

Optimising STEM Industry-School Partnerships: Inspiring Australia's next generation

A response to the STEM Partnerships Forum Issues Paper

On behalf of

The Australian Council of Deans of Science,
The Australian Council of Engineering Deans.

Collaborating for the evolution of STEM Education

STEM Industry-School partnerships should be at the vanguard of change in STEM education, and its adaptation to preparing citizens for work and life in 21st century Australia. There is a broad consensus that school STEM education needs to involve greater emphasis on authentic curriculum experiences that are meaningful to students, and to introduce '21st century' skills such as critical thinking, problem solving and working in teams. These elements are significantly under-represented in traditional science and mathematics curricula, and in the pedagogies that surround them.

STEM Industry-school partnerships offer the potential, not only of injecting contemporary STEM knowledge and practices into the curriculum experience of teachers and students, but also challenging default teaching and learning practices that are frequently criticized for their lack of fidelity to the diverse ways of thinking and working in STEM. They offer the potential to contribute to the significant re-invigoration of teaching and learning in STEM areas that is called for in so many reports.

However there is no general agreement, and considerable gaps in our understanding, about how these changes are to occur and what the resulting 21st century STEM education should look like. Many issues about the nature of the curriculum, the role and skills required of teachers, school management, and external relationship management, remain to be resolved. Moreover there are longstanding curriculum structures and traditional emphases that inhibit desired changes.

The Issues Paper appears neutral on these matters. However, we believe that advice to Education Council for the development of effective STEM-school partnerships needs to make them a primary consideration. Specifically, we believe that there should be a stronger focus on the particular role that these partnerships are intended to play.

We believe that STEM-school partnerships should be viewed as a collaboration towards the evolution of STEM education. These collaborations should enable teachers and their leadership to change practices and develop new understandings of STEM disciplines, their curricula and pedagogies, especially how they relate to each

other and to contemporary practices of STEM professionals. They should enable industry and community partners to understand the challenges of school STEM education and the value and rewards of their contributions to it.

We argue that the predominant focus of STEM-school partnerships should be on developing and managing facilitated interaction between teachers and STEM professionals towards these ends, at a school or school cluster level.

We ask the STEM Partnerships Forum to call upon the States, through COAG's Education Council, to adopt such a policy and set out a framework for the key elements that schools should include in their management of STEM-school partnerships. We accompany this submission with an example of such a framework that has been trialled and tested in schools over a number of years.

The Issues Paper catalogues a comprehensive list of concerns about STEM education in Australia —participation, achievement, teacher qualifications, primary education, secondary education, university prerequisites, the diversity of outreach activities, student identifiers and achievement databases, career awareness, the relevance of the ATAR, current industry needs, 21st century skills, and more. While this demonstrates an appreciation of the complexity and interactivity of issues, not all of these can or should be addressed through school-industry partnerships.

A number of previous attempts to address such issues (see for example, Australian Science and Technology Council, 1991; MCEETYA, 1998; DEST, 2006) have also taken an omnibus approach. While we acknowledge that it is difficult to tease apart many of these interconnected issues, it is our view that omnibus approaches lead to diffuse policy and ineffective action.

Rather we advocate a focused approach that begins by identifying a strong curriculum purpose for STEM-school partnerships. The purpose is to challenge traditional curriculum emphases and pedagogies in ways that lead to genuine change in teaching and learning practice; changes that engage students through meaningful and authentic STEM experiences and promote 21st century skills.

In the STEM Hubs project in Queensland the local principals quickly recognised the potential of partnerships and, with the school STEM leaders, identified their aims and the types of businesses who would potentially make suitable partners. Support from AiGroup and university academics connected the schools with suitable industry contacts. Building on this relationship, opportunities were created for teachers to workshop with industry partners in the collaborative design of STEM teaching sequences mapped to the curriculum for junior and senior classes.

While we do not seek to promote any particular activity like STEM Hubs, we do assert that it is only activities that share its characteristics, as abstracted in our framework, that lead to the desired long term changes in STEM teaching and learning. We believe that the Forum should be drawing attention to and promoting these characteristics.

Some Challenges

There are many efforts to engage industry and community organisations with teachers, many of which are indicated in the Issues Paper. We believe that a much stronger argument should be made that the connections should be at school rather than individual teacher level. We acknowledge that the Issues Paper says

High quality professional learning with opportunities for ongoing support, collaboration, interaction, connections and communities of practice will be the most successful elements in industry partnerships.

However it does not recommend that schools provide or manage these opportunities, or say to what end they should be directed, and the case studies that it provides do not appear to exemplify them.

The Issues Paper states, prior to this point,

To deliver an effective model of industry-supported professional development in STEM disciplines it will be important to build on existing professional development programs that have already demonstrated a positive impact or elements of success.

