Mathematics education in Australia, 1980–2011
Jan Thomas

Readers of the Gazette don’t need to be told that mathematical sciences and mathematics education in Australia are in serious trouble. It wasn’t always so, and it shouldn’t be, and so the question is ‘why?’

Caveat: The following is a personal interpretation. If it initiates debate and discussion — good! But don’t dwell too much on history except to avoid the mistakes of the past.

Then and now

When I started teaching in the mid-1970s I had an honours science degree from the University of Adelaide and had studied mathematics for a quarter of first year and a third of second year. Someone with similar qualifications nowadays would likely be expected to teach Year 12, especially if sent to a hard-to-staff school. Fortunately I wasn’t, because there were teachers in the school with better mathematics qualifications than me.

There was a shortage of mathematics teachers in the 1970s. That problem has a very long history. However, the problem is now much worse. Many schools that produced some of Australia’s best mathematical scientists no longer offer the more advanced Year 12 subjects. In 2006 only 64% of high schools offered advanced mathematics at Year 12a. Low socio-economic, rural and remote areas are faring the worst. These areas are also seeing greatly diminished opportunities for studying mathematics at university.

Although there is certainly no single cause, I believe the problems that now beset mathematics education in Australia have their origins in the 1980s and escalated in the 1990s.

The 1980s

The Fifth International Congress on Mathematical Education was held in Adelaide in 1984. At that time there was pride in mathematics education in Australia. Some of the states, Victoria for example, had extensive curriculum development

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capabilities involving very knowledgeable former teachers. Across the nation there was duplication of effort and fragmentation but it was considerably better than what was to come.

At the end of the 1980s the State and Federal education ministers met and agreed to collaborate on a national curriculum. Well before any national curriculum emerged, there was a huge reduction in curriculum services capability in Victoria and probably Australia more generally. The State Education Departments appeared to assume that curriculum would be developed centrally and their curriculum services could be reduced. It ultimately left very few people in the Victorian Department of Education with any knowledge of mathematics education and this was probably the case in most Australian states.

In 1989 the Australian Mathematical Sciences Council (AMSC) was formed under the Federation of Australian Scientific and Technological Societies (FASTS) umbrella. The inaugural President was Professor Garth Gaudry, and initial membership comprised the Australian Mathematical Society (AustMS), the Statistical Society of Australia (SSAI), the Australian Association of Mathematics Teachers (AAMT), the Mathematics Education Research Group of Australasia (MERGA) and the Mathematics Education Lecturers Association (MELA).

At the end of the 1980s mathematics education in Australia was, especially compared with 2011, in reasonable shape. The AMSC was providing a united voice and the late Dr David Widdup, FASTS Executive Director, provided enormous support to mathematics education. David was a lawyer with a PhD in mathematics education from Monash University. So yes, there were problems but they were not nearly as deeply entrenched as they are now. In particular the full effect of the proposed attempt at a national curriculum was still to be felt, as was the expansion of the university system on both mathematics departments and teacher education.

The 1990s

From both a political and curriculum point of view, serious problems emerged in the early 1990s when the Statements and Profiles covering eight ‘key learning areas’ (KLAs) were produced. Both AMSC and MERGA vigorously criticised the development, structure and approaches used for the Mathematics Profiles. However, as described by Ellerton and Clements [1], AAMT received substantial Federal funds to help support their implementation. Ellerton and Clements note that ‘clearly the AAMT’s approach with respect to the Mathematics Profile was quite different from that adopted by MERGA and AMSC’ and that this meant there were inconsistencies in the messages going to politicians and others.

