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Committee Secretary
Senate Education, Employment and Workplace Relations Committees
PO Box 6100
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Canberra ACT 2600
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Dear Secretary,

Re: The effectiveness of the National Assessment Program - Literacy and Numeracy

I am writing this personal submission to address the terms of reference (b) and (f), which also involve (c) and (e). I was Foundation Chair of Mathematics Education at the University of Melbourne for 20 years before my recent retirement, and so I have expertise in many aspects of mathematics education, including both curriculum and assessment. In addition, I have been the Chair of the international Mathematics Expert Group for the OECD PISA study which collected data in 2012 and in which mathematics is the major domain assessed. PISA 2012 is due to report the first results in December 2013. The main tasks of the expert group were to write the new framework for the PISA mathematics assessment (which has now been published by the OECD) and to select the items that students do.

My focus is on the impact on the mathematics curriculum, as delivered in schools. In the first section, I address (f), and describe how the OECD assessments focus on knowledge and skills that are likely to be important for knowledge economies in the future. In the second section, I compare this approach to NAPLAN and show that NAPLAN is much more focussed on basic skills. In the third section, I point out that NAPLAN inevitably sets a model for school mathematics, but this model neglects deep objectives for the curriculum, which are becoming increasingly important in a knowledge economy. Finally, I suggest that ACARA or other bodies pay attention to using assessment to encourage a deeper and more ambitious mathematics in Australian schools.

Term of reference (f)
International best practice for standardised testing

The trend in international assessment from the OECD is to ensure that it focusses strongly on 21st century skills – the abilities which are predicted to be crucial for economies to do well in the emerging economic order, as well as to enhance the life chances of individual citizens. The PISA assessment is of the concept ‘mathematical literacy’ which is defined as

"Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens." (OECD, 2013)

Mathematical literacy is not the whole of the school subject Mathematics – for example, it does not include the study of mathematics for its own interest, nor the development of rigorous proof. Instead, it aims to capture those aspects of the school subject mathematics that are likely to be important in most people's lives. The OECD framework further explains as follows:

"The construct of *mathematical literacy*, as defined for PISA, emphasises the need to develop within students the capacity to use mathematics in context, and it is important that they have rich experiences in their mathematics classrooms to accomplish this. This is true for those 15-year-old students who are close to the end of their formal mathematics training, as well as those who will continue with the formal study of mathematics." (OECD, 2013)

"Mathematical literacy is not an attribute that an individual either has or does not have. Rather, *mathematical literacy* is an attribute that is on a continuum, with some individuals being more mathematically literate than others—and with the potential for growth always present." (OECD, 2013)

An important development in the 2012 PISA study was the optional component of "Computer Based Assessment of Mathematics", in which Australia participated. This innovation was a first step towards testing mathematics as it is done in conjunction with a computer. A lot of mathematical work in industry is now like this, and different skills are required.

Comparison of NAPLAN and PISA items

I compared the sample Year 9 items given on the ACARA website (ACARA, 2012) with the PISA items for 2012 (secure items which I have access to, and also released items). Both tests are designed to be taken by the whole spectrum of students; in PISA this spectrum may even be a little wider because it is also given in about 30 non-OECD countries. A wide range of mathematical topics is tested in both assessments. Both NAPLAN Numeracy and PISA mathematical literacy emphasise using mathematics in contexts out of school. There is a difference in year level between PISA and NAPLAN 9 because around 70% of the Australian PISA sample of 15 year olds are in Year 10, rather than Year 9. However, the important differences in the items are clear, and are not accounted for by an additional year of schooling.

(a) NAPLAN items are more straightforward than PISA items. The sample NAPLAN items commonly require only one calculation, or test one concept in a direct way. There are very few items that require a chain of reasoning of more than two steps. Many PISA items require students to engage in multiple step reasoning.

