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The Australian Industry Group

# STRENGTHENING SCHOOL - INDUSTRY STEM SKILLS PARTNERSHIPS

Final Project Report

June 2017



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# Foreword from the Chief Scientist

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Most of us have our own take on the four-letter word STEM. For me, with my background in neuroscience and engineering, the letters S and E shimmer to pronounce my own particular engagement in the world of Science, Technology, Engineering and Mathematics.

All these disciplines represent a breadth of opportunity, almost without limit.

They foster skills relevant across the entire economy and form an outstanding foundation for a world of constant and rampant change.

Schools are the principal means by which we instil these skills and interests in our children; but it is industry that understands the interplay between the cutting edge of science and our everyday world.

As such, we need businesses and schools to work together in order to ensure that our teachers and students are provided with the most up-to-date scientific methods and information.

It is a daunting challenge – one that requires an understanding and appreciation of each other's drivers; the development of different models of working and interacting together; and most importantly, teachers who are encouraged and supported.

That is why my Office commissioned the Australian Industry Group to write the guidebook to further these school-industry partnerships. The result: the Strengthening School-Industry STEM Skills Partnership Project.

This project identified models of schools and industry working together that we can learn from and scale up; it exposed the gaps in available resources; and it provided the evidence base that teachers require a range of support and development.

This work has also resulted in the production of the STEM Programme Index 2016 publication, which my Office is currently using to provide the seed data for an online portal of extracurricular STEM activities in Australia.

This report is an important step in achieving our goal: seeing schools and industry working in partnership to realise the full potential of future generations. I congratulate the Ai Group on the quality of the report.

A handwritten signature in purple ink, reading "Alan Finkel". The signature is fluid and cursive, with a long, sweeping underline.

Alan Finkel AO  
Australia's Chief Scientist

# Foreword from Ai Group

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The advancement of Science, Technology, Engineering and Mathematics (STEM) skills is of major importance for our workforce and the economy. It was this and our concern about the provision of STEM in all the education sectors that led us to develop the *Strengthening School-Industry STEM Skills Partnerships Project* in conjunction with the Office of the Chief Scientist. Our particular focus was the school sector and how we could link it with industry to advance this agenda. When we began at the start of 2015 there was very little happening that was system-wide in the school sectors. Now most school systems around the nation have released STEM policies and in late 2015 the Education Council released the National STEM School Education Strategy.

In this project, we have been able to make some significant inroads into this agenda. Our research, and the assistance of the Office of the Chief Scientist, has enabled us to produce the STEM Programme Index 2016, which has proven to be a useful reference for schools and other STEM-interested parties.

The project also co-ordinated several pilot programs and participated in initiatives across four jurisdictions. We were able to enlist the support of the Australian Curriculum Assessment and Reporting Authority (ACARA) to conduct teacher professional development on a national basis. The pilot activity has resulted in the articulation of some models of school-industry partnerships which demonstrate the diversity of potential approaches to what is a complex area, especially for schools. These models have the potential to be replicated so that the levels of participation by both schools and industry can be expanded for the benefit of all.

There remains a long way to go. There are challenges for schools and education systems to provide the appropriate professional development for teachers to implement STEM approaches. This includes support to enable teachers across different disciplines to work together – especially mathematics teachers and those involved in the delivery of digital technologies curricula. Similarly, employers need assistance to participate in STEM skills partnerships with schools.

As a nation we need to get moving on the STEM skills agenda. This project has made a significant contribution to the school-industry interface within the broader STEM skills context.

A handwritten signature in black ink that reads "Innes Willox". The signature is written in a cursive style and is underlined with a single horizontal stroke.

Innes Willox  
Chief Executive  
Australian Industry Group

# Recommendations

## Teacher Professional Development

1. Education systems to provide:
  - a) professional development for teachers of mathematics on how to integrate mathematics into a STEM-based curriculum
  - b) professional development activities for teachers of digital technology on how to integrate digital technologies into a STEM-based curriculum
  - c) professional development for teachers on integrating other subjects into a STEM-based curriculum

## Resources for Schools

2. Education systems to develop advice and resources for schools on how to engage with industry partners to develop STEM skills in schools.
3. Education systems to promote the three models of school-industry engagement identified in this project:
  - a) Single school – single company
  - b) Multiple schools and multiple companies and university
  - c) Multiple organisations – schools, government, peak industry bodies

## Resources for Industry

4. Develop resources for use by employers that highlight approaches to forming partnerships with schools to implement STEM strategies.
5. Establish a national forum that will facilitate dialogue between industry and schools in STEM education, thus enabling best practice to be shared.

