AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

February 16, 2018

Office of the Chief Scientist
Industry House
10 Binara Street
Canberra City ACT 2601 Australia

Dear Dr Finkel,

The Australian Mathematical Sciences Institute (AMSI) welcomes this opportunity to respond to the STEM Partnerships Forum's Issues Paper.

Closer engagement of industry with Australia's schools is highly desirable as we build an innovation system driven by Australian talent. Making a clear and real connection between the school mathematics and STEM jobs has manifold benefits in this context.

As the national advocate for the mathematical sciences, AMSI has a significant body of policy recommendations and submissions concerning the education system, which we invite you to review. These documents can be found on our website at http://amsi.org.au/publications_category/publications/submissions/.

Australia's mathematical sciences pipeline is critical to the nation's STEM capacity. But it does far more than support science, engineering and technology. It is a direct and crucial contributor to a world so dependent on data acquisition, data analysis, data security and simulation.

While our discipline has a strong record in individual research and in research training, the pipeline has some major challenges. Mathematics is in dire shape in our schooling system with declining number of students studying intermediate and advanced maths at Year 12, the almost complete absence of mathematics prerequisites for STEM degrees, significant gender imbalance and some of the worst out-of-field teaching problems in the OECD.

These critical failings must be considered when scoping industry-schools engagement. On the one hand they indicate a lack of school capacity, especially in low SES, regional and rural areas. Secondly, the lack of prerequisites and the prevalence of ATAR gaming could derail the best intentions of all parties.

AMSI commends the work of the STEM Partnerships Forum and we look forward with some optimism to the adoption of its recommendations.

Yours sincerely,

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Optimising STEM Industry-School Partnerships: Inspiring Australia's Next Generation Issues Paper

AMSI Submission
February 2018

Comments on the Provisional Recommendations

- *Chapter 1: STEM in Education and Work*

Provisional recommendation:

1. Universities should reinstate prerequisites for university entry with the aim of ensuring that students study STEM subjects in senior secondary school so that they are well prepared for further study and work.

Comment:

Suggest rewording: the current wording incorrectly implies prerequisites were previously universal. There may also be confusion between prerequisites for university subjects versus university courses.

- *Chapter 3: Teacher Professional Development*

Provisional recommendation:

3. There should be a greater emphasis on discipline-specific professional development for teachers of STEM education, with a role for industry in connecting teachers with the latest developments in the field.

Comment:

The scale of out-of-field teaching should be recognised here.

- *Chapter 4: Solving Real-World Problems – Careers Awareness*

Provisional recommendations:

5. Governments and industry should focus the public narrative on the prospect of well-paid jobs and the increasing importance of STEM skills and 21st-century skills in the future economy.

6. Industry should develop communication activities to illustrate real-world problems and change perceptions of STEM careers for students and parents.

7. Industry should contribute to positive perceptions of STEM careers through hosting site visits, supporting events and collating and distributing relevant materials for teachers and students.

8. Industry should be encouraged to showcase the success of underrepresented groups in STEM related careers as role models in their engagement with primary and secondary schools.

Comments:

We suggest explicit and persistent public endorsement of STEM education and STEM careers by prominent industry CEOs and aimed at parents.

We strongly recommend clear and unequivocal advice to students, teachers and parents about the mapping of school science and maths subjects to STEM professions.

- *Chapter 5: Outcomes and Impact*

Provisional recommendation:

10. Industry and industry associations should develop and provide data about future workforce needs, including vacancies and the skills required of employees both in STEM specific areas and areas where STEM skills are valued. This data should be collected in a centralised national repository and made freely available to maximise its use.

Comment:

The recent GOS outcomes for Natural and Physical Sciences (https://www.qilt.edu.au/about-this-site/graduate-employment) are particularly unhelpful in this respect. The apparent oversupply of biological sciences graduates threatens the credibility of 'bountiful STEM jobs' claims. The GOS should drill down to discipline level.