(b) All NAPLAN numeracy items are multiple choice or require students to write only a single written number. In contrast, approximately one third of the PISA items are "open constructed-response items" requiring a somewhat extended written response from a student, perhaps asking the student to show the steps taken or to explain how the answer was reached.

(c) Both NAPLAN and PISA set a good example to teachers by making prominent use of real-world contexts in which to pose the mathematical question. This is a good model for schools because it encourages teachers to put mathematics in a context and not teach only "naked number" calculations. Some PISA items have a complex real-world context for the problem, whereas the NAPLAN contexts are nearly all very direct.

(d) Some PISA items require mathematics from different topics to be used together, as in solving real life problems. In contrast, NAPLAN assesses numeracy as students' basic understanding of isolated curriculum topics.

PISA has attempted to set a forward looking agenda for mathematics, in so far as it is possible in an assessment constrained by the need to be suitable for students around the world. In contrast, NAPLAN focusses on checking students' mastery of basic mathematical ideas in context. The first of the modern Australian mandated testing of student achievement in primary schools was the NSW "Basic Skills" testing introduced around 1990. NAPLAN continues this mission of only testing basic mathematical skills.

Terms of reference (b)
Unintended consequences of NAPLAN (Numeracy)

The ACARA website says that "The National Assessment Program is the measure through which governments, education authorities and schools can determine whether or not young Australians are meeting important educational outcomes."

However, as the only state-mandated assessment below Year 12, the numeracy NAPLAN tests send very powerful messages to teachers about what mathematics at school should be like. Teachers conclude that what is in NAPLAN is all that is important in mathematics. Many NAPLAN is especially influential because of the well documented scarcity of highly qualified mathematics teachers working in the NAPLAN years 3 – 9. The role of the NAPLAN numeracy assessment in providing a model for mathematics curriculum is unintended, but powerful. Indeed, it has even been the case that some schools have renamed the subject "Mathematics" as "Numeracy" – fortunately this has not been adopted by ACARA.

NAPLAN does not provide an adequate model for the school mathematics curriculum. It does not promote complex thinking, or reasoning, or explaining mathematical ideas.

Conclusion and Suggestions

NAPLAN does a good job in giving a fairly quick, fairly reliable assessment of the basic mathematical skills of every student. However, given its place as the only state-sanctioned assessment of mathematics below Year 12, it is inevitably seen as a model for the whole of school mathematics and for this purpose it is inadequate. It sets only limited goals.

ACARA in particular, and each of the school systems, need to stress that the whole of the mathematics curriculum matters, that deep understanding of mathematical topics (rather than just being able to answer NAPLAN-like items) is valued, that an essential part of mathematics is being able to explain reasoning and to understand logical arguments, and that good mathematics teaching gives students need experience of solving problems that are far from short and quick "text-book exercises".

Suggestions:

1. Rename NAPLAN "Numeracy" as "Basic Numeracy" so that teachers and schools are not satisfied if their students do well on this test. Mastery of basic numeracy is important – everyone agrees with this – but it is not sufficient. We should have higher aspirations for a large proportion of students.

2. Resist calls to conduct elaborate national testing of mathematics. Even though a wider range of curriculum goals might be tested, previous experience shows it to be cumbersome, expensive and intrusive. An example is the LAP performance assessment in Victoria in the 1990's.

3. ACARA could develop and promote a range of assessment materials for schools to choose to use, that have some 'prestige' and which move assessment beyond basic numeracy skills.

References

OECD (2013) PISA 2012 Assessment and Analytical Framework. Mathematics, Reading, Science, Problem Solving and Financial Literacy. http://www.oecd-ilibrary.org/education/pisa-2012-assessment-and-analytical-framework_9789264190511-en

ACARA (2012) National Assessment Program Numeracy Year 9.
http://www.nap.edu.au/verve/_resources/Example_Test_Numeracy_Y9_calc.pdf
http://www.nap.edu.au/verve/_resources/Example_Test_Numeracy_Y9_non_calc.pdf

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