AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

6 August 2018

Ms Emily Dann
Department of Industry and Science
Canberra

RE: DIS Women in STEM Strategy Consultation

Dear Ms Dann,

The Australian Mathematical Sciences Institute (AMSI) welcomes this opportunity to make a submission concerning the Department's Women in STEM strategy.

As a lead organisation for mathematics and statistics in Australia, the Australian Mathematical Sciences Institute is well placed to make comment and provide advice pertaining to participation of girls and women in mathematical sciences across the education pipeline and the careers spectrum.

AMSI is a major provider of programs in this field. We are delivering 'Choose Maths' in a $22m project with the BHP Billiton Foundation to increase the participation of girls and women in the mathematical sciences and the 'Supporting More Women into STEM Careers: National Research Internship Program' in a $34m project with the Department of Education and Training. Details of these programs can be found at https://amsi.org.au/

For a general summary of AMSI's policy position on mathematical sciences we refer to the 2017 AMSI policy document "Improving Australia's Maths Grades" and the "Discipline Profile of the Mathematical Sciences". The responses below are based on AMSI's policy base and the contributions of those listed at the end of the submission.

Yours sincerely,

Professor Geoff Prince

AMSI Director

AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

Consultation questions:

Do you think the identified issues affecting women and girls in STEM education and careers are correct? Are there other key issues that have not been identified?

AMSI response: *In broad terms the issues are accurate. However, there is an implicit assumption that they apply uniformly to the STEM components. The strategy needs to address the individual STEM disciplines: 'STEM' is a construct and in educational settings Science (Chemistry, Physics, Biology and Psychology), Technology, Engineering and Mathematics disciplines are significantly different, in their female participation, e.g., Year 11 & 12 Biology and Physics, and in their levels of resourcing, e.g., the rates of out of field teaching. Moreover, in the school system mathematics and science are separately taught and science is not identifiable as chemistry, physics, biology, computer science, psychology until year 11.*

So, for example, it must be recognised that putting science labs in primary schools is a science initiative, not a STEM one.

Beyond the school system, the one size (STEM) fits all approach may also be less effective because, for example, physics students won't be attracted by messaging that focuses on the wet bench sciences, and ICT and mathematical sciences students are not engaged with the pervasive science imagery of STEM outreach.

It is conventional to see a simple pipeline which supplies STEM graduates through the school to university system. However, the recruitment of mature age women is not addressed in the list of issues. On the face of it there has been a decline in the number of mature age students in general, and women in particular, studying STEM disciplines over the last few decades. If this is the case, then identifying the underlying obstacles should be undertaken.

What role can Government best play in addressing the issues of gender inequity in STEM fields?

AMSI response: *Government should build and maintain the evidence base and use it to create a bipartisan policy framework under-pinned by investment. This policy framework should emphasise long term measures, both stand alone and integrated with, for example, education policy and workforce planning. International experiences and best practice must be considered and monitored continuously.*

Government should also take a co-ordinating role through appointments such as the Women in STEM ambassador position at the OCS. Such roles should reflect a 'whole of government' approach.
Both the Education and Science Councils should take leading and connected roles in Government's addressing of gender inequity issues in STEM.
(See also our response to Q6.)

What role should the science and research community, along with industry, play in addressing these issues?

AMSI response: *A shared focus on coherent messaging, joint and complementary programs is fundamental. We strongly recommend a shared public awareness campaign involving explicit industry endorsement of the importance of STEM trained women in business. We also recommend broadening the advocacy base beyond single role models to female peer groups, especially in higher education, agencies and industry.*

Workplaces in general are getting better at saying the right things but adopting methods for actually making a difference is another story. Employers need to be seen to be taking action and to mean what they are saying both in encouraging and increasing STEM trained women on staff and in combating the negative attitudes that are still prevalent.

Are current initiatives focusing on the right areas? What existing initiatives do you think are particularly effective at encouraging greater participation of women and girls in STEM education and careers (including those managed or funded by government, and those led by the science, education and industry sectors)?

