



Math matters

The Profession of Mathematics

Cheryl E. Praeger

You who glance at this column may care about Mathematics as passionately as I do. You may feel that the importance of Mathematics education is self-evident, for both individuals and society. On the other hand you may also have experienced conversations such as one I had with a friend this week. On telling her that I intended to write about the Profession of Mathematics, she responded that she didn't think that Mathematics was a profession. To be a profession, she said, there had to be a range of careers available, and there were none listed for Mathematics in careers material that her high school-aged son had brought home to show his parents. As a student, she continued, she knew that she had strong problem-solving skills, and good logical and analytical thinking. However, based on her (negative) experience in studying calculus, she had decided to build on her strengths and *not* proceed with Mathematics.

The skills my friend chose in describing her strengths are close to those I would nominate as generic skills to be obtained from a good Mathematics education. However my friend had a very different view from me on the purpose and outcome of a Mathematics education. My view, already on record, is that "the most important outcome from a mathematics education

[is] an automatic expectation by students that mathematical thinking will play a key role in their understanding, and problem-solving in every part of their lives"¹.

Why did my perceptive and well-educated friend have such a different understanding from me of the role of Mathematics? *Is there a Mathematics Profession?* If so, what is it like? If not, and if we want there to be one, what must we do to achieve this?

Let us assume for the moment that there is a Mathematics Profession and that we are members of it. What are our perceptions of the Profession? Who are the members and where do they work? What do they need professionally, and in particular, what do they need from a professional association?

Purpose of the Profession

The two hallmarks of Mathematics are its power and its beauty. "The high technology that is so celebrated today is essentially mathematical technology"². Moreover mathematical literacy is critical for an individual to function effectively in modern society. Politicians, industrial leaders, and educators all say they recognise this. To summarise, let's say that the role of the Mathematics Profession is:

¹In *The Essential Elements of Mathematics*, a paper I wrote in March 2004 in response to an invitation from the Victorian Curriculum and Assessment Authority with respect to its work on developing *Framework of Essential Learning*.

²E.E. David, President of Exxon Research and Engineering, see http://www.maths.uwa.edu.au/students/prospective/first_year_general.php

- To strengthen Mathematics education in schools and tertiary institutions, in order to fit young people to function effectively in society;
- To enhance the impact of Mathematics research for the health of our own and other disciplines, and ultimately for the public good; and
- To promote effective applications of Mathematical methods and analysis in commerce and industry, for the economic benefit of our community and nation.

Inevitably most of us, as members of the profession, will focus on some aspects more than others. *Indeed it is the major challenge for the Mathematics Profession to harness the energy and commitment of all its members to work together towards fulfilling this role.*

Many mathematicians are striving towards this. One celebrated successful initiative is the long-running Mathematics in Industry Study Group that seeks to provide annually a forum where mathematicians and other professionals meet to bring mathematical thinking and expertise to bear on a range of problems arising in industry.

Moreover, the mission of the recently established Australian Mathematical Sciences Institute³ is aligned precisely with this role, as discussed by Garth Gaudry in the third of these columns. In his role as Director of AMSI, Garth found “the level of appreciation of our discipline and its extraordinary impact [to be] extremely high”. He called on us in the profession to “broaden our horizons” and “demonstrate our willingness to cooperate, not only among ourselves but with people from the many other endeavours in which the mathematical sciences play a significant role”⁴.

Similarly, in the second of these columns, Tony Dooley⁵ argued cogently that, in the area of mathematics research, the Mathematics Profession must take “greater control of the mysterious process between theory and applications” and develop “better structures for sharing ideas and projects across the whole spectrum from the purest to the most highly applied research”. Taking control of the connection between theory and application is critical, and must be taken seriously. The reason why the process may look “mysterious” is that many of us have not done it – it is challenging and sometimes very difficult as a real application is rarely as clear-cut as theory. However, the mathematical mind is a good one for solving these problems because of the ability to think clearly, recognise what is a proof (or more commonly, what is not) and to simplify complex systems.

Membership of the Profession

The Mathematics Profession deserves a depth of membership that embraces undergraduate “trainees”, mathematics teachers at all levels, mathematics researchers, and commercial and industrial mathematicians. Universities certify as graduate mathematicians those who have a major in a mathematical science. Usually this means graduates with three year degrees. At the least, all of these graduates are part of our profession.