While we can appreciate the good sense of wanting to build on initiatives that already exist, we think that the Issues Paper must say something about the directions in which they should build. The case studies in the Issues Paper appear to support interaction on an individual basis, either teacher to STEM professional, or individuals attending a workshop or a MOOC. There is no guarantee that the activities of these individuals will translate into systemic change. We don't believe that the Forum report should endorse these activities without indicating the need for them to develop their engagement beyond the individual level to at a school or school cluster level. Any recommended support should be conditional on them planning to meet such advice in some form.

The curriculum, pedagogy and organisational challenges involved in creating and sustaining partnerships with industry and community organisations are not ones that teachers generally can be expected to meet on an individual basis. Outstanding teachers will make outstanding contributions to them. However, more generally, experiences need to be organised that engage teachers and STEM professionals in a way that develops organisational learning, organisational practices and supporting structures that give the insights and practices that result in a life beyond the enthusiasm of talented individuals.

Among the challenges is the concept of STEM itself. At times the Issues Paper uses the term to refer to the collection of disciplines in science, technology, engineering and mathematics. At others it uses the term to refer to an integrated interdisciplinary science, which somehow obviates the need to consider individual disciplines. In our view, the argument for school-STEM partnerships would be enriched with a clarification of the relations between the individual STEM disciplines/subjects, interdisciplinary STEM curriculum purposes, and practices within the STEM community.

Part of the traditional advocacy of interdisciplinarity in STEM curriculum is that scientific and industrial research and practice is generally conducted using cross-disciplinary ideas, and teams. However, often this means experts in individual disciplines bringing their knowledge to bear on complex problems and practices, often in concert with other discipline experts. The argument thus amounts to advocacy of the development of both inter- and mono-disciplinary approaches. Meaningful problem solving and explanatory approaches need to be pursued within the individual STEM subjects, as well as in interdisciplinary settings.

Interdisciplinarity is itself a significant challenge. Secondary school STEM teachers currently specialize in the separate STEM disciplines, in which engineering is not explicitly included, and teach to separate discipline-based curricula. Science itself is divided into its sub-disciplines. The STEM – Connections project, conducted in 2014-15 by the Australian Curriculum Assessment and Reporting Authority (ACARA), while positive about the outcomes, demonstrated the challenges involved in asking teachers to collaborate across disciplines, and with external experts, to organize student learning around solving a particular problem. There is no shortage of evidence of such difficulties; the Step Up and ReMSTEP projects from the ETMST program provide more recent examples.

The debate over interdisciplinarity is just one of the challenges for curriculum and pedagogy that are thrown up by the demand to connect STEM with contemporary ideas and contexts. In short, we believe that the changes to STEM education envisaged in the National STEM Education Strategy demand a reimagining of science education on a scale set out in the 2007 landmark essay of that title by Russell Tytler. The then Chief Scientist wrote the foreword to that essay strongly supporting its contentions. He went on to found CSIRO's scientists in schools. We believe that systematic STEM-school partnerships that foster collaborative professional learning and ownership of learning outcomes by all parties is the best way to achieve a lasting reimagining of STEM education over the longer term.

Effective models for creating systemic STEM-school partnerships have proven elusive, both in Australia and internationally. Most attempts have underestimated how difficult these relationships are to establish and sustain, particularly over long timeframes.

The authors of this submission include STEM educators and teacher educators with more than a decade of experience in school partnerships with industry and community geared towards STEM education. Their research and experience have revealed that while time and resources can be a hindrance to such endeavours, the major impediments to school-industry partnerships are cultural differences between the worlds of school and industry. That is, school and industry stakeholders generally bring assumptions, values, priorities, language and "world views" that can be substantively at odds. For example, the language that teachers use to discuss the curriculum may seem foreign to industry representatives and conversely, industry terms may seem extraneous to teachers.

Experience shows that this major challenge requires teachers and industry representatives to cross boundaries into unfamiliar domains. Without careful navigation of this boundary crossing, the partnerships will likely fail. Successful

partnerships occur because key facilitators or brokers invest considerable energy, intellectual capital and time in planning, liaising and communicating with stakeholders. Engagement of such facilitators is therefore, in our view, an essential part of STEM industry- school partnerships and forms a key element in our proposed framework.

A framework to manage the evolution

In the document accompanying this response we offer an example of a framework for organised interaction between Schools and STEM professionals. It can be regarded as a form of quality standard that schools, educational authorities and STEM partners can use, both to design and to evaluate their partnership and its activities.

The key points of the framework commit to

- school organisation and leadership of partnerships with STEM professionals and their organisations,
- the conduct of the partnership through a collaborative learning environment for STEM partners, teachers and students,
- significant support from facilitators/‘boundary crossers’ as essential catalysts for their mutual learning.

In an attachment to the framework we provide a set of principles for teacher professional learning through STEM partnerships from which the framework was distilled, and a list of projects, run over a decade, that provided the experience on which those principles are based.

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