



## Australian Academy of Science

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### Optimising STEM – Industry School Partnerships: Inspiring Australia's Next Generation. Issues Paper

The Australian Academy of Science (the Academy) strongly supports the mission to develop a framework for industry to play a greater and more constructive role in enhancing the role of STEM in Australia's education system.

The [National STEM Education Strategy](#) offers a useful backbone to achieve this. However, it will only be successful if all actors are involved in a national scale solution.

The Academy notes that the lack of real and effective industry engagement is not a new problem. Industry has, for decades, lamented the preparation of students to take up employment. The situation now is past the stage of hand-wringing and talking, and it becomes more critical to do something about it with every passing year. Accordingly, the Academy is working to bring its programs, expertise and successful track record to the table to make real and lasting improvement in STEM education.

The Academy is of the view that the Australian STEM Partnership must enable interventions that fill four critical gaps:

1. Establish coordinated and national-scale reform in both supply and demand for STEM talent (ie, enhance supply, enhance employment and minimise talent loss).
2. Select STEM interventions that have a national focus, but are applied locally to mitigate risk factors such as differing teacher and student abilities, geographic locations, and gender.
3. Establish a common tool to evaluate STEM education activities
4. Enable mobilisation of impact investment opportunities for deployment of private sector and investment capital to leverage strategic and targeted government funding.

The recommendations below primarily focus on the first of these gaps (to enhance supply) and draw on the Academy's three decades of experience in developing and delivering science and mathematics education programs in primary and secondary schools.

#### The Academy's role in STEM education

The Australian Academy of Science offers three STEM education programs to primary and secondary teachers and students: *Primary Connections* (formerly Primary Investigations) began development in 1995, *Science by Doing* in 2007 and *Resolve: Maths by Inquiry* in 2015. These programs draw on the expertise and standing of the Fellows of the foremost body of scientists and mathematicians in Australia. The programs are award winning and independent evaluations undertaken to date show that they have an impact on teaching and learning.

Each of the three programs include features to improve teacher quality through professional learning and improve students' skills through a guided inquiry approach that enhances problem solving ability, science literacy and numeracy. Teachers, schools and classrooms that have implemented the programs attest to their impact, and independent program evaluations support this finding (see metrics provided in Appendix A; additional evaluation data are available on request). The resources and training are widely available to schools at low or no cost to them. The programs reach hundreds of rural and remote students and teachers.

Through its years of experience, together with its longstanding engagement with teachers and schools, the Academy is acutely aware that more needs to be done.

Consequently, the Academy has been actively working on three key fronts:

1. Preparing to integrate our three programs and take them into **all** schools in Australia, rather than the present sub-set, in order to play our part in reversing the decline in performance in science and mathematics in too many of our schools;
2. Building **partnerships** with industry to further develop our programs and to encourage wider understanding of the need for higher levels of scientific literacy and numeracy in our community and workforce.
3. Exploring **enhanced delivery** of its programs such that interactive adaptive learning tools can monitor student performance in real time and assist teachers in nipping problems in the bud. Ideally, evaluation solutions adopted in the classroom would complement national evaluation tools.

By working with teachers and students in primary and secondary schools, and by working in partnership with industry, the Academy believes it can play an important part in producing the skills that Australia needs as it prepares to secure a stable, prosperous and safe future for itself.

## Recommendations

While the Issues Paper presents numerous questions and observations, our submission makes six specific recommendations that mainly address the **supply and retention of STEM talent** and that seek to address the 4 critical gaps identified on page 1 above.

Although not explored in detail, the Academy acknowledges the importance of demand side considerations that impact STEM in Australia: mobility of specialist STEM skills; portability of intellectual property; consequences of over reliance on overseas recruitment; equitable workplace environments particularly in regard to gender.

**Recommendation one: Scale up. The Academy maintains that declining national STEM performance will not be reversed until STEM activities that have proven impact on teaching and learning reach national scale.**

Like industry, the Academy is concerned about the decline in science and mathematics performance in Australian schools. This decline is occurring despite investment in a myriad of education programs to address the issue by successive governments. Over the past twenty years, Australian teachers have been offered a profusion of STEM resources and programs produced by a range of public and private providers. The STARPortal (itself a collaboration between Government and Industry) -

Australia's first and impressive centralised national portal that provides visibility to all of the STEM activities available to students, teachers and parents - currently lists 493 activities. While these may meet some needs, no single program is truly of national scale and reach, and many are not scalable.