However the profession is broader than this. For example, the PhD program in any of the mathematical sciences offers a rigorous training in research, and this is one of the possible routes into a mathematical career. Some graduates in disciplines other than the mathematical sciences become members of the Mathematics Profession through such a program.

³See <http://www.amsi.org.au/about.html>. The AMSI mission is to become a nationally and internationally recognised centre for the mathematical sciences, providing service to its member institutions, improving the international competitiveness of Australian industry and organisations and enhancing the national level of school mathematics, by the provision and support of mathematical and statistical expertise.

⁴AustMS Gazette **31** (2004), 145–146.

⁵AustMS Gazette **31** (2004), 76–78.

Alternative routes into the Mathematics Profession for those without a complete mathematics or statistics major are of equal validity: for example, the “in-house” and “on-the-job” training and experience that produce effective commercial or industrial mathematicians and statisticians; or the professional development and further study that enable those without a mathematics major to become competent mathematics teachers in schools. *Mathematical ability and commitment should determine membership of the Mathematics Profession, not formal qualifications* – certainly not the holding of a PhD degree. And let us not forget our undergraduate student members.

When it comes to defining the profession, it is important to use the broadest possible umbrella. It is especially relevant to embrace those diverse users of Mathematics and Statistics (in fields such as Computer Science and Bioinformatics) who may not describe their work as Mathematics. Much of what they do is Mathematics by any reasonable definition. The Mathematics Profession should be taking credit for it and welcoming those who practise it into our fold.

Professional associations

There are many mathematical associations in Australia, of which we may like to think of the Australian Mathematical Society as one of the major ones. The membership of each covers only a “slice” of the profession’s membership. Most members of the Australian Mathematical Society (including ANZIAM) are mathematicians or statisticians in universities. A minority are research or commercial mathematicians and statisticians from government or private enterprise, and some are mathematics teachers in schools.

Several other professional mathematical associations include teachers of mathematics in primary and secondary schools, statisticians from all sectors, and mathematical scientists from special sub-disciplines such as Operations Research. There is no single organisation to which all professional mathematicians can logically belong. Moreover, none caters very well for undergraduate mathematics students as members.

By contrast Engineers Australia⁶ offers free student membership to all undergraduate engineering students, entailing a monthly student newsletter, and access to careers services, discussion forums and professional advice. From this early stage undergraduate engineering students are welcomed into the Engineering Profession. In addition Engineers Australia has active programs run by its branches, and offers structured professional development programs for individual members and teams.

Efforts to provide opportunities for undergraduate mathematics and statistics students led to the inaugural AMSI Summer School in Melbourne in February 2003, whose success was praised by the Federal Minister, Dr Brendan Nelson⁷. In addition, the Statistical Society of Australia runs a Young Statisticians Section⁸ for statistics students and new graduates. Both the Statistical Society of Australia and the Australian Association of Mathematics Teachers have strong state branches that run their own programs independently of the central organisation.

The Accredited Mathematical Scientist

Several mathematical associations have tried to raise public awareness of Mathematics and Statistics, and the quality of members of the Mathematics Profession, by introducing accreditation of their members

⁶<http://www.ieaust.org.au>

⁷Garth Gaudry, *Math Matters*, AustMS Gazette **31** (2004), 145–146.

⁸<http://www.statsoc.org.au/Sections/YoungStatisticians.htm>

or of university courses. While accreditation may benefit an individual by providing recognition of their qualifications and experience, *the most valuable purpose of accreditation is to assure those outside the profession that the accredited person can help them mathematically.*

When the Australian Mathematical Society introduced its accreditation scheme in 1994 during my term as President, it was a controversial decision. The scheme was conservative, measuring worthiness for accreditation against performance levels of university academic staff. Three levels of accreditation were offered, and the Society website currently lists 108 persons who have been accredited as Fellows (the highest level). However, no lists of accredited members, or accredited graduate members are given. We have, it seems, failed to attract young mathematicians to accredited graduate membership, which is available to those who are graduates with a major in a mathematical science.

The Statistical Society of Australia (SSAI) introduced its accreditation scheme in 1996, and more recently decided to offer graduate accreditation status to those with a three year degree with a major in statistics. Unlike the Society, the SSAI provides a list⁹ of all Accredited Statisticians and Graduate Statisticians, together with their contact details and professional areas of interest, thus helping to achieve the major purpose of accreditation. I question whether the accreditation scheme of the Society is sufficiently outwardly focused.

