Maths matters

Can the mathematical sciences thrive in Australia?

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The Australian mathematical sciences community has become more organised in recent years, especially with the assistance of the Australian Mathematical Sciences Institute (AMSI) through the Australian Council of Heads of Mathematical Sciences Departments. We have a better opportunity to address national issues, such as the National Curriculum for mathematics in schools and the Excellence in Research Assessment process.

All areas of higher education are currently in a tight budget situation, with the very slow implementation of the Bradley and Cutler reviews. The question I want to address is: can we lay the foundations for a strong revival of the mathematical sciences, when the new funding finally comes through?

The government has stressed the aim of increasing numbers of students going to universities, especially from disadvantaged areas. To achieve this, the supply of fully trained mathematics teachers to schools needs urgent attention. In the 2006 review, figures from the Department of Education, Science and Training (DEST) from 2003 showed that 0.4% of university graduates produced by Australia majored in the mathematical sciences. By comparison, the OECD average was 1% and probably the gap has widened since then, with further cuts in mathematics and statistics programs in Australia. Given such a low number of mathematical science majors it is not surprising that almost none go into school teaching.

Recently, at a conference in Banff, I met a senior mathematician from a small Midwest university. His department specialises in training school teachers. Here is a summary of their program to get certification to teach mathematics in high schools (each numbered course is one semester).

- Calculus 1,2 and 3;
- Computer Science 1: development of algorithms and implementation in C++, Java, or similar language;
- Technology in Mathematics: use of technology to model, simulate, and solve mathematical problems, with emphasis on potential applications to secondary teaching;
- Introduction to Linear Algebra;
- Foundations: an introduction to doing mathematics from a theoretical perspective, including basic logic, set theory (from a working point of view, rather than an axiomatic approach, construction of the number system, or anything like that), relations and functions, induction, proof strategy;

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- Geometry 1 and 2: a rigorous course using Hilbert's axioms, including neutral geometry, Euclidean and hyperbolic geometry, some elliptic geometry, models, constructions, relative consistency, a bit on the Kleinian approach if time permits;
- Abstract Algebra: basics of groups, rings, and fields;
- Probability and Statistics 1 and 2: probability spaces, random variables, discrete and continuous densities/distributions, operations with random variables, conditional probability, central limit theorem, basic estimation and hypothesis testing (usually not much); degree of emphasis on a sigma-algebra of measurable sets varies (no measure theory, of course, but they always do the standard example of an unmeasurable set);
- Teaching Secondary Mathematics: this is a methods course, but the math education specialists in the department teach it;
- History of Mathematics.

At his university, they also offer a program for primary mathematics certification.

In Australia, we have mainly lost the ability to give programs like this. Mathematical sciences departments are funded on the basis of large service courses, so specialised programs aimed at teachers are squeezed out. Many universities penalise small enrolment courses, and this is clearly government policy as well. Finally, rules for registration for teachers vary widely from state to state. On the other hand, it is likely that some form of national registration for teachers will be introduced in the near future.

I think we need to regain the initiative in this area. It is vital that *discipline knowledge* be clearly specified for teaching mathematics in schools. Increasing the number of mathematical sciences majors going into teaching should be a national aim, if the equity and access problems are to be addressed. We need clear instructions to universities that programs for teachers as above should have priority and be properly funded, with a reasonable period to build up numbers. Collaboration with Faculties of Education is essential in this process.

We should not permit this to be hijacked by other areas. By this I mean, the mathematical sciences need to be addressed separately from other areas of need in education. Most countries recognise the special role and needs of mathematics and statistics and do not subsume it within science or science and technology. If this can be achieved, it will provide much needed relief for our hard-pressed university departments.

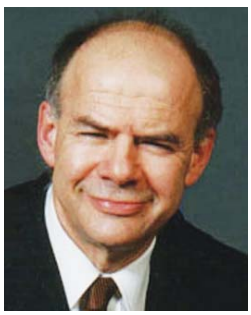
A second issue is interaction with the community of people using mathematics and statistics outside universities. Reasonably good contact occurs with the Commonwealth Scientific and Industrial Organisation (CSIRO), the Defence Science and Technology Organisation (DSTO), and the Australian Bureau of Statistics (ABS). However there are many other opportunities. I have been involved in the mining industry for about 10 years now. Every two years there is a big meeting in Perth, the Ore Body Modelling and Strategic Mine Planning Conference. Essentially all the talks are primarily mathematics and statistics — optimisation,

geostatistics, numerical modelling, geomechanics. There are many opportunities here for research, including student projects.

AMSI has introduced a student industry internship program — this is an excellent initiative but requires us all to get involved. I had a go this year with my student Chris Goddard working on a transport project. This is definitely a learning experience for supervisors as well as students.

Some time ago, John Henstridge, of Data Analysis Australia, suggested to me the idea of an Industry Forum to promote the mathematical sciences in Australia. I believe John's concept is for this to be run primarily by mathematical scientists outside universities, so that their needs and interests are addressed. There are many outstanding individuals who are our former students and occupy high-level positions in industry. The main problem is that these individuals have many demands on their time. But I strongly support this idea and would be interested in a dialogue within the Australian Mathematical Society, Statistical Society of Australia Inc. (SSAI) and Australian & New Zealand Industrial and Applied Mathematics (ANZIAM) to see if there is support for such an initiative.

Mathematical sciences research, as a theoretical activity within universities, does not have strong support in Australia. We have difficulties working within the cooperative research or special research centre framework. Internationally, mathematical sciences research institutes promote short programs on very active topics, rather than being organised around a small group of individuals. We don't seem to be able to convince government that the mathematical sciences need a different approach to research centres, to other areas of science and engineering. We need to continue seeking out opportunities and alliances within science, engineering and industry; being outward-looking is crucial to thrive in the long term. Only in this way, can we win this argument for a properly resourced AMSI.



Hyam is Chair of the National Committee for Mathematical Sciences and was the Chair of the working party of the National Strategic Review of Mathematical Sciences Research which was completed during 2006. He is interested in geometric topology, differential geometry, shortest networks and has been at Melbourne University so long that he gets to walk behind the Chancellor at academic processions for graduation ceremonies.