The book by Ellerton and Clements [1] is a thorough account of the formation of AMSC and the 1990s attempt at a national curriculum. Unfortunately many of their predictions came true. These included outcomes-based education leading

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bMELA subsequently merged with MERGA
to a fragmented view of mathematics and increased state and national testing. Irrespective of some concerns, subject associations believed they should support their teachers and accepted funding from the Department of Employment, Education and Training for implementing the Profiles. This compromise undermined the stand of other professional groups, including the AustMS. However, Ellerton and Clements [1, p. 336] also predicted this approach would end after five years and that

Hopefully, at that time, mathematicians, statisticians, mathematics educators, and mathematics teachers will be invited to cooperate in producing a national mathematics framework for Australia in the twenty-first century.

That is still yet to happen in any significant way.

The tensions that arose between AAMT and the discipline-based societies in regard to the Profiles eventually led to the AAMT leaving FASTS and therefore AMSC. The AAMT had demanded that they be the only body to speak on anything concerned with school mathematics. This was unacceptable to AustMS, SSAI and MERGA. The Australian Science Teachers Association also left FASTS but kept their office in Canberra. They maintained contact and visibility in the broader science policy arena. I was on the FASTS Board and Executive for seven years and AAMT was invisible. Further, David Widdup left FASTS and his voice and support were also lost.

All Australian states adopted the Statements and Profiles in different ways. This began a period of constant change for teachers as various new documents were introduced. A common feature of many of them was their complexity at a time when the number of unqualified teachers was increasing. For example, my last position with the Victorian Education Department was concerned with what was meant to be a simple guide for Years 7–10 mathematics to assist teachers while new Year 11–12 mathematics courses were implemented. The document subsequently emerged some years after I had taken a university position. It was now several years overdue, 4.5 cm thick and of no use to any but the most experienced teacher.

The 1990s also saw the widespread adoption of ‘numeracy’ instead of mathematics. In 2011 there is still no sensible definition of what ‘numeracy’ means and in spite of concerted efforts by, for example, the AAMT to broaden the meaning, it continues to be seen as the kind of skills needed for vocational education and training. The persistent use of this definition in political circles does not help to promote mathematics.

In a similar vein, the most commonly quoted international achievement data is from the Programme for International Student Assessment (PISA)c study. The mathematics is low-key and the questions are very dependent on reading comprehension. As they are ‘context’ questions, cultural bias also occurs.

[cwww.pisa.oecd.org/pages/0,3417,en_32252351_32235731_1_1_1_1,00.html]
There is no doubt in my mind that the best indicator of how Australia is traveling in school mathematics compared with other nations is the Year 8 Trends in Mathematics and Science Study (TIMSS)\(^d\) data. The mid-1990s TIMSS showed Australia performing statistically above both England and the USA, yet there seemed to be little enthusiasm for attempting to bridge the gap between Australia and higher-performing countries. Further, there was no concerted effort to address teacher supply issues or the lack of discipline studies in many primary teacher courses in our universities.

The combination of teacher shortages and the eight KLAs introduced as part of the Statements and Profiles also put pressure on time in the curriculum for mathematics.

It is no surprise that, from the mid-1990s, there was a decline in the percentage of students studying the advanced and intermediate Year 12 mathematics courses\(^e\). This has affected the health of mathematical sciences in the universities. And the health of mathematics and statistics in the universities has a profound impact of the quantity and quality of teachers, especially secondary teachers.

The 1995 review of advanced mathematical sciences\(^f\), published in early 1996 just before there was a change of government, found challenges, but was reasonably optimistic. In particular it expected that there would be many retirements in the coming few years that would open up opportunities for talented young people, especially expatriates who had gone overseas for their PhD or to postdoctoral positions. In the climate created in the universities by the Howard government this didn’t happen. Instead a steady contraction of university mathematical sciences began and there was a ‘brain drain’ rather than opportunities for young people to come back\(^g\).

By the end of the 1990s:

- the mathematical sciences community was fractured,
- teachers were having to deal with a flow of incomprehensible curriculum documents,
- most, if not all, Australian states had reduced their curriculum support services,
- the percentage of Year 12 students studying the advanced and intermediate mathematics courses was declining,
- university mathematics departments were contracting, and
- the quality and quantity of mathematics teachers was declining.