AMSI response – correct areas for focus: *In our view there is insufficient focus on students, parents and teachers in schools. The pipeline of female STEM graduates is most fragile in schools. This appears to be particularly so in mathematics. It will be fatal not to address these issues in parallel with those in higher education and employment[1]. We advocate a co-ordinated, whole of school approach combining student pedagogy and career planning, teacher awareness and training, and parental engagement both in supporting their daughters' learning and in encouraging them into STEM careers.*

[1] Some interesting evidence on this is provided in Stoet, G., & Geary, D.C. (2018). The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education. *Psychological Science 2018, 29*(4), 581–593.

Students

It is well known that the gender gap in mathematics participation and performance (and the physical sciences) is particularly evident among the highest performing students. It is vital that capable and high performing females be provided with sufficient support, inside and outside the classroom and at university. For example, it is not sufficient to be inspired once or twice a year at school by exposure to an inspirational female scientist, engineer or mathematical scientist.

School Teaching Workforce

It must also be accepted that teachers of science and mathematics are themselves STEM professionals and that the securing of this part of the STEM workforce, and female engagement in it, underpins the entire Women in STEM enterprise.

Pre-service teacher education. Gender and STEM issues should be addressed in primary and secondary "methods" courses in science, technology, and mathematics education. This will go some way to breaking the stereotyping of girls by teachers. AITSL standards for the process of teacher education program accreditation should more specifically include this requirement.

Streaming (ability grouping) practices for mathematics should be curtailed, not only is this happening at the secondary level[2], but is creeping into primary schools. Too many mathematics teachers (and school leadership teams) condone this practice, while shunning it for other subject areas. There is more research demonstrating that streaming is only marginally beneficial for high achievers but is devastating for lower achievers in particular. ACER reports on TIMSS and PISA have revealed that countries with high levels of ability grouping (and tracking) perform less well than in countries where there is less streaming.

Only about 57% of nearly 800 primary teachers who responded in a recent AMSI Choose Maths teacher survey conducted by ACER said that their training adequately prepared them for teaching mathematics in primary school. Worse still is that only 61% of this cohort of primary teachers who are primary trained to teach mathematics say that their mathematics training is adequate to teach mathematics. These numbers indicate clearly that pre-service training of primary teachers is not adequate in terms of preparing them to teach mathematics to students and, in particular, to girls who are more influenced by teachers' perceptions and attitudes. For example, it is known that amongst primary teachers, a

[2] Forgasz, H. (2010). Streaming for mathematics in years 7-10 in Victoria: An issue of equity? *Mathematics Education Research Journal, 22*(1), 57-90.

predominantly female profession, that maths anxiety is high. It is understood that mathematics anxiety is contagious, and that primary school girls are more susceptible than boys.

In Australia's secondary schools out of field teaching in mathematics is rife, running at more than 30% in Years 7-10[3]. We do not know if this is affecting girls more than boys but we do know that twice as many boys as girls take advanced mathematics in Year 12 and that the graduation of secondary mathematics teachers has slowed to a trickle. It is telling that of the large cohort of mainly female biological sciences graduates in our schools, very few are qualified to teach mathematics.

Parental influence

It is also relevant that adult numeracy rates are considerably lower amongst women than men. This goes along with a common misconception that mathematical competence is innate and more common in males. There is no such misconception about literacy. So, a new campaign to build parental (home) engagement with primary school mathematics is worth scoping[4].

The "Maths Multiplies Your Choices"[5] campaign in the 1980s was effective in making parents aware that their daughters' career choices would be limited by avoiding the highest viable level of maths. This campaign saw an increase in female participation in intermediate and advanced mathematics at Year 12. The lesson learnt was that a three year campaign does not deliver sustainable change!

AMSI response – effectiveness of existing initiatives:

AMSI collaborates with the Office of the Chief Scientist, Science Technology Australia, the Academy of Technological Sciences, the Academy of Science and State Chief Scientists in our public outreach on STEM issues.

We restrict ourselves here to a description AMSI's current programs, all of which operate and are effective at national scale. We have three program areas: Schools, Research and Higher Education and APR.Intern. All three have a significant or dedicated focus on female participation in the mathematical sciences and STEM in general.

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[3] Wienk, M (2017) Discipline Profile of the Mathematical Sciences. Australian Mathematical Sciences institute. https://amsi.org.au/publications/discipline-profile-mathematical-sciences-2017/
Weldon, P.R. (2016) Out0of-field teaching in Australian secondary schools. ACER. https://research.acer.edu.au/policyinsights/6/

[4] Such projects have been tried in Australia and elsewhere. For example, see Goos, M. (2004) Home, school and community partnerships to support children's numeracy. Australian Primary mathematics Classroom, 9(4), 18-20 (2004).

