

AAMT response to Senate Inquiry into Academic Standards of School Education

Introduction

The following are the responses of the Australian Association of Mathematics Teachers Inc. to the Terms of Reference for the Inquiry. The Terms of Reference have been broadly interpreted in line with the additional information made available through the Inquiry website. Consistent with the Association's interest in mathematics education, the submission focuses mainly on the teaching and learning of mathematics and associated issues.

The process for developing this Response has been that a Draft response was made available through the AAMT website for comments from members of the Association (23 March-20 April). Members' input was used by the AAMT Executive to finalise the submission.

AAMT response

Concerning the issue of whether school education prepares students adequately for further education, training and employment, we believe that there are areas in need of considerable improvement, particularly in the quality of teaching and learning of mathematics and numeracy. Key issues in this include the qualifications of teachers of mathematics, the level of professional support for teachers of mathematics to adopt new approaches and foci, and the time applied to the teaching of mathematics (in the context of the so-called 'crowded curriculum').

Significant numbers of students are not being well prepared for further education, training and employment. These are, in particular, students identified as not meeting national benchmarks and disadvantaged students whose results in PISA leave Australia wanting in international comparisons as a 'high achievement, low equity' country¹. There are others who do not reach their full potential in mathematics — this is unacceptable in the context of skills shortages in the mathematically-rich areas of science, technology and engineering. These disciplines have evolved significantly in themselves, and in the nature of the mathematics they require. Curriculum development in mathematics to account for these changes needs to be forward-looking in defining new 'basics' appropriate for the 21st century, not just those of the past that are the subject of current, ill-informed calls for a 'back to the basics' movement.

The preparation is inadequate for a large proportion of students for the following reasons:

- Mathematics teaching methods are frequently poor and modelled on methods used in the '60s which focus primarily on the inculcation of mathematical routines and algorithms; these approaches foster memorisation as opposed to deep learning needed by students if they are to be confident users of mathematics.
- Mathematics teaching methods that are out-of-date but nevertheless promoted through the media, making it difficult for teachers to attempt more appropriate methods amid ill-informed cries for 'back-to-basics'.

¹ See Magaw, B. (2005) *Achievement and equity: Where is Australia at?* Keynote address to the 2005 Curriculum Corporation Annual Conference, Brisbane. Downloaded from <http://cmslive.curriculum.edu.au/conference/2005/conference.asp?id=167> on 27 April 2007.

- Mathematics curriculums interpreted as lists of content to be taught as opposed to approaches that embed *working mathematically* meta-cognitive processes through research-based pedagogies.
- Mathematics teaching methods that do not harness the enabling and enhancing powers of technological development in computation and the ‘doing’ of mathematics which have changed the nature of the mathematics discipline in recent decades²; the issues here are awareness and training for teachers of mathematics at all levels in relation to ICTs and the teaching and learning of mathematics.

Concerning the extent to which each stage of schooling (early primary, middle schooling, senior secondary) equips students with the required knowledge and skills to progress successfully through to the next stage, we believe that there are areas in need of considerable improvement, particularly in the teaching and learning of mathematics and numeracy.

Significant research has informed the development of programs currently being employed by many jurisdictions to address the teaching and learning of mathematics and numeracy in the **early phase of schooling**. These include *First Steps in Mathematics*, *Count Me in Too*, and the Victorian *Early Years Numeracy Project*. These curriculum and professional development programs are addressing much needed issues concerning the mathematical understandings of primary teachers and their understandings of appropriate ways of teaching mathematics for deep learning with the assistance of technologies for the 21st Century.

Similar careful and focussed programs are needed for students in the **middle years** to ensure they grasp important mathematical concepts such as multiplicative thinking and the use of algebraic representations. These are critical to satisfactory progress in and beyond the middle years. It is in these years that engagement in learning becomes a greater challenge. In addressing the needs of middle years students, many schools and teachers have focussed on building powerful relationships and in making learning meaningful and relevant for students in order to engage them in the learning process. This direction has been taken in response to research findings about students in the middle years. Sometimes, however, this results in a diminished emphasis on the critical components of the mathematics, particularly if teachers lack their own deep learning of the mathematical concepts taught during these years, and why they are crucial to students’ future access to mathematical learning. This issue is becoming more widespread as suitably qualified mathematics teachers become harder to find. As a consequence, fewer students are being adequately prepared for the senior secondary phase.

Students in the **senior phase** sometimes lack appropriate mathematics for university courses. This can be a result of various factors including:

- Universities lowering entry standards for ‘mathematics-rich’ subjects in order to maximise enrolments; this includes changing or not making pre-requisites explicit in documentation
- The increasing shortage of specialist mathematics teachers, particularly in rural and remote locations

² Zevenbergen, R. and Lerman, S. (2005) *Numeracy, Equity ICT: Final Report*. Brisbane: Centre for Learning Research, Griffith University, recently found that teachers make little use of ICTs to support learning

- Increasingly, university courses require application of mathematics rather than pure mathematics. This means that year 11 and 12 mathematics preparation must include higher-order meta-cognitive skills rather than merely content. Some teachers in the senior years who primarily focus on teaching mathematical content lack appropriate pedagogic skills to embed these thinking skills in their teaching practices. Curriculum and assessment design at this level can also militate against an emphasis on these increasingly important higher-order skills.

Students in the **senior phase** sometimes lack appropriate preparation for further study other than university and for employment for reasons indicated previously, including inadequate foundational development in the middle years. Other reasons might include the lack of appropriate mathematics courses available in senior secondary schooling. Frequently the conceptual ‘leap’ required to study year 11 mathematics courses is not manageable for many students; often they are forced into Vocational Education and Training (VET) courses because there are no academically oriented courses available at this level to suit their needs. This ‘two-tiered’ system predominates in some jurisdictions. More demanding and rewarding mathematical application courses would be more relevant and engaging for large proportions of students; these might include courses in financial literacy and budgeting, mathematics of social issues, and other offerings that build on ‘applied’ mathematics (ie using mathematics) rather than ‘pure’ mathematics.

