AMSI News

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Universities and the health of mathematical science

There are some encouraging signs that the government and the community at large are taking the future of the mathematical sciences more seriously. While mathematics departments at some universities are currently being strengthened, an equal number are languishing below critical staff mass. Some of the problems of our discipline are related to university practices. Universities have a tough financial juggling act and some of their leaders have sound academic values. Some do not.

> The decline has already taken its toll: the university presence — the essential foundation for future success — has been decimated, in part by unanticipated consequences of funding formulas and by neglect of the basic principal that mathematics be taught by mathematicians. In parallel, the supply of students and graduates falls short of national needs. . . .
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> (Foreword by the international reviewers J.-P. Bourguignon, B. Dietrich and I.M. Johnstone, to the report of the National Strategic Review of Mathematical Sciences Research in Australia [2].)

The discussion here focuses on the universities but this sector is connected to all of the other equally important links in the chain of mathematics education. By most estimates, since 1995, Australian universities have lost more than 30% of their mathematics and statistics teaching staff. That this should be allowed to happen indicates that we have a weakening cultural value attached to our discipline, worse than in other parts of the western world. Over the past few years, we have been working hard to articulate the value of mathematical sciences to other disciplines, to industry, to government and to the community at large. We have also been identifying specific structural problems, which if fixed, will put us in a stronger position.

The first problem identified by the international reviewers is the use of disadvantageous funding formulae. The federal budget of May 2007 adjusted the Discipline Funding Model, giving an increase of over $2700 per equivalent full time student in mathematics and statistics. This is based on numbers of students taking all mathematics and statistics subjects, including service courses. It makes up additional funding of $25 million to our universities, without detracting from other disciplines. Early this year, heads of mathematics department from 34 universities responded to a questionnaire on the state of their departments:
http://www.amsi.org.au/pdfs/Questionnaire_summary.pdf .

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From January 2007 to January 2008, the number of permanent academic positions in those departments had dropped from 596.5 to 553. At that time, only eight universities had agreed to pass down a significant portion of the extra funds to the mathematics coalface. As reported in the Australian on 25 May, Hyam Rubinstein, Chair of the Australian Academy of Science's National Committee for Mathematical Sciences, estimated that of the $25 million allocated, only $4 million to $5 million has gone into mathematics and statistics departments.

Now in the 2008 budget, there was announced a halving of HECS fees for mathematics and science students, with appropriate compensation to the universities. We are greatly heartened by Education Minister Julia Gillard's intention to ask for more accountability of directed funding, as stated on 20 May:

> ... we will be making it perfectly clear to universities what it's for and the policy objective there. We obviously want our maths and science faculties to be able to teach quality maths and science. ... you should expect to see accountabilities in that area of the Budget and in relation to Budget funding generally.

After this pronouncement, I am confident that more universities will direct the money to its intended target. Tell it to the Deans.

The reviewers' second problem relates more generally to lost opportunities in service teaching. Since mathematics and statistics underlie modern advances in many other fields, it is natural to include some relevant mathematical content in engineering, applied sciences, business and finance. However, students need a broad preparation in mathematics in order to take advantage of that material. In order to win support of the client disciplines, we must listen carefully to their needs and to form some joint management structure so that they share ownership of the subjects that are designed for them.

Over the last year, while working with academic engineers on the government-funded project, 'Mathematics for 21st Century Engineering Students', I have become sympathetic to their needs in the difficult task of educating a diversifying student body. The engineering profession requires 10 000 new students per year but only 80 000 Year 12 students study advanced mathematics. There is much that we can do to improve their situation as well as ours. Our report [1] has just been posted to all mathematics and engineering departments and it is available online at http://www.amsi.org.au/carrick.php .

Similarly, there is enormous scope for developing mathematics and statistics courses for modern biosciences. Burrage [3] has recently commented on this in the context of preparation for research degrees. In Australia, there is an unfortunate trend, starting at secondary level, to run separate science strands for physical sciences and life sciences. The real action in North American biotechnology is based on the mathematical sciences. Eric Lander, the leader of the MIT-based human genome project and a founding director of the Broad Institute, holds an Oxford D. Phil in discrete mathematics. He was a member of a team whose classification algorithm identified a third genetic class (20%) of leukaemia patients who are potentially curable by an identified deficient enzyme [4]. At the

University of Delaware, the Biological Science Department apologised to me for asking Mathematical Sciences to deliver a second compulsory mathematics course for their students. Let me know if there's an Australian bioscience program with two compulsory mathematics subjects.

Thirdly, there needs to be more mathematics content in primary teacher education programs, and there needs to be better cooperation between mathematics staff and lecturers of secondary mathematics teachers in training. There is a worsening shortage of qualified mathematics teachers. Therefore, any university that offers a teacher training program should also offer a full major in mathematics and statistics. Further training in mathematics has a strong influence on job satisfaction of mathematics teachers. I quote from the survey by ACDS of mathematics teachers [5]:

> By the criteria described by heads of mathematics, many of the mathematics teachers surveyed lacked the tertiary background appropriate to their current teaching roles. Among the 2116 teachers of senior school mathematics, 13 percent had not studied mathematics beyond first year ... Mathematics teachers with the highest levels of mathematics-related tertiary study were the most satisfied with their tertiary preparation.

Thirty-one universities offer degree programs in primary education. Most accept students in the bottom third of university entrance scores. Only 12 of them have prerequisite mathematics subjects; 8 of these are at Year 11 level. 15 have mathematics content within teacher training courses.

The government is moving towards my way of thinking. I quote from the Senate report on Quality of School Education, 2007:

> Recommendation 3: The committee recommends that schools and school systems take particular measures to improve teacher professional development in mathematics.

Finally, on the subject of university practices, I would like to comment on the role of legal departments of research offices. AMSI has had some success in brokering research contracts between industries and multi-university teams. Every university employs legal advisers to protect us against liability and to stake claims of intellectual property. This almost always delays any collaborative work by several months and it has convinced many companies never to collaborate with universities. I am advised that mathematical software cannot be patented. I am also advised that the idea of using a mathematical algorithm for a new commercial purpose can be patented but that income from this source rarely exceeds the legal costs. Some American mathematics departments receive much larger amounts from corporate benefactors but these are more often donations from recipients of good mathematical advice that had been given freely. More profit is to be made from cooperation and goodwill than from suspicion and greed.

References

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His PhD was in mathematical physics (University of Adelaide). He has an unusually broad range of research interests, including mathematical physics, applied nonlinear partial differential equations, hydrology, heat and mass transport and population genetics. He has published two books and 100 refereed papers, including one with 150 ISI citations. He is a member of the editorial boards of three journals and one book series.