Chapter 1: STEM in Education and Work

1.1 What are the STEM skills the future workforce will need and that industry would like to see strengthened?

Mathematical sciences skills:

(a) Statistics (data science): acquisition, processing, analysis and visualisation of data
(b) Computational science skills: modelling and visualisation
(c) Optimisation
(d) Mathematical content knowledge from number theory (cryptography) to geophysical fluid dynamics (weather/climate, defence)

1.2 What are the STEM skills the future workforce will need and that industry would like to see strengthened?

Coding and data science-related ICT.

1.3 Should industry focus its efforts on strengthening discipline-specific knowledge, or developing 21st-century skills? Why?

Both: many maths teachers are teaching out-of-field and require more discipline-specific knowledge. '21st-century skills' are insufficiently emphasised in school maths and science subjects (and in science degrees, as opposed to engineering and ICT degrees).

1.4 Are 21st-century skills fundamentally different and more challenging than 20th-century skills?

No! By the definition in the 'What is STEM' box, '21st-century skills' have been a focus for employers and (some) university STEM educators since last century. In schools the English curriculum can, and often does, provide a vehicle for the development of these skills.

1.5 Are NAPLAN, PISA and TIMSS appropriate for measuring achievement in the skills we are aiming to teach? If not, what assessment tools would be better?

We ignore the results of NAPLAN, PISA & TIMSS at our peril.

1.6 Is the ATAR sending the wrong signals to schools and students about choosing science and mathematics subjects appropriate for anticipated university courses? What is the evidence for this and how can this be addressed?

Dependence on ATAR scores alone (as opposed to a basket of relevant subject scores), and in the absence of appropriate prerequisites, is indeed sending the wrong signals. This is evidenced by the exodus from calculus-based mathematics, physics and chemistry and the widespread ATAR gaming practices of some schools. Introducing relevant tertiary course prerequisites and replacing ATAR with a more sophisticated approach based on relevant subjects may rectify the current serious situation.

1.7 Do you agree with the premise that the lack of prerequisites for entry into university courses sends the wrong signals to schools and students? What is the evidence for this?

Yes! See 1.6 above; in this regard, see http://amsi.org.au/publications/improving-australias-maths-grades/.

Chapter 2: The Role of Industry

2.2 Can you please provide one or more examples of school industry partnerships in STEM areas that are working well? What are the key elements of the partnership that make it successful?

An industry group that seems to work well with schools: the Regional Development Association (http://rdahunter.org.au/initiatives/2018-stem-workforce-conference) in Newcastle has run conferences for a while where schools and industry catch up for exactly these types of conversations.

2.3 What are the barriers to creating effective school-industry partnerships?

a) What actions could schools take to encourage industry to develop partnerships and support STEM education in schools?

Utilise the common Year 10 Work Experience programs. This has the advantage of leveraging existing resources and minimising dislocation of the school year. It also has the advantage of breathing new life into a program which is 'rusted on' in some jurisdictions.

b) How can universities and vocational training institutions help industry to develop partnerships and support STEM education in schools?

Universities (and scientific institutes and agencies) can open their STEM facilities to engage with Year 10 Work Experience programs.

c) How can governments help?

Mandate and fund the engagement of their scientific agencies.

2.4 What resources or guidance materials would be most useful to encourage, or improve the quality of, industry partnerships with schools?

Toolkits for engagement through Year 10 Work Experience programs and 'Scientists/Mathematicians in Schools' programs, including a Ribit-type (https://www.ribit.net/) match-making portal.

Chapter 3: Teacher Professional Development

3.1 What role should industry and tertiary institutions play in supporting teachers of STEM disciplines in their ongoing professional development? What should they avoid doing?

We suggest that industry and tertiary institutions partner with peak bodies such as AMSI, Engineers Australia, AAS, ATSE, AAMT and ASTA to produce online resources for teachers delivered through Scootle by ESA. It is important to avoid ad hoc resourcing and delivery.

3.2 How can industry and tertiary institutions best support professional development in STEM discipline-specific knowledge, applied practice in industry and focused on 21st century skills?

See above.