Likewise, there are no common data frameworks nor common impact metrics applied to the activities, thereby preventing both evaluation of their respective impact and the aggregation of meaningful national data.

The Academy's education programs are proven and scalable. That is why we are now preparing to integrate our three programs and take them into **all** schools in Australia. Partnerships with government and industry will be critical to achieving this and to building the STEM skills and workforce the nation needs.

**Recommendation two: National gains cannot be made in the absence of able and confident STEM teachers. This necessitates a national and coordinated focus on professional learning and STEM teacher recruitment.**

Well-trained, well-supported and motivated teachers play a critical role in engaging students and embedding in our children and young adults a lifelong understanding and appreciation of STEM. The role of teachers in Australia's 9,400 primary and secondary schools cannot be understated, but all too often the support they require is lacking.

The Academy is well recognised for the quality of its professional learning. We have devoted significant resources and energy to developing and promoting inquiry-based teaching resources for teachers in science and mathematics from Foundation to Year 10. The Academy is actively involved in pre- and in-service teacher training for both in- and out-of-field teachers.

In primary schools, over the period 2014 to 2017, the Academy has focused on delivering professional learning to teachers in disadvantaged schools as well as teachers in regional and remote locations. In just three years we have reached 880 in-service teachers and 1324 pre-service teachers in this vulnerable cohort.

Our resources have been developed and guided by rigorous evidence and external review of guided-inquiry learning and best practice teacher professional learning from Australia and abroad. They support learning outcomes in the relevant Australian curricula and are widely recognised and highly-regarded across the Australian school education sector and internationally.

Above all they have been shown to be effective through independent evaluation.

A summary of the current programs along with a small selection of teacher testimonials is included at **Appendix A**.

The Academy stands willing to work with the Forum, Australian and State and Territory governments, universities and industry to expand our proven professional learning approach to reach more teachers than ever before. We propose that our approach be coupled with the development of a facilitated community of practice amongst teachers that would offer peer support and enable shared learnings.

Outside of the Academy's jurisdiction, but equally important, is the need to ensure teachers have an adequate number of dedicated hours for accredited professional learning in STEM content and pedagogy, both during their training and while in service.

**Recommendation three: Bring STEM to life for teachers and students**

A national framework is needed to support large-scale partnerships between schools and industry. It should offer guidance and support to industries of all sizes to enable their engagement within schools. It should also be designed to be flexible and responsive so that businesses can respond quickly to new challenges such as cybersecurity and artificial intelligence.

In particular, programs that promote and encourage meaningful industry partnerships with schools in regional, remote and disadvantaged areas should be specifically identified and assisted. Attention should also be given to partnerships between schools and public sector STEM agencies and organisations, such as CSIRO, Centres of Excellence, CRCs and Questacon.

Curriculum content and scientific principles need to be contextualised with real life examples and applications that enable students to realise the diverse career paths their studies can lead to. Gender issues need to be appropriately and carefully managed in this regard. The Academy's primary and secondary curriculum resources currently contain several references to industry in order to contextualise learnings, but a national framework is needed to scale up content of this nature.

Host visits by students to local industries offer a practical mechanism to see STEM in action. While large Australian firms may have the capacity to routinely host students or visit schools, it is likely to be beyond the ability of small and medium businesses to devote time and resources to such an endeavour. Consequently, guidance and potentially incentives could be offered to small firms to create and maintain connections with local schools.

Programs aimed at encouraging industry participation in teacher professional learning would be of additional benefit. However, such programs should complement, not replace, evidence-based curriculum-linked professional learning programs.

Industry efforts to contextualise and promote diverse STEM careers could also be achieved by their involvement in a much needed national and ongoing public awareness campaign.

**Recommendation four: Preparing and retaining the future workforce**

While the specific nature of future workforce requirements cannot be predicted with accuracy, it is clear that in order to remain competitive Australia's economy will need a greater proportion of firms and employees producing high-value, knowledge-based products and services. Much of the knowledge needed will require at least a solid grounding if not discrete specialisation in STEM.

The current pipeline of school and university STEM students is inadequate to meet future demand for highly skilled STEM professionals. In the absence of such skills, the workforce of the future, and indeed Australians, risk being left behind.

Students with adequate and appropriate preparation for STEM related university degrees are likely to perform better and complete their degrees. It is for this reason that STEM studies in senior secondary years are so important.

