



Maths matters

Quantitative disciplines in Australia

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Having recently completed a review of Education in Mathematics, Data Science and Quantitative Disciplines for the Go8 (Group of Eight) universities, I have a natural core theme for reflection.

Let us begin by considering the Report itself. Its preparation was significantly aided by three factors. The first of these was an outstanding Reference Committee which contained not only leading Australian mathematicians but also senior representatives from engineering, statistics and economics. Secondly, the Go8 provided Alan Mackay, fresh from a distinguished career with the Australian Bureau of Statistics, as coordinator/secretary. Finally, the terms of reference were suitably broad and by no means confined to the Go8, although they commissioned the review.

From the beginning I was very pleased to discover that there was no hint of tribalism within the Reference Committee. This does have its sinister side because we all agreed that the state of the enabling discipline mathematics was poor, had deteriorated, and continues to deteriorate. There have been several recent broad reviews which have demonstrated this and have made many long-term recommendations. This is important but we decided to focus on some highlight problems and a small number of recommendations capable of immediate implementation. Rather than indulge in a culture of complaint we tried to find recipes for self-help from universities, mathematicians, users of mathematics, and government. Australia faces significant problems in simply replacing skilled personnel in engineering, statistics and IT in the existing economy. That economy is also growing and, in some cases, very quickly. Moreover we seek to shift more to a technology-based creative economy. The development of an education resource base is essential and, without major change, unattainable.

Good practice begins at primary school when some of the first habits of thought are laid down. Entry to primary teacher training is healthily competitive but does not, of course, mandate mathematics. It is no surprise that many primary teachers are insecure over quantitative skills and several appear to suffer even from math-phobia. The Universities of Newcastle and Wollongong have introduced apparently highly successful units, taught by the mathematics departments, to impart greater confidence to primary teacher trainees, and RMIT has doubled the numeracy component of its training.

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It is self-evident that the assignment of a randomly selected member of a mathematics department seconded to a school of education would not necessarily enhance the environment for trainee teachers but the Report makes a sharp recommendation nevertheless:

It is proposed that the Go8 should encourage dialogue between Faculties of Education and Mathematics Departments with a view to introducing a component in the primary training program giving mathematical confidence and resources to future teachers. This would be taught by the Mathematics Department or School.

The important point is that the end-users, be it mathematicians or other quantitative disciplines, accept some responsibility and that there is a tangible outcome.

In later primary and early secondary school, international benchmark tests can be interpreted as not too bad for Australia as far as technical achievement is concerned. We are, however, heavily outperformed by most Asian countries who participate, in particular Singapore, Taipei, Hong Kong and Korea. Finland also stands out and, over recent years, we have regressed relative to the US and UK. The statistic which worries me, although it is qualitative in nature, is the fact that in Year 8 only 33% of Australian students retained a positive attitude to mathematics compared with an international average of 54%. This points towards a recent flood away from serious mathematics options in Years 11 and 12. The Report recommends the raising of mathematics and science awareness in the community and extra-curricular resource provision. These are matters central to the mission of my current responsibility at the RiAus and highly relevant to the Government's *Inspiring Australia* agenda.

For the senior secondary level the Report quotes statistics which show that, from 1995 to 2007, the proportion of the Year 12 cohort (not counting International Baccalaureate students) whose highest level of mathematical attainment was Elementary increased by almost 30%. During the same period, the proportion taking Advanced Mathematics dropped by 27%.

What is particularly distressing here is that the term 'advanced' refers to the solid mathematical background required for, say, a good engineering degree. It is not an indulgent trip into the more esoteric realms of pure mathematics. Nevertheless it is difficult to find teachers well-qualified to teach this with confidence. This is especially true of smaller regional centres so there is inherent unfairness in the distribution of resources.

Much of the success of Finland, which performs outstandingly in international benchmark tests, has been attributed to that country's treatment of teachers—well-paid, well-resourced and respected in the community. I believe that Australia must set long-term goals in this regard.