The problems were becoming intractable.

\(^d\)http://nces.ed.gov/timss/
\(^e\)http://www.amsi.org.au/index.php/component/content/article/78-education/123-updated-year-12-mathematics-figures
\(^f\)http://www.review.ms.unimelb.edu.au/95Review.pdf
\(^g\)http://www.austms.org.au/AustMath/lookfuture.pdf
Glimmers of hope in the 2000s

A few good things happened in the 2000s. The Australian Mathematical Sciences Institute (AMSI) was formed, providing national infrastructure for the mathematical community. Minister for Science and Education, Dr Brendan Nelson, found funding for the first two AMSI Summer Schools and then the International Centre of Excellence in Mathematics Education (ICE-EM). Nelson had a very clear understanding of the role of content knowledge in teaching. He once told me he was ‘going to fix the education faculties’. Unfortunately he was made Minister for Defence before this happened.

The new Minister, Julie Bishop, seemed to take an instant dislike to anything Nelson had championed. Professor Garth Gaudry — now director of ICE-EM — and Professor Phil Broadbridge, Director of AMSI, met with Bishop just before the IMU Congress in Madrid and told her an Australian was about to receive the Fields medal. Even this failed to enthuse her about matters mathematical.

In 2006 a new review of advanced mathematical sciences was completed. One of the international reviewers was Professor Jean-Pierre Bourguignon and, at dinner when the Working Party first gathered together, he was bemoaning what was happening to mathematics in his part of the world. After a day or so hearing from university people in Australia, he sat back in his chair and said: ‘I am living in paradise’.

This review certainly provided a glimmer of hope. At a forum held to promote its findings, members from both sides of the political spectrum seemed to accept the findings and the need for action. In the May 2006 budget there was even an increase in funding for the teaching of mathematics and statistics. However, little ended up in mathematical sciences departments and once again there was a change of government.

Another glimmer of hope was when the new Minister for Science, Senator Carr, said in an address to the Australian Academy of Science:

A nation that cannot turn out top-notch mathematicians and statisticians is a nation in deep trouble. Unless we turn around the trends that have bedevilled this discipline over the last decade or so — in schools, in universities and in research — we will not be able to meet our needs for people with a sound knowledge of mathematics.

However, endless reviews and little to address the key problems have followed this statement.

\[\text{http://www.review.ms.unimelb.edu.au/}\]
Status in 2011

With one exception the problems in existence at the end of the 1990s remain. After some of the dreadful documents from the Profiles on, the current version of the Foundation-Year 10 mathematics curriculum is a clear and simple statement of what students should be taught at the various year levels.

New data has emerged since the 1990s:

- The percentage of Year 12 students studying the intermediate and advanced mathematics courses continues a slow downward trend.
- From being statistically above both England and the USA in TIMSS in 1995, the 2007 results showed Australia now statistically below both these countries. The next results are due late in 2012. PISA results have also declined.
- An analysis using 2002/2003 TIMSS data comparing Australian Year 8 students with the average for the top five countries shows extensive underachievement. TIMSS puts student achievement in bands and Australia has more students at the lower achievement bands and only 7% compared with 34% in the highest band.
- Responses from 32 mathematics and statistics departments at the start of 2010 showed seven not offering a major in mathematics and 16 (possibly 17) not offering a major in statistics. Many of these have large Education Faculties.
- In 2006 the Australian Deans of Science warned that 1 in 12 high school mathematics teachers studied no mathematics at university, 1 in 5 studied no mathematics beyond first year and 1 in 4 senior mathematics teachers did not study mathematics through to third year.
- In the recent past the mathematics and statistics share of all graduates from bachelor degrees was 2.5 times higher in the OECD than it was in Australia.
- Figures for the percentage of graduating secondary teachers who are qualified to teach mathematics are consistently around 7%. The time in curriculum is about double this.

There is nothing to indicate any improvement in these figures.

