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Submission to the Queensland Parliamentary Committee Inquiry "Assessment Methods for Senior Maths, Chemistry and Physics".

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[redacted]

We would like to thank the Queensland Parliament for the opportunity to make a submission to the very important inquiry into Assessment Methods for Senior Mathematics, Chemistry and Physics. We also thank the QSA for their willingness to engage in discussions with various stakeholders in a number of meetings leading up to this Inquiry.

This submission is being made jointly by Professor Peter Adams, Associate Dean (Academic) in the Faculty of Science at the University Queensland, and Professor Joseph Grotowski, Head of Mathematics Discipline at the University of Queensland.

This is not a submission on behalf of the University of Queensland, but instead based on our expertise as Professors of Mathematics, with deep, long-term experience of tertiary level mathematics education and research.

Our expertise

We have each worked in tertiary mathematics in Australia and internationally for over 25 years, with great experience in teaching mathematics to students in mathematics, science, engineering, business, health sciences and other areas, at introductory and advanced levels. We both have been awarded institutional and national awards/fellowships for excellence in tertiary mathematics education, and we hold leadership positions in Australian mathematics and scientific organisations.

We are very familiar with the mathematical ability of students entering tertiary study after graduating from the Queensland secondary school system. The University [redacted] requires at least a Sound Achievement in Mathematics B for students to enter tertiary studies in disciplines including science, engineering, commerce and economics, so we interact with thousands of such students each year. In addition, a large number of our students have also completed Mathematics C on entry.

Professor Grotowski is a member of the QSA Mathematics Learning Area Reference Committee (LARC) for, and we both participate in various outreach activities involving mathematics and science. The QSA invited both of us to meet with the then Acting Director of the QSA, [redacted], on 23rd October, 2012, and on 7th February this year we were invited to participate in the QSA Mathematics Forum.

Scope of our comments

We clearly recognize the societal requirement for the secondary education system to graduate students who are intending to pursue a wide range of life and career goals. Preparing students for participating in tertiary study is a very important aim of the secondary education system, although of course it is not the only aim. However, we certainly do believe that tertiary preparation is the primary intention for almost all students studying Mathematics C, and for most students studying Mathematics B. Thus, we consider that the key measure of success for Queensland secondary Mathematics B and C is how well prepared graduating students are to participate in tertiary study that requires mathematical skills and knowledge.

Given our strong level of expertise in mathematics and tertiary mathematic education, we suggest that we are very well qualified to provide expert comment on precisely this measure of success. We will address our comments particularly to the Term of Reference "The ability of assessment processes to support valid and reliable judgments of student outcomes", in the context of Queensland secondary mathematics education.

Our comments

At both of the meetings we attended at the invitation of the QSA, we expressed the view that the **mathematical content** of the Queensland Mathematics B and C syllabi is very appropriate for preparing students for subsequent tertiary study. We reiterate this view: students with a sound working knowledge of the identified mathematical content and processes would be well placed to embark upon tertiary study.

There are certainly students completing secondary mathematics study in Queensland who are outstanding. However, in our expert views, there are many students entering tertiary study, with at least a Sound Achievement in Mathematics B and/or C, whose skills and knowledge is very weak, and not consistent with any particular mastery of the mathematical content and knowledge identified in the syllabi. We expressed this view very clearly in both meetings with the QSA. It is also our expert view that the number and proportion of such students has increased dramatically in recent years.

Indeed, in a substantial number of cases, students appear to be incapable of demonstrating proficiency at some mathematical techniques that are covered prior to Year 11. This observation is shared by colleagues in mathematics departments at other universities in Queensland, and is particularly alarming.

This suggests that there is a significant mismatch between what is being identified as a Sound Achievement in mathematics by the secondary education system, and what we would understand as a sufficient understanding and mastery of the mathematics that is being taught.

Of course, it may be suggested that we are expecting too high a standard from a student with a Sound Achievement. However, we would reject such a suggestion. First, as mathematicians we are familiar with the expected level of mathematical skills and knowledge from students completing secondary education in a range of jurisdictions, nationally and internationally. Our expectations are very consistent with expected standards and achievements elsewhere. Secondly, we are certainly not expecting absolute mastery, just a reasonable level of proficiency on the content identified in the syllabi. Demonstrating such proficiency should be a minimum requirement for students to

receive a Sound Achievement. Finally, having taught large first year classes over many years, we find that we often need to re-teach much of the content identified in the syllabi, or even at a lower level than Years 11 and 12.

Given that the mathematical content of the syllabi is appropriate, and given that there are a significant number of students completing Year 12 with a Sound Achievement in Mathematics B and C whose mastery of this mathematical content is demonstrably inadequate, the only reasonable conclusion is that the assessment component of the syllabus is not putting sufficient weight on demonstrating mathematical proficiency. In other words, students are achieving Sound Achievements or higher in the mathematics courses without being able to demonstrate appropriate mathematical skills and knowledge.

As we stated at both the QSA forum In February and our meeting with [redacted] in late 2012, oral and written communication skills are important for tertiary level mathematics students, and students studying discipline areas that require mathematics. We do not *solely* aim to teach students mathematical content: communication skills are required outcomes for all UQ mathematics graduates. However, we believe strongly that the *primary* aim of technical mathematics courses (including Mathematics B and C) must be to develop students' mathematical skills and knowledge. Being able to communicate is important, but of greater importance in these courses is for students to be able to do mathematics. Indeed, all mathematics develops communication skills such as logic, precision, conciseness, clarity and accuracy, even when not studied in a "real life context".

It is our very strong view that achieving the communications exit criterion (and indeed any other criteria) <u>must not</u> come at the expense of achieving proficiency at mathematical skills and content knowledge.

At the tertiary level we would typically assess communications criteria in relatively short, well-defined pieces of work, in which there is still a major focus on mathematics. We have been contacted by a number of current Queensland secondary teachers, the vast majority of whom expressed significant concerns at aspects of the assessment processes, both procedural and content based. In particular, many teachers commented on the considerable length and complexity of school assessment items involving communication, the lack of content focus in such assessments, and the disproportionate amount of time and effort required to mark and moderate the work. Certainly, both in comparison with tertiary education and also in terms of student preparation for tertiary study, we would view the observed student and teacher time and effort needed for the EEIs as being disproportionately high. Furthermore, it is not at all clear to us whether such investigations are the best way to develop appropriate mathematical skills and knowledge. Contextualising mathematical content is appropriate, provided contextualisation does not detract from mastering the core mathematical content. However, given the generally poor level of mathematical skills shown by students entering tertiary study in Queensland, we believe that the focus on contextualisation in assessment is having a significantly negative effect on students' mastery of mathematical content.

We close with a few comments on numerical grading.

In the past few months we have had direct contact with many teachers, and also with representatives of the QSA. In our views, there is a clear disconnect between QSA's stated position that numerical marks can be used for grading, and many teachers' experiences that such grading is, in practice, effectively banned or unworkable. We note that all grading in mathematics at The University of Queensland is done on the basis of allocating marks to student work, and then numerically combining these marks to give a score. We stress that using marks is completely consistent with criterion based assessment. Indeed, at the start of each course we provide students

with clear information on the correlation between marks and the achievement of identified exit criteria and levels of performance. Furthermore, this approach is repeatedly used throughout the sector, nationally and internationally.

We believe that numerical grading of student work in mathematics can and does function very effectively, is very efficient, is transparent, is robust, and should be supported. If the QSA or any of the related assessment processes are implicitly or explicitly discouraging the use of numerical grading at any stage, then we would strongly urge that this be changed.

At the tertiary level, we will, of course, continue to make exclusive use of numerical grading processes.