Submission

This is a joint submission representing the shared perspectives of the Australian Association of Mathematics Teachers (AAMT), the Australian Mathematical Sciences Institute (AMSI) and the Australian Mathematics Trust (AMT) on the importance of sustained measures to nurture and grow a quantitatively literate workforce in Australia.

The delivery of a high-quality labour force of quantitatively trained people is the underlying driving factor that will facilitate national productivity growth, job security and wages, removal of barriers to employment, and will enable Australia to develop and participate in the industries of the future. With digital expertise increasingly pivotal to future workforce capability; and Australia's identified Critical Technologies all requiring expertise that is highly quantitative in nature, the mathematical sciences must be recognised and fostered as a vital foundational skill for Australia's capacity, productivity and competitiveness.

AAMT, AMSI and AMT represent a broad coalition of the mathematical sciences in Australia with expertise in mathematical education across the entire workforce pipeline as well as industry engagement.

Overview of the Australian Association of Mathematics Teachers (AAMT)

The Australian Association of Mathematics Teachers Inc. (AAMT) is the leading organisation that supports and promotes mathematics education in schools in Australia. AAMT was established in 1966, has charitable status and is a federation of mathematics teaching associations in each state and territory. The work of AAMT includes:

- The continuous professional development of teachers of mathematics across Australia
- The provision of publications, resources and support for mathematics teaching and learning
- Communicating and advocating for mathematics education
- Providing policy and strategic advice to government and other parties
- Collaborating with a wide range of stakeholders in research, projects and other initiatives that further mathematics education in Australia

Overview of the Australian Mathematical Sciences Institute (AMSI)

AMSI is Australia's peak body for the mathematical sciences in Australia. Members include Australian universities, professional societies and government agencies, with a shared mission to champion the mathematical sciences for Australia's advancement. AMSI was founded 20 years ago to ensure the mathematical sciences propel Australia; and its activities include programs that support the mathematical sciences pipeline and careers, policy research and advocacy. AMSI has been deeply connected to industry through its national PhD internship division since 2008.

Overview of the Australian Maths Trust (AMT)

The Australian Maths Trust is a national not-for-profit whose mission is to be a leader in helping young Australians realise their problem-solving potential using maths and algorithmics. It has been delivering a range of competitions, enrichment, mathematical and

informatics Olympiads and STEM programs and other activities and resources for teachers and students since 1978. It will be hosting the International Mathematical Olympiad in Melbourne in 2025.

I. The emerging workforce

Children and young people are the emerging pipeline of future workers across all industries as well as the next generation of school and university educators. The importance of equipping this generation with a solid education in mathematics is critical to underpinning its capacity to exploit and drive innovation and problem solving across STEM based industries in the future.

While growth in STEM occupations grew by 85% in the 20 years to February 2020[1], maths anxiety is driving many young people away from the subject and therefore, future study and employment opportunities:

> 'People with heightened levels of math anxiety often experience a lifelong tendency to avoid math, math-related situations, career paths that require math, and most notably, courses and degrees in Science, Technology, Engineering, and Mathematics. In short, there is evidence that math anxiety negatively impacts math performance and can influence how one experiences and interacts with the world.'[2]

This phenomenon has been persistent amongst young Australians:

The proportion of students taking more advanced, calculus-based levels of mathematics as their "highest" maths subject has been in long-standing decline. The latest data from 2020 show a further additional drop that takes maths participation in Year 12 to an unprecedented low. While in the last decade or so Year 12 enrolments in mathematics in Australia seemingly remained stable – albeit at a low level – as a proportion of all students who complete high school exams, things took a turn for the worse in 2020. While during the past decade typically around 71-73% of Year 12 students were enrolled in one or more mathematics subjects, this percentage suddenly dropped to a mere 66% in 2020.

In order to ensure that a sufficient number of young Australians are prepared and motivated to pursue further mathematical or scientific study and employment, we need to equip teachers, students and parents with the capacity to address maths anxiety.