The future

A national curriculum, even a sensible one, is not a panacea. The UK introduced a national curriculum and testing in 1988. It had little or no effect on achievement and participation until this century. Then a number of strategies to improve the supply of teachers, the qualifications of existing teachers, and promotion of mathematics to students and the wider community were implemented. As Professor Celia Hoyles reported in her presentation in Melbourne in February 2010\(^1\), this has turned mathematics around.

Australia also needs a concerted campaign to improve awareness of the career options that studying mathematics and statistics can open up. The effectiveness of this had been demonstrated in the UK and in the 1980s in Victoria. The Victorian 'maths multiplies your choices' campaign was directed at girls with a message to parents not to 'pigeonhole your daughter', and is still remembered.

Critically, the lack of mathematical content knowledge of many primary teachers and the supply of mathematics teachers in secondary schools must be addressed. This requires a national coordinated effort. However, although there is now a national curriculum to guide this, nearly all the money that could have supported it has been distributed to the states.

There were two measures directed at teachers in the 2011 budget. Teach Next seems to be another version of Teach for Australia\(^k\) that currently has about 80 trainee teachers and 15 staff in the office. At considerable cost, it is producing few mathematics teachers. The other measure was a bonus for outstanding teachers that should do a great job of demoralising the many teachers doing their best to teach mathematics without adequate qualifications or the support to complete further study.

Meanwhile, the Australian Institute for Teaching and School Leadership (AITSL), which will accredit teacher education programs nationally, currently proposes that: Graduate entry secondary programs must comprise at least two years of full-time equivalent professional studies in education. How many mathematics and statistics graduates are going to consider a two-year course to become a teacher? What of the many career-change people who have been able to adjust their lives for one year but will reconsider a two-year commitment? Australia cannot afford to lose a single potential teacher of mathematics and the demise of the one-year DipEd will most surely lose many.

Mathematics education in Australia has been in serious trouble for 20 years. The divisions in the community that arose in the 1990s have taken a terrible toll. In the UK a coherent voice through the Joint Mathematical Council of the United Kingdom\(^l\) formed in 1963 has served them well.

The USA had the so-called ‘math wars’. While it may have been destructive at the time, it has led to much greater cooperation between the various bodies. There has also been a succession of Presidents who spoke of the importance of mathematics and supported improvement with funding.

In Australia, chances to raise issues are missed. There should have been a coordinated voice from the mathematical community to publicise and highlight the Deans of Science report on mathematics teachers in secondary schools. The study was coordinated by Professor Tim Brown, former President of SSAI, and conducted by the Centre for Higher Education at the University of Melbourne. In spite of this the Executive Director of the AAMT publicly questioned the methodology and it is seldom quoted in the mathematics education literature. If this

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- \(^k\)http://www.teachforaustralia.org/
- \(^l\)http://www.jmcuk.org.uk/
report had appeared in the early 1990s, AMSC and FASTS would have grabbed the opportunity to work with the Deans and run a forum to publicise it.

Everyone with any interest in mathematics education should be insisting that the possible impact of the demise of the DipEd be examined before it ceases to exist.

The mathematical community must start to speak with a coordinated voice and grab opportunities to promote issues as it did in the early days of FASTS and AMSC. An elementary structure is in place through the Australian Council of Heads of Mathematical Sciences. But it needs a commitment from all the key players.

Mathematics education needs a coordinated, collaborative voice and it hasn’t had that since the mid 1990s.

References


Jan Thomas was AMSI’s Executive Officer until March 2011. She is now a senior fellow at the University of Melbourne. She had previous positions in teaching, as a consultant in schools and as a lecturer in teacher education. She believes access to a good mathematics education, along with good communication skills, is fundamental to an equitable and socially just society. She was President of the Australian Mathematical Sciences Council, FASTS Vice-President, and Executive Officer for the AustMS. She was the first woman to be made a life member of the AustMS.