3.3 What resources can industry make available for teachers? How can industry help teachers link what they are teaching to job opportunities?

This is an interesting idea and could be pursued with ESA by linking topics in the various Australian Curricula to career profiles. We suggest a pilot.

3.4 Would work experience or mentoring programs for teachers be valuable and feasible? Please provide successful examples, and also examples of challenges.

We suggest programs of this type be introduced to pre-placement training programs for teachers.

3.5 What role could industry play in supporting out-of-field STEM teachers to gain deeper subject knowledge?

Industry should advocate to government on this important issue (see AMSI's policy document http://amsi.org.au/publications/improving-australias-maths-grades/). Industry perspectives could form part of structural professional development for out-of-field teachers, especially around STEM careers. It should be noted that these teachers tend not to undertake PD outside of their normal faculty, so are further disadvantaged by not getting access to PD in their out-of-field area.

3.7 What role should industry play in supporting the ongoing Professional Development of careers advisers?

This should be actively pursued to overcome the tendency for some careers advisors to focus on ATAR scores rather than optimising study pathways.

Chapter 4: Solving Real-World Problems – Careers Awareness

4.1 Language is important:

a) Is the term 'STEM' a barrier to reaching a diverse audience? If so, what terms would be more appropriate?

For schools and teachers, STEM seems extra-curricular and adds an additional layer of demand on resourcing. Maths often gets lost in dedicated STEM programs.

b) Instead of promoting 'STEM related careers', should we be asking young people what skills and knowledge they will need to solve real-world problems in a technology-rich world?

We suggest clear and unequivocal advice to students, teachers and parents about the mapping of school science and maths subjects to STEM professions. Current careers documents do NOT provide this advice, e.g. the 'bulls-eye' charts at https://docs.education.gov.au/node/21546.

4.2 How can schools and industry work together to help young people understand the ways that STEM skills can be used to solve real-world problems and prevent any mismatch between what a student studies and what they need to study to fulfil their career aspirations in STEM and non-STEM occupations?

a) What information about solving problems using STEM skills and STEM careers could industry provide to schools?

Ubiquitous public endorsement by industry; national career-awareness campaigns including personal case studies, e.g. AMSI's Choose Maths and STA's Superstars of STEM. Job ads, e.g. AMSI's Maths Adds.

b) Would a greater focus on work exposure or experience in STEM areas increase future participation in STEM disciplines?

Yes, for example the University of Melbourne's Faculty of Science runs a Year 10 Work Experience program with exactly this intention. An online match-making portal will help.

4.3 How can industry communicate best with parents so that they can have informed conversations with their children about the benefits of STEM and STEM-related careers?

Through a national awareness campaign. It is not enough to talk about 'science jobs' or 'maths jobs', parents and students need a clear idea of what's involved. Industry needs to create professional profiles akin to those for medical doctors and lawyers.

4.4 How can industry best assist teachers, career advisers and other influencers of student career aspirations?

By demonstrating explicit linkages between curriculum and careers, e.g. linear equations and the warehouse problem.

4.5 How can schools and industry work together to provide support, increase confidence and raise aspirations for all students in STEM related education and STEM-related careers, particularly from the following under-represented groups?

a) Girls
b) Aboriginal and Torres Strait Islander students
c) Students from low socio-economic backgrounds
d) Students from regional, rural and remote areas

AMSI's Choose Maths program (http://choosemaths.org.au/) and CSIRO's Indigenous STEM Education project (https://www.csiro.au/en/Education/Programs/Indigenous-STEM), both funded by the BHP-Billiton Foundation, are exemplars of such partnerships.

Chapter 5: Outcomes and Impact

Comment: many of the questions about Chapter 5 require hard data which should be gathered from industry.

5.8 Is there any workforce data that industry can contribute to improve our understanding of the STEM pipeline, for example around workforce planning or recruitment activity?

Yes! Communicating current and future recruitment demands to school communities will help make subject choice real for teachers as well as students and parents. So, Ai Group and the BCA could run campaigns to make this data accessible to schools (Provisional recommendation 10).