Australia needs to put in place sustained measures to engage Australian youth, by nurturing their curiosity and fostering enthusiasm for the mathematical sciences in every way possible: in and outside of school, in the media, and in wider society. Emphasising the career opportunities that arise from mathematical ability should be a broad-based national effort.

Emerging workforce recommendations:

1) Provision of targeted training of pre-service teachers on how to identify and mitigate maths anxiety as part of their university training,
2) Provision of micro-credentials for practising teachers on addressing maths anxiety in the classroom,
3) A nationwide initiative to address maths anxiety and improve awareness about quantitively focused careers, including among underrepresented student populations, parents, teachers, career professionals, industry and the general community, promoting the mathematical sciences as the foundation and gateway to an

abundance of career choices, and options in Australia's areas of critical technologies.

4) Removing barriers in the school and university system that provide a disincentive for students to engage with mathematics and re-introducing clear prerequisites to ensure a better transition from school to tertiary education.

1 https://www.nationalskillscommission.gov.au/reports/state-of-australia-skills-2021

2 "Disentangling the individual and contextual effects of math anxiety: A global perspective" (N Lau, Z Hawes, P Tremblay, D Ansari, Proceedings of the National Academy of Sciences, 2021)

II. The current workforce

The issues of teacher supply in the workforce were significant before the onset of the Covid-19 pandemic. The pandemic has exacerbated and accelerated the challenges that already existed. There is a need to respond to these in innovative ways. The challenges need to be considered in three distinct categories:

- Increasing the supply pipeline (both for new graduates and second career candidates)
- Reducing attrition rates in in-service teachers particularly those in their first 5 years of the profession.
- Supporting the retraining needs of teachers currently teaching subjects that are not their area of expertise or undergraduate qualification.

Supply pipeline recommendations:

1) The supply pipeline needs to be strengthened by ensuring that teaching is an attractive prospect to all. This includes look at methods of stimulus in attracting students into the profession.
2) Additionally, for those potential second-career candidates, supporting the transition across and any retraining is fundamental to ensuring that these candidates can actually fiscally make the move.
3) A proactive partnership with industry to identify and target the best candidates should also be advocated for. This has benefits for both the teaching profession, industry and the labour workforce lifecycle in general.

Reducing attrition recommendations:

1) Teachers continue to leave the profession at an alarming rate. This is particularly true for those who have served for less than five years in the classroom. Whilst the workload issues are beyond the scope of this White Paper, there are other considerations that are not. Advocating for a way that teachers can stay connected with the applications of the subject is critical in ensuring that teachers are retained but also in ensuring that the quality of learning and teaching meets the
2) Needs of the higher education and employment market. As such, strengthening of industry partnerships are a critical component of building effective and adaptable education in the months and years ahead for Australia.
3) Mathematics is a dynamically changing landscape. Thus the importance of teachers understanding its relevance and impact in the current world cannot be overstated.

Retraining needs recommendations:

1) The number of teachers teaching mathematics who did not enter the profession as a teacher of mathematics is increasing. We know from the AITSL teacher workforce study published in December 2021 that somewhere in the region of 40% of mathematics classes across the country are taught by non-specialist teachers each and every day. This has a direct impact on the

workforce cycle. Teachers who do not fully understand the beauty, application and importance of the subject cannot impart this to students. As such we must facilitate necessary retraining for those teacher who identify as needing support in delivering this crucial subject.

III. Higher education and industry

Skills shortages

Between 2008 and 2020 the number of domestic students starting university has grown substantially, from roughly 180,000 new bachelor students in 2008 (106,000 in the 16-19 age group) to more than 256,000 in 2020 (with over 139,000 between the ages 16-19). The number of domestic students embarking on an undergraduate STEM degree grew by more than 65%, from 35,498 in 2008 to 59,562 in 2019. Many degrees in other areas such as Management and Commerce and Health also have significant quantitative components. Annual new enrolments in undergraduate Health degrees alone increased by over 80% in the same period. However, the increasing academic aspirations have not been accompanied by a similarly growing take up in Year 12 of mathematical subjects at intermediate and higher levels intended to prepare students for university study in these types of degrees.