# Contents

Foreword

Recommendations

Chapter 1: Introduction .....	7
1.1 Rationale .....	7
1.2 Project Aims and Purpose .....	8
1.3 Project Objectives .....	9
1.4 Methodology .....	10
1.5 Project Governance .....	10
Chapter 2: The School-Industry STEM Mapping Exercise .....	12
2.1 Overview .....	12
2.2 Key Findings .....	12
Chapter 3: Background to the School-Industry Pilot .....	21
3.1 Conclusions from Mapping Exercise .....	21
3.2 Pilot Overview .....	22
3.3 School Selection .....	23
3.4 Program and Model Features .....	24
3.5 Student Cohort .....	26
3.6 Co-ordination and Support .....	26
3.7 Engagement with Industry .....	27
Chapter 4: Case Studies .....	30
4.1 Introduction .....	30
4.2 Individual School-Industry Pilots .....	30
4.3 Multiple School-Industry-University Models .....	45
4.4 Multiple Organisation Model .....	47
4.5 Industry Associations and Research Organisations .....	48
Chapter 5: Project Evaluation .....	50
5.1 Overview of Methodology .....	50
5.2 Qualitative Evaluation .....	50
5.3 Evaluation Surveys .....	51
5.4 Student Survey Evaluation .....	52
5.5 Teacher Evaluation .....	58
5.6 Industry Evaluation .....	61

Chapter 6: Summary of Results and Implications .....	65
6.1 Project Findings .....	65
6.2 Analysis of Models .....	72
 Bibliography .....	 76
 Appendices .....	 79
<b>1. STEM Skills Project Brochure</b>	
<b>2. Project Plan</b>	
<b>3. Sample Ai Group – ACARA Professional Development Workshop</b>	
<b>4. QSTEM Hubs Flyer</b>	
<b>5. Geelong Region Schools STEM Curriculum Industry Link Scoping Paper</b>	
<b>6. Australian Information Industries Association, Hewlett Packard Enterprises and SA     Department of Education and Child Development teacher professional development     program</b>	
<b>7. Ai Group and CSIRO SMiS Brochure</b>	
<b>8. Evaluation Framework and Surveys</b>	



## Chapter 1: INTRODUCTION

### 1.1 Rationale

The importance of STEM disciplines for the future economic and social well-being of Australia cannot be emphasised enough. The Office of the Chief Scientist has estimated that 65 per cent of economic growth per capita from 1964 to 2005 is due to improvements in the use of capital, labour and technological innovation made possible in large part by STEM.<sup>1</sup> International research indicates that 75 per cent of the fastest growing occupations require STEM skills and knowledge.<sup>2</sup> Employment in STEM occupations is projected to grow at almost twice the pace of other occupations.<sup>3</sup> Despite these findings, the Australian Council of Learned Academies (ACOLA) reports that:

*“... the news is good but not great. Australia has travelled fairly well until now, but there are holes in capacity and performance. Further, many other countries are improving STEM provision, participation and performance more rapidly than us.”<sup>4</sup>*

Ai Group research indicates that there are significant skill shortages and recruitment difficulties for specific STEM-related occupations. The most prominent difficulties were for technicians and trade workers (41 per cent), professionals (26.6 per cent) and managers (26.3 per cent).<sup>5</sup>

As well as difficulties within the workforce there are problems in the pipeline from schools and universities into the workforce. Despite attempts by governments over the last decade to increase school student participation in STEM, the proportion of school students commencing in senior STEM-related studies has flat-lined at around 10 per cent or less.<sup>6</sup> A decreasing number of secondary students are participating in many branches of mathematics.