The Academy strongly supports the principle of STEM pre-requisites for relevant university degrees. However, the reintroduction of pre-requisites necessitates an analysis of the impact and influence of ATARS on student choices in senior secondary school. Therefore, the Academy recommends that a review of the ATAR system, its impact on student subject choice and its use and relevance in contemporary university admission be undertaken.

**Recommendation five: National evaluation is critical to inform decision making.**

A rigorous approach to evaluation, identifying what works and why it is needed, is required in Australia. We suggest three initiatives:

- i. The multitude of well-intentioned and diverse STEM activities for students and teachers should be evaluated against their ability to meet both the needs of teachers and students and the needs of industry all over Australia.
- ii. A common data framework is required to capture national STEM education performance as an alternative to the PISA and TIMMS measures.
- iii. A STEM evaluation tool is needed to gauge the success of measures that may be introduced to facilitate school-industry partnerships.

This level of data capture would allow a clearer national picture without forgoing critical local level insights. Importantly, it could inform future investment decisions so that support is provided to those activities that have impact and meet identified national needs.

**Recommendation six: Financing our STEM future**

The Academy suggests that in developing a STEM Industry partnership, the Forum assess financing options, including social impact investing that would enable deployment of private sector and investment capital to leverage public investment in STEM education. This is required as it is unlikely that a single government department, organisation or business is adequately resourced to deliver the scale of change required to reverse the decline in STEM education.

**Concluding remarks**

The Academy would be pleased to engage with the Forum and Australian governments as this body of work progresses.

## ACADEMY SCIENCE AND MATHS PROGRAMS IN AUSTRALIAN SCHOOLS

The Australian Academy of Science has been developing and a strong track record delivering evidence-based school science and mathematics professional learning and curriculum resources to Australian teachers and students. Its flagship programs *PrimaryConnections* and *Science by Doing* are used by teachers and students throughout Australia and many other countries, and its newest program *reSolve: Maths by Inquiry* is generating great interest and uptake from teachers around the country.

### Curriculum resources

- **38 curriculum-linked primary science modules** (digital and hard-copy; Foundation to Year 6, linked to literacy)
- **18 interactive curriculum units** for high school (Years 7-10)
- **88 maths modules** and lesson plans covering every strand of the Mathematics curriculum for Foundation to Year 10
- Resources developed by curriculum experts and reviewed by hundreds of educational experts, teachers and scientists from Australia and abroad

### Reach

- **94%** of Australian primary teachers are aware of *PrimaryConnections*
- **290 reSolve Champions** from every state and territory selected for a 12-month professional learning and evaluation program during *reSolve* development and piloting.

### Partnerships

- Australian Association of Mathematics Teachers
- Australian Mathematical Sciences Institute
- Australian Science Teachers Association

### Professional Learning (PL) & Uptake

- More than **23,500 primary teachers** (including 2,200 preservice teachers) have participated in *PrimaryConnections* PL workshops
- **160,000 registered users** of *Science by Doing*, including 2 in every 3 high school science teachers
- **More than 2,500 maths teachers** and educators have subscribed to *reSolve* during pilot phase
- **32,000 regular users** of *Science by Doing* download 9 Terabytes of curriculum resources each month

### Impact

- *PrimaryConnections* has been shown to increase confidence and self-efficacy of teachers, and more collegial approach to PL and **more science being taught**
- *Science by Doing* results in **~50% increase** in student group work, cooperative learning and student investigation
- Comprehensive evaluation of all programs underway (reports due Feb, 2018)

### Support and recognition

- **Program support from the Australian Government** between 2004 and 2018
- [Numerous awards](#) for excellence in educational publishing

## WHAT OUR TEACHERS SAY

*I think the resources and the whole Science by Doing program is quite literally the best resource available for interactive and meaningful science teaching. I wanted to thank you and your team for designing everything in this magnificent set of curriculum activities.* **Maths and Science Teacher, Queensland**

*I highly recommend this workshop and think it should be compulsory! Primary Connections puts students in the driver's seat and encourages them to find answers to their own questions. This model should be encouraged in all teachers.* **Primary Science Teacher, WA.**

*The reSolve resources provide excellent opportunities for reflection and use of mathematical language. They cater for all levels and have excellent scaffolding to build students' skills and language. Discussions were very robust and it was lovely to hear the variety of ideas and sharing of concepts. The meaningful, hands on approach gave everyone the opportunity to contribute and share ideas.* **Primary Maths Teacher, NSW.**