Concerning the extent to which schools provide students with the core knowledge and skills they need to participate in further education and training, and as member of the community we believe that there are areas in need of considerable improvement, particularly in the teaching and learning of mathematics and numeracy.

Many of these have previously been highlighted, such as:

- Lack of suitable course offerings
- Lack of appropriate ‘balance’ in teaching to include not only essential content but also higher-order thinking skills that are critical to being effective life-long learners
- Lack of suitably prepared and experienced teachers and insufficient ongoing professional learning targeted at improving teacher knowledge of both mathematical content and appropriate pedagogy
- Insufficient class time for the teaching of mathematics

The AAMT views ‘numeracy’ as a core competency to which students’ learning in all curriculum areas contributes, and that investigative and inquiry approaches are best to develop numerate behaviour in students. Many teachers in secondary schools in curriculum areas other than mathematics still do not see themselves as teachers for numeracy. Numeracy needs to receive the same attention as literacy in order to generate understanding that all teachers are teachers for numeracy (cf the contemporary view that all teachers are teachers for literacy).

Concerning the standards of academic achievement expected of students qualifying for the senior secondary school certificate in each state and territory we believe that:

- Australian students compare favourably with their international counterparts
- The achievement standards embedded in senior mathematics courses compare well with those expected of students from overseas countries
- Standards at this level should include more than content standards, in particular, employability skills, meta-cognitive skills, skills in application and transference of mathematics to problem-solving and real-life contexts, including in the workplace

In addition, we believe that there is a disproportionate focus on comparisons between the states and territories, particularly through the media, which is not helpful to improving standards. Contrary to what is portrayed in the media powerful synergies currently exist between teachers from state to state including the sharing of good practice through resources and professional dialogue. Similarly, jurisdictional curriculum developments have incorporated the 'best' from other states to contribute to a continued state of curriculum renewal. This has been particularly noticeable in the use of computational technologies where some Australian states are seen as world leaders.

Concerning factors impacting on teacher quality we believe there are a number of issues that need urgent attention. These include:

- a focus on the provision and access to quality, ongoing and targeted professional development in areas such as, but not limited to enhanced knowledge of mathematics and its contemporary applications, improved pedagogy including exploiting the potential of ICTs in learning mathematics, promoting 'deep learning' of mathematics, and addressing the learning needs of currently under-achieving students.
- a concerted approach to changing public opinion towards teachers and teaching, to raise their profile in the community and public confidence
- recognition that quality mathematics teachers maintain particular standards as outlined in the AAMT *Standards for Excellence in Teaching Mathematics in Australian Schools* (2002, 2006) (see <http://www.aamt.edu.au>)
- recognition that quality mathematics teachers are experts in more than the content of their subject area; they also need to be experts in pedagogy and content pedagogical knowledge (powerful ways of delivering the content in ways that promote learning)³
- recognition that teachers need strong and supportive school leadership to support them to improve and change their practice and in particular, to present a balanced approach that delivers working mathematical skills as well as content knowledge and computational skills
- recognition that national tests do not encourage teachers to use a broad repertoire of practices — on the contrary they can encourage teachers to 'teach to the test'; since current tests focus on those elements of the curriculum that are 'testable' in this format this promotes a narrowing of the curriculum which leaves students under-prepared for both their next phase of schooling and for further education and employment
- recognition that as more and more experienced mathematics teachers leave the classroom it is frequently those students who are not achieving well (and these are often educationally disadvantaged students) that suffer since the more experienced teachers remaining are allocated to teaching the more academic, high achieving students

³ The idea of 'content pedagogic knowledge' and its importance for teachers was first articulated by Lee Schulman; see for example Schulman L. S. (1986) *Those Who Understand: Knowledge Growth in Teaching*. Educational Researcher, 15(2), 4-14.

About the Australian Association of Mathematics Teachers Inc.

The Australian Association of Mathematics Teachers was founded in 1966 as a 'federation' of mathematics teacher professional associations in the states and territories. The AAMT is the pre-eminent professional association in school mathematics and numeracy education. It exists to support and enhance the work of teachers, to promote the learning of mathematics and to promote progress in mathematics and numeracy education.

The Association's members come from all states and territories and all levels of schooling. They form an extensive network of committed and enthusiastic mathematics and numeracy education professionals including teachers, academics, policy leaders and administrators.

Through the work of its many volunteer members and a highly skilled staff, the AAMT provides a range of services that includes:

- Three refereed journals (primary, middle school and secondary)
- Student Activities, including the *National Mathematics Talent Quest* and numeracy activities as part of *National Literacy and Numeracy Week*.
- An extensive catalogue of teaching materials
- Professional Development activities including electronic networking of teachers and biennial conferences.
- Projects to undertake research, and curriculum and professional development — current projects include one to develop and strengthen leadership in mathematics in rural and regional areas, and to research the factors that affect students' choice of mathematics subjects in the senior years of schooling.

The nature of the organisation enables the AAMT to play a significant role of national leadership in mathematics and numeracy education over many years. Since 1999 its work on the development and implementation of advanced teaching standards in mathematics has been an important and valued contribution to the professional work of teachers of mathematics. This work continues to inform wider efforts in the area of teaching standards. The Association conducts national 'special interest' conferences that use current best practice in schools as the basis for developing policy and program advice. These are *Students, mathematics and graphics calculators* (2000); *Springboards into numeracy* (2002); and *Quality mathematics in the middle years* (2005).

For more information, go to <http://www.aamt.edu.au>