The state of mathematics and science in schools has deteriorated to a ‘dangerous level’ according to a review commissioned by the Vice-Chancellors of Australia’s eight research-intensive universities. The number of students undertaking intermediate and advanced mathematics in secondary school fell by 34 per cent over the past 18 years<sup>7</sup>.

Ai Group has drawn attention to the unacceptably low level of participation by secondary school students in STEM-related areas of knowledge and skills.<sup>8</sup> There are concerns regarding school student performance in mathematics. The most recent reports from the Trends in Mathematics and

<sup>1</sup> *Science, Technology, Engineering and Mathematics: Australia’s Future*, Office of the Chief Scientist, September 2014, page 7.

<sup>2</sup> Becker, K. and Park, K.; Effects of integrative approaches among STEM subjects on students’ learning, *Journal of STEM Education* 12, July – September 2011.

<sup>3</sup> Elizabeth Craig et al., *No Shortage of Talent: How the global market is producing the STEM Skills needed for growth*, September 2011, Accenture Institute for High Performance.

<sup>4</sup> *STEM: Country Comparisons*, Final Report, Australian Council of Learned Academies, May 2013, page 15.

<sup>5</sup> *Lifting our Science, Technology, Engineering and Maths (STEM) Skills*, Australian Industry Group, 2013.

<sup>6</sup> *Australia’s skills and workforce development needs*, Discussion Paper, Australian Workforce and Productivity Agency, July 2012.

<sup>7</sup> *Dealing with Australia’s Mathematical Deficit*, Australian Mathematical Science Institute, May 2014.

<sup>8</sup> *Lifting our Science, Technology, Engineering and Maths (STEM) Skills*, Australian Industry Group, 2013.

Science Study (TIMSS) and the Programme for International Student Assessment (PISA) indicate that Australia's performance in mathematics and science has stagnated over the past 16 years.<sup>9</sup>

In addition to concern about the levels of participation, there are further concerns about pedagogy. A 2012 Universities Australia report highlighted many concerns in relation to secondary education including:

- “In too many schools STEM is still mostly science and mathematics taught separately with little or no attention to technology and engineering”; and
- “Students need to be made aware of the career opportunities afforded to STEM graduates at an earlier age rather than just years 11 and 12.”<sup>10</sup>

These are the concerns that prompted the creation of the *Strengthening School-Industry STEM Skills Partnership Project*. Ai Group can make a definitive contribution to the aggregation of activity and a more effective alignment between school and industry. This project brought a co-ordinated approach to addressing the curriculum implications and opportunities as well as widening the net of industry involvement. As the most recent ACOLA report expressed:

*“Education providers need to engage with business to gain a better understanding of trends in STEM skill needs.”<sup>11</sup>*

## 1.2 Project Aims

In February 2015, Ai Group was commissioned by the Office of the Chief Scientist to work to address the issue of declining Science, Technology, Engineering and Mathematics (STEM) skills through a project to strengthen school-industry STEM skills partnerships.

The project aimed to strengthen linkages between industry and school systems:

- to advance participation by secondary school students in STEM-related disciplines in conjunction with industry;
- to improve students' and teachers' understanding of STEM skills and their demand in the workplace; and
- to encourage students to consider further study and /or a career in STEM.

The evaluation process for the STEM Skills Pilot Project will determine:

- that the objectives of the contract agreement have been met; and
- the achievement of outcomes and the impact of the project.

The project was informed by the *Guiding Principles for School-Business Relationships*.<sup>12</sup> There are seven key guiding principles:

<sup>9</sup> Sue Thompson et al., *TIMSS 2015*, Australian Council for Educational Research, 2016 and *PISA 2015: A first look at Australia's results*, 2016.

<sup>10</sup> Universities Australia, *STEM and non-STEM First Year Students*, January 2012.

<sup>11</sup> *The role of science, research and technology in lifting Australia's productivity*, Australian Council of Learned Academies, June 2014, page 20.

<sup>12</sup> *Guiding Principles for School-Business Relationships*, Australian Government, 2012.