Attempts have been made to understand student choice in Year 12 where it is available. One obvious issue is to balance the later gain in preparedness for further study against the immediate benefit of high marks to facilitate entry to that study. Students falling below the highest attainment level in mathematics often describe

the advanced course as difficult and unforgiving where there is no guarantee that hard work will earn its reward in examinations.

It has been suggested that the way to fix the problem is to persuade the universities to show more courage in demanding specific mathematical prerequisites. Such a strategy ignores the social equity dimension and could have the effect of lowering numbers in quantitative disciplines at a time when we are already concerned about falling enrolments. Accordingly, the Report recommends that the universities develop a systematic structure of enabling (remedial) programs which allow students to gain the skills which are necessary for maintaining the standard of degrees. This should, of course, be designed in such a way that it does not disadvantage those who *have* acquired appropriate skills in high school.

Australia has a proud history of achievement in statistics, so it is painful to recognise that this discipline is now significantly weak. There is a serious shortage of practitioners who can apply existing methodology to a wide range of fields including the social sciences and the life sciences, and our university training programs fall well short of demand. We lack also a strong group of researchers in probability and statistics who push the boundaries of methodology and are linked with new developments world-wide. (There remain some first-rate individual achievers but that does not constitute a stable base.) In fact the Academia Sinica in Taipei is accepted as the leading intellectual hub for probability and statistics in our region, with 37 full-time researchers in a cluster of excellence. The populations of our two countries are of similar size.

We need to develop some basic statistical intuition in future citizen voters, whether or not they proceed with study in a quantitative discipline, so that advertised claims can be evaluated. We need researchers to have a still more sophisticated sense of how their data can be interpreted and how their experiments should be designed, even if, as is mandated by the NIH (National Institute of Health) in the US, they will seek professional statistical advice.

That is another example where longer term investment is essential, but the Report offers some short-term recommendations. In particular we call upon universities to pay heed to the structural deployment of statisticians within their institutions to avoid regression to a model in which there are only isolated specialist consultants attached to different disciplines. Our own consultations provide confidence that bodies like the Australian Bureau of Statistics, CSIRO and employer groups will co-operate strongly in strengthening postgraduate training in statistics.

An aspect of the statistics problem can be seen in mathematics departments, as a whole. Many of these have shrunk to a size which is barely viable. Where matters are more healthy it is usually because good relationships have developed over service teaching. There are certainly tales from the past describing the arrogance and inflexibility of mathematicians acting as monopoly suppliers and driving engineering or economics schools to hire their own tutors to service local needs. Mathematicians and users alike are now so concerned about the shared enterprise that there is considerable will to co-operate. The Report recommends that vice-chancellors review their internal funding models and encourage effective agreements for service teaching.

The remaining recommendation recognises the importance of an active research culture to underpin everything else we have discussed. Moreover it is to the advantage of all if the Go8 can use its stronger position to invest in shared research activities. One specific suggestion is that the Go8 could second personnel to AMSI to assist with the organisation of thematic research network meetings. In comparable countries an organisation such as AMSI would be government-supported to perform such a role and I believe that demonstrated self-help by the mathematical community in Australia is a powerful way to show commitment.

The full Report is available on the Go8 website¹ and the Go8 currently has an implementation group at work. I have been pleased by much wider interest than from the Go8 and hope that there will be further implementation, discussions and ideas. Certainly there have been positive responses from mathematicians in universities generally, from teachers' associations, from engineers and other users, from the Academy of the Social Sciences in Australia and from governments, state and federal.

It is my fervent hope that this can be an early manageable part of the process of rebuilding the base of mathematics and the quantitative sciences in Australia. I look forward to a time when we are driven more by ambition than rehabilitation.



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¹www.go8.edu.au/storage/go8statements/2010/Go8MathsReview.pdf