Meanwhile, industry demand for graduates with quantitative skills has been growing rapidly in recent years, with Data Science specialists particularly popular. Fuelled in large part by immigration, between 2016 and 2021 the mathematical workforce between the ages 20-39 has doubled. Of all mathematical sciences graduates between 25 and 34, 47% have arrived in Australia between 2011-2020, while only 39% were born in Australia. The high demand is visible in the increasing salaries of mathematical scientists, with new Coursework Postgraduates now commanding average starting salaries over $100,000. The high demand and excellent remuneration available for those with an interest in mathematical sciences has compounded the already substantial difficulties in attracting enough young people to become maths teachers, which has been addressed above.

Gender diversity

While female participation in mathematical sciences has gradually and continuously increased over a long period of time, the participation level seems to have stagnated in recent years. The cohort of the mathematical workforce aged 35-39 in 2021 has nearly reached gender parity at 48%. However, the younger cohorts following behind it have not reached the same participation level (44% of 30–34-year-olds, and 37% of 25–29-year-olds). Continued efforts to increase female engagement with the mathematical sciences – besides for reasons of increased participation, job security, and eliminating the gender wage gap - will also be essential to increase the homegrown supply of people with quantitative talent.

Inequities between students from metropolitan and rural, regional and remote areas

The number of students studying mathematical sciences at universities located in rural, regional and remote Australia, has not increased at the same rate as for metropolitan Australia. Regional universities often struggle to attract enough students to implement a complete mathematical sciences curriculum.

Improving work-readiness of new graduates

It is well understood that Australia has fallen behind international trends which see more research trained staff employed in the private sector and increasing numbers of university-industry collaborations across all disciplines. The problem here is two-fold: the long-term lack of interest in research capacity in some sectors of the economy and the disconnect

between the research training system and Higher Degree Research (HDR) graduate employment outside of academia. There are two aspects to this: work-readiness of new graduates and deploying research talent in industry to boost innovation, research and development outside of academia.

Deploying research talent in industry

Australia's PhD graduates in the mathematical sciences (which include mathematics, statistics and data science) have the skillsets to help industry unlock innovation, competitiveness and productivity advances. Australia has more PhD students in STEM fields coming through the system than ever, with not enough jobs in academia to support a career as an academic. In the last decade the number of PhD graduations in STEM increased by 63% - with the largest growth by far coming from international students.

The post-study work rights conferred upon international graduates are necessary to allow the student to remain and contribute to Australia's productivity, but not sufficient to provide industry with the confidence to take them on. A proven way to assist in the confidence to employ international PhD graduates is through internships, where industry get to test skills and fit for a short period, with no obligation.

Recommendations for addressing the skills shortages:

1) Continued focus on gender diversity in mathematical sciences and STEM subjects in general by addressing underlying impediments for female participation, such as maths anxiety and gender stereotyping. At universities, drive up female retention into honours and postgraduate programs from the undergraduate cohort through embedded diversity in STEM events, dedicated travel scholarships, participation of high-profile role models. It is particularly important that female contributions in tertiary education and in research are clearly visible to girls in schools and Ambassador programs remain important.
2) Addressing the inequity between regional and metropolitan higher education offerings through supporting initiatives that facilitate collaboration between universities to jointly offer mathematical sciences subjects. Given that students are more used to online learning and distance education than before the pandemic, the existing Advanced Collaborative Environment facilitated by AMSI has become ever more popular but lacks sustained funding.
3) Improve work-readiness for STEM students through building professional networks, providing careers advice, organizing opportunities for students to meet industry, facilitating research collaborations, building communication skills, targeted workshops ad schools dedicated to topics informed by new developments and industry priority areas. Provide sustained funding for this.
4) The introduction of a new rebate program to assist with the cost of a PhD intern for Small to Medium Enterprises (SMEs). A 50% or higher rebate will significantly stimulate the take-up rate by SME's and provide an immediate boost to the workforce of the highest quality research skills that will help drive innovation and productivity.