NCMS News

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'The Mathematical Sciences in 2025': a report of the US National Research Council

The US National Academies Press published the report 'The Mathematical Sciences in 2025' earlier this year.[1] This was a serendipitous discovery, as it happened around the same time as the call for submissions to the Decadal Plan for Mathematical Sciences in Australia. The report makes eight recommendations, which are listed below. Whilst the funding for and support for mathematical sciences is very different between USA and Australia, we share similar concerns, hopes and ambitions. In this column, I would like to ask you to consider the report's recommendations and whether they are equally important for the Australian context.

The concerns of this report overlap with many of the themes of the Decadal Plan. I was pleased to read statements such as these:

> In order for the whole mathematical sciences enterprise to flourish long term, the core must flourish. This requires investment by universities and by the government in the core of the subject.
>
> (from the Summary, p. 2)

The overview to the report describes the vitality of the US mathematical sciences as 'excellent'. Chapter 4 reports that there are eight institutes of mathematical sciences funded by the National Science Foundation in the US, not including various others such as the Clay Mathematics Institute, the Simons Center for Geometry and Physics and the Kavli Institute for Theoretical Physics. Such sentiment and level of funding is very different to the current state of concern expressed by many of us about the mathematical sciences in Australia. A major issue of concern, for example, is the decrease in the number of departments of statistics in Australia. Two of the recommendations below refer to 'mathematics and statistics departments' in the US. It is sobering to reflect that in Australia there are only two departments of statistics left from about twenty or so that operated in the mid 1990s.

The report contains six chapters in addition to the summary and six appendices. The actions are encapsulated in eight recommendations, which are quoted below

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This article will also appear in the newsletter of the Statistical Society of Australia Inc.

[1]This report can be downloaded freely, after registration, from the National Academies Press at http://www.nap.edu/catalog.php?record_id=15269.

along with additional information (in italics) needed to make them self-contained for this column.[2] As you read each recommendation, I would like to encourage you to try imagining the corresponding actions in Australia, with commensurate bodies such as the Australian Research Council replacing the National Science Foundation. What would your reactions to such recommendations be if they were to appear in the Decadal Plan? I would love to know your thoughts. (Please feel free to email me.)

- Recommendation 3-1 (p. 68): The National Science Foundation should systematically gather data on such interactions (*i.e. data on graduate student training that crosses discipline boundaries with mathematics*) — for example, by surveying departments in the mathematical sciences for the number of enrollments in graduate courses by students from other disciplines, as well as the number of enrollments of graduate students in the mathematical sciences in courses outside the mathematical sciences. The most effective way to gather these data might be to ask the American Mathematical Society to extend its annual questionnaires to include such queries.
- Recommendation 3-2 (p. 69): The National Science Foundation should assemble data about the degree to which research with a mathematical science character is supported elsewhere in the Foundation. (Such an analysis would be of greatest value if it were performed at a level above DMS (*i.e. Division of Mathematical Sciences*).) A study aimed at developing this insight with respect to statistical sciences within NSF is under way as this is written, at the request of the NSF assistant director for mathematics and physical sciences. A broader such study would help the mathematical sciences community better understand its current reach, and it could help DMS position its own portfolio to best complement other sources of support for the broader mathematical sciences enterprise. It would provide a baseline for identifying changes in that enterprise over time. Other agencies and foundations that support the mathematical sciences would benefit from a similar self-evaluation.
- Recommendation 5-1 (p. 127): Mathematics and statistics departments, in concert with their university administrations, should engage in a deep rethinking of the different types of students they are attracting and wish to attract and must identify the top priorities for educating these students. This should be done for bachelors, masters, and PhD-level curricula. In some cases, this rethinking should be carried out in consultation with faculty from other relevant disciplines.
- Recommendation 5-2 (p. 127): In order to motivate students and show the full value of the material, it is essential that educators explain to their K–12 and undergraduate students how the mathematical science topics they are teaching are used and the careers that make use of them. Modest steps in this direction could lead to greater success in attracting and retaining

[2]Each recommendation has a number referring to the chapter in which it is made. I have also supplied the page number on which each recommendation can be found.

students in mathematical sciences courses. Graduate students should be taught about the uses of the mathematical sciences so that they can pass this information along to students when they become faculty members. Mathematical science professional societies and funding agencies should play a role in developing programs to give faculty members the tools to teach in this way.

- Recommendation 5-3 (pp. 127–128): More professional mathematical scientists should become involved in explaining the nature of the mathematical sciences enterprise and its extraordinary impact on society. Academic departments should find ways to reward such work. Professional societies should expand existing efforts and work with funding entities to create an organizational structure whose goal is to publicize advances in the mathematical sciences.
- Recommendation 5-4 (p. 137): Every academic department in the mathematical sciences should explicitly incorporate recruitment and retention of women and underrepresented groups into the responsibilities of the faculty members in charge of the undergraduate program, graduate program, and faculty hiring and promotion. Resources need to be provided to enable departments to monitor and adapt successful recruiting and mentoring programs that have been pioneered at many schools and to find and correct any disincentives that may exist in the department.
- Recommendation 5-5 (p. 144): The federal government should establish a national program to provide extended enrichment opportunities for students with unusual talent in the mathematical sciences. The program would fund activities to help those students develop their talents and enhance the likelihood of their pursuing careers in the mathematical sciences.
- Recommendation 6-1 (p. 152): Academic departments in mathematics and statistics should begin the process of rethinking and adapting their programs to keep pace with the evolving academic environment, and be sure they have a seat at the table as online content and other innovations in the delivery of mathematical science coursework are created. The professional societies have important roles to play in mobilizing the community in these matters, through mechanisms such as opinion articles, online discussion groups, policy monitoring, and conferences.

The report goes into much more detail in its two hundred or so pages. There are also focused topics encapsulated in 'Boxes'. For example, Box 5-1 'Mathematical Circles: teaching students to explore' describes a longstanding, engaging initiative in mathematical outreach. The appendices describe past strategic studies, such as the David report of 1990 which 'led to striking increases in federal funding for mathematical sciences for a few years' (pp. 155–156). Chapter 2 'Vitality of the Mathematical Sciences' provides a very thoughtful description and exploration of current and recent advances and strengths in the mathematical sciences, ranging from the topology of three-dimensional spaces to compressed sensing.

In the Decadal Plan, we need actionable goals as well as aspirational statements. For example, if Recommendations 5-1, 5-3 and 5-4 were adopted in the Decadal

Plan, I would have urged the addition of specific pathways that would fund and enable academic departments to implement 'deep rethinking', rewards for outreach and recruitment initiatives.

In the Australian context, we also need actions that will bring mathematical sciences to the level of vitality that the USA and other western countries enjoy. My hope is that after the first Decadal Plan is put into action, the next one will be able to start from a baseline of revitalised mathematical sciences in Australia.

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