- Enhance student learning and outcomes: the basic aim of these relationships is to improve the learning experiences and educational outcomes of students. Business investments in schools are most likely to be successful if this is recognised as the core goal of school-business relationships.
- Benefit both schools and businesses: these relationships work best when both schools and businesses see clear benefits from working together.
- Are built on strong foundations: this means that partners have a shared sense of what is to be achieved, a clear understanding of successful outcomes and shared accountability.
- Have the support of the school community: these relationships work best when they have the support of teachers, students and parents within the school community.
- Are embedded in school and business cultures: to achieve long-term sustainability, it is crucial that relationships are embedded in organisational cultures including operational structures and processes.
- Have the support of school and business leadership: commitment from senior leadership in school and business organisations is critical to the success of the relationship.
- Are adequately resourced by both schools and businesses: both schools and businesses need to contribute both tangible and intangible resources to make the relationship a success.

These principles were used in the analysis of the mapping exercise of current activity and the planning for the pilot program.

### **1.3 Project Objectives**

The project sought to strengthen linkages between industry and school systems to advance the participation by secondary school students in STEM-related disciplines and in industry-partnered activity. The aim was to improve students' and teachers' understanding of STEM skills and their demand in the workplace, and to encourage students to consider further study and/or a career in STEM. A project brochure was developed to reflect these goals (Appendix 1).

This approach is consistent with the Australian Government's Guiding Principles for School-Business Relationships (2012). This project aimed to directly enhance student learning and outcomes and benefit both school and businesses as outlined in the document.

The project also focused on bringing together companies which currently support or are interested in supporting STEM activity in schools.

School-industry activities were chosen with the ability to be scaled and to make a difference to the implementation of STEM models across the broad schooling sector.

To achieve these aims, the following activities were undertaken:

- The identification and mapping of existing school-industry partnerships in STEM-related activities;
- The identification and documentation of key success features of school-industry STEM skills partnerships;
- The development of transferable models of school-industry STEM skills partnerships;

- The recruitment of industry to be involved in an industry-led school-industry STEM skills partnership model as a pilot to expand the take-up of STEM in secondary schools with the capacity to produce system-wide influence;
- The co-ordination of companies currently supporting or interested in STEM-related initiatives with schools at both a local and national level; and
- The determination of mechanisms for coordinating the funding for the continuing application of models deriving from the pilot program.

A key feature of the project was to address the issue of sustainability of school-industry STEM skills partnerships into the future. It was anticipated that the pilot program would provide examples of mechanisms that can be used to realistically maintain partnerships beyond the life of the project and recommendations designed to address the issue of sustainability.

A detailed project plan, methodology, and evaluation framework were developed in consultation with the Project Reference Group (Appendix 2). The Government’s Guiding Principles for School-Business Relationships together with other tools were used to inform the development of the evaluation criteria.

#### **1.4 Methodology**

The main elements of the methodology are:

- Mapping current STEM projects/programs nationally including:
  - Collecting companies’ engagement/interest and degree of contribution/commitment; and
  - Identifying existing and potential funding sources including duration and longevity.
- Identifying success criteria for effective and successful models.
- Documenting and evaluating current successful models with capacity to be transferred or replicated.
- Identifying and implementing a selected pilot program.

#### **1.5 Project Governance**

The project was supported by a Project Reference Group which in addition to contracted parties included a range of stakeholders including:

- Michael Taylor, Chair, Australian Industry Group
- Roslyn Prinsley subsequently replaced by Krisztian Baranyai, Office of the Chief Scientist
- Michael Hubbard and subsequently Blye Decker, Business Council of Australia
- Deborah Palmer, Australian Curriculum Assessment and Reporting Authority
- Scott Thompson, Lockheed Martin Australia
- Tim Fawcett, Cisco Systems Australia
- Bronwyn Smith and subsequently Louise Goold, Faculty of Education, Monash University
- Nagla Jebeile, Department of Education and Communities, NSW
- Ben Samy, Department of State Development, SA

- Maggie Farrell, Project Manager, Australian Industry Group

The following Terms of Reference were adopted by the Reference Group.

The Reference Group will:

- oversee all aspects of the work encompassed by the project;
- meet at least five times over the course of the project including face-to-face meetings as appropriate;
- provide advice and other input as appropriate;
- consider and contribute to the project reports and provide advice as appropriate; and
- provide advice in relation to the dissemination of project outcomes.

