weak at abstract problems or vice versa. How then could I objectively separate students on this criterion. I also note that there would appear to be considerable subjectivity and ambiguity in the application of some criteria.

At a University level, the key differentiation of student grades occurs on how *well* students can carry out problems in the four categories alluded to in the criteria referenced assessment: "routine simple", "routine complex", "non-routine simple" and "non-routine complex". The inclusion of abstract and life-related mathematics should be dealt with in the curriculum content, not the assessment standards.

At Queensland high schools in the past, examination papers or assignments were set with a balance of the different types of questions. Twenty years ago these were referred to as "content", "skills" and "process". To award a mark, a numerical value was assigned to each question and summed. The A, B and C standards are assigned to a range of marks (A=85%-100% etc.). This is simple, and measures and rewards proficiency in the different types of assessment.

This is essentially the way that examinations are carried out in mathematics throughout Australian and international universities. I think it would be useful to considerably simplify the criterion for mathematics, and it would be beneficial to allow numerical measures to gauge proficiency and set standards.

Summary

I believe that removing written assessment items, and allowing teachers to use proficiency-grading for assessment levels in Mathematics B would better allow our excellent teachers to teach, and improve learning outcomes for Queensland's high school students, and ultimately its Universities.