How is the Profession perceived?

As well as internal strength, the Mathematics Profession needs external recognition to ensure that:

- Young people see the relevance of a mathematical training for developing strong problem-solving skills and critical thinking, and the possibility of a variety of satisfying mathematical careers;
- Companies expect and obtain maximum, and cost-effective, benefits from incorporating mathematicians on their staff, or as consultants, to enable them to achieve their competitive edge; and
- Government comprehends the value of investing in mathematics education for its citizens.

How are we as a profession faring in terms of recognition? Some data indicate that Mathematics is facing a crisis, with decreased resources, splintering of the discipline, and dissipation of mathematics content in courses at all levels. In the first of these columns Peter Hall¹⁰ analysed the negative impact on Mathematics and Statistics in Australian universities of government policies on research and higher education, principally the “penalising of highly performing Australian mathematical scientists” and lack of provision of “adequate career paths for younger Australian mathematical scientists”. Documenting the decline in resources is important, but does not necessarily shed light on the causes.

If we, as members of the Mathematics Profession, assume that the only relevant issues are government decisions on support for Mathematics, then the cause of the decline is the government. But this might divert the Mathematics Profession from facing the possibility that much of the problem may lay within itself.

The most recent university mathematics enrolment data I have seen indicate that, in the Mathematical Sciences during the period 1995–99¹¹, the ratio of the number of graduates with majors in a mathematical

⁹<http://www.statsoc.org.au/Accreditations/AccreditedMembers.htm>

¹⁰AustMS Gazette **31** (2004), 6–11. Peter called for increased government funding for university mathematics teaching, structured research/teaching fellowships, and fundamental changes to government policy on the measurement of research performance.

¹¹Information collected from Heads of Mathematics Departments in 2001.

science from Australian universities to the number who graduate with honours is more than 5:1. In past years the mathematical associations have largely ignored the former, and they account for 80% of the Profession. Unless the government sees a vigorous Mathematics Profession that acknowledges and engages *all* its members, we cannot expect it to regard Mathematics as important politically.

A way forward

All undergraduate students studying a mathematics subject should be of interest to the Mathematics Profession, not only because they are its clients, but also because they are students with a good mathematics education and we want to ensure that they understand the “unreasonable effectiveness”¹² of mathematics in solving real-world problems. Two simple initiatives the Society might take are:

- *To extend the offer of free student membership of the Australian Mathematical Society for the duration of a student’s undergraduate career*¹³; and
- *To establish a Young Mathematicians section of the Society.*

However, from a student’s perspective (and indeed the perspective of most members of the community), the “angles of separation” between academic mathematicians and statisticians, industrial and commercial mathematicians, and school mathematics teachers, are very small indeed. Students should be welcomed into the Mathematics Profession early in their undergraduate careers – before most of them distinguish (let

alone choose) between the various mathematical career paths, not to mention alternative career paths such as the computing or physical sciences, or engineering.

An appropriate initiative to achieve this would involve:

- *A joint initiative by several mathematical bodies*¹⁴ *to welcome and engage undergraduate mathematics students in the Mathematics Profession.*

Fortunately for this country, the Australian Mathematics Trust engages many thousands of Australian students in mathematics challenges and enrichment activities while they are in primary and secondary school. Equally fortunately, the Australian Mathematical Sciences Institute has a focus on school and undergraduate training in the mathematical sciences, and the professional development of mathematics teachers. The Trust’s activities could become the first part of a seamless program of mathematics enrichment, promotion and information offered to young people by the Mathematics Profession.

Australia is a talented country. It is also a small country, too small to waste its mathematical resources. Success in building the Mathematics Profession demands the goodwill and commitment of all Australian Mathematicians (in the broadest sense of the word).

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School of Mathematics and Statistics, University of Western Australia, 35 Stirling Highway, Nedlands WA 6009

E-mail: praeger@maths.uwa.edu.au

¹²E. Wigner, *The Unreasonable Effectiveness of Mathematics in the Natural Sciences*, Communications in Pure and Applied Mathematics **1** (1960).

¹³Currently one year’s free membership is offered.

¹⁴Involving at least the Australian Mathematical Society, the Statistical Society of Australia, the Australian Association of Mathematics Teachers, the Australian Mathematics Trust, and the Australian Mathematical Sciences Institute.