[5] htt://amsi.org.au/publications/maths-multiplies-choices/

1. **CHOOSEMATHS (2015-219)**

Changing community attitudes to maths is necessary to improving female participation in STEM. CHOOSEMATHS, supported by the BHP Billiton Foundation, is AMSI's flagship Schools Program. Through CHOOSEMATHS we aim to increase participation, engagement, enthusiasm and confidence in mathematics demonstrated by Australians of all ages, particularly girls and young women. A five-year (2015 to 2019) program, CHOOSEMATHS works across four components with an underlying research stream that both informs and evaluates the work undertaken:

- *Schools Outreach delivered on-the-ground in 120 Australian schools. Based on a cluster arrangement, where a secondary school and up to three of its feeder primary schools are formed into a professional development group. Teachers work with an AMSI Outreach officer to focus on enhancing content knowledge in mathematics. Teacher support is face-to-face, and online through www.calculate.org.au*
- *Career Awareness Campaign - A national public-awareness campaign to help students, their teachers, parents and the public see that rewarding and interesting careers exist for people who 'stick with maths'. See www.careers.amsi.org.au The program has taken advantage of social media, radio, public transport, outdoor billboards to get the message out there as well as delivering materials to schools and through careers events across Australia to continue the discussion.*
- *CHOOSEMATHS Mentoring introduces Year 9 and Year 10 girls to the community of mathematical high achieving women and men currently working in industry and business.*
- *Teachers are very good celebrating their students' achievements but are seldom celebrated for their own. The CHOOSEMATHS Awards for Excellence in the Teaching and Learning of Mathematics rewards high achieving teachers and showcases student videos portraying important areas making connections between mathematics and their daily lives. There is an emphasis in the teacher awards on exceptional initiatives involving girls.*

2. **Securing Australia's Mathematical Workforce (2016-2020)**

This joint program with the Department of Education and Training delivers AMSI's flagship research training program in the mathematical sciences. Increasing female participation in these programs and in tertiary studies involving mathematics and statistics is a major deliverable. The 2017-18 Participation Report is available on request. See https://highered.amsi.org.au/ for details

3. **Supporting more women into STEM careers: National Research Internships Program (2017-2020)**

   The program objective is to support industry–based training of PhD research students in all Australian universities to increase their employment opportunities, in particular for women in STEM fields. The program will place 1400 PhD students into research internships with private and public sector organisations across Australia from 2017 to 2020. We are aiming to reach 40% female participation in 2018. This will be a significant milestone given that female PhD enrolments across engineering, ICT , mathematical and physical sciences runs around 25%. We will be hoisting a major event on 4 September 2018 at Engineers Australia to showcase a variety of Women in STEM programs from major private enterprise, the academies and professional organisations. See details at https://aprintern.org.au

What gaps exist in current efforts that the Government could address?

AMSI response: *The evidence base required for policy and investment is severely under-developed. Without a disciplined approach to data gathering it is not possible to monitor trend in key indicators such as the geographic, business or research distribution of female STEM graduations and employment. For example, it appears to have gone unnoticed that the number of domestic female students taking honours degrees and PhDs in key STEM disciplines has been declining for the last five or so years.*

Of course, having accurate trend data then requires the capacity for modelling shortages and remediation strategies. It is not clear that this capacity is always readily available to Government.

Is there anything else the department should consider in developing the Strategy?

AMSI response: *There is the appearance of manifold activity in the Women In Stem space. It is not easy to see how much is real and/or at scale. The Department might consider hosting a roundtable of the significant players with a view to identifying opportunities for*

collaboration at various levels. To this end we suggest that the department resource an audit of existing programs with a view to identifying the significant participants.

Sustainability is vital for Women in STEM initiatives because of the depth and duration of the problems contributing to the gender imbalance. The department should consider the sustainability issue and the related evidence gathering as an important project. The program audit and the roundtable we are suggesting would be an asset to this sustainability study and it would greatly assist forward planning for current and future contributors.

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