## Chapter 2: THE SCHOOL – INDUSTRY STEM MAPPING

### 2.1 Overview

The purpose of the school-industry mapping was to undertake a stocktake of existing programs to inform the development of pilot programs for 2016. The exercise was extensive and updates were provided throughout the project.

In late December 2015, Ai Group undertook further updating of the mapping document for the Office of the Chief Scientist with a view to producing a comprehensive public resource for teachers. The **STEM Programme Index 2016 (SPI 2016)** was produced and published on the Chief Scientist’s website in late January 2016 (see References). Subsequently, following additional updating, a hard copy version was produced by the Office of the Chief Scientist in April 2016.

The Office of the Chief Scientist is working with Engineers Australia and industry partners to produce an online portal that will digitise the STEM Programme Index and result in significantly enhanced search capabilities. This will also allow individual institutions and organisations to maintain and update their own information. The portal is expected to be available in June 2017.

The mapping exercise process identified key issues to be addressed and informed decisions on the focus, aims and structure of the proposed pilot options.

### 2.2 Key Findings

#### 2.2.1 Definition of STEM and understanding what it means

In mid-2015 Ai Group observed that despite growing public and educational discussion about STEM, there continued to be some confusion among teachers about what exactly is meant by the acronym STEM. The primary focus seemed to be on science and technology and mathematics to a lesser extent. Some see the acronym as a descriptor of jobs rather than skills sets.

The situation was clarified somewhat by the release of the National STEM School Education Strategy by the Education Council in December 2015. The definition in this statement became the operating definition for the project. Specifically,

*“STEM education is a term used to refer collectively to the teaching of the disciplines within its umbrella – science, technology, engineering and mathematics – and also to a cross-disciplinary approach to teaching that increases student interest in STEM-related fields and improves students’ problem solving and critical analysis skills.”<sup>13</sup>*

There is a need to have a constructive discussion about the definition of STEM and what is the ideal scenario for development and utilisation of STEM skills. The statement that 75 per cent of the fastest growing jobs will require STEM skills is often interpreted as 75 per cent of ALL jobs will require high level maths and science.

This lack of clarity about the definition and meaning of STEM can have significant consequences.

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<sup>13</sup> National STEM School Education Strategy, Education Council, December 2015.

“While STEM is recognised as a key enabler for national skills, its various (and occasionally conflicting) meanings and excessive use render it increasingly meaningless.”<sup>14</sup>

What is too frequently missed is the understanding that for industry at least, the emphasis is on skills as much as the acquisition of academic or technical knowledge. Further, it needs to be remembered that scientific and technical education and skill formation are not limited to schools and universities but are also intrinsic in the vocational education and training (VET) sector.

Ai Group has emphasised from the outset that the acronym STEM is not a jobs descriptor. It should only be used in the context of skills, not only for the 21st century workplace but for everyday life in the increasingly complex technologically driven world. It is suspected that many more teachers and parents continue to see STEM as referring only to jobs in single subject disciplines.

On 20 August 2016, The Australian Chief Scientist, Dr Alan Finkel, made the point to the ABC Science Show in an interview with Robin Williams:

*“The disciplines that I know best, often grouped together as STEM, meaning science, technology, engineering and mathematics, all foster skills with applications right across the economy. Quantitative analysis, data gathering and mining, prototyping and experimentation, in my case instrument design and optimisation. Combine these and more with an eye to the possibilities on the technology horizon, an understanding of the way the science community works and a passion for the pursuit of new ideas, and I see a person well prepared for life.*

*Surely, in a knowledge led economy we want people with strong STEM backgrounds designing cities, planning infrastructure, sitting on corporate boards, and protecting our industries from every risk, from climate change to cyber-attack, just like every other nation that has made the choice to excel in these fields.”<sup>15</sup>*

### 2.2.2 Integration of STEM subjects

In many forums, there are debates about whether STEM can simply have a single subject focus or whether all STEM subjects need to be integrated. By mid-late 2016 there was a noticeable shift in the conversations about how to integrate individual STEM subjects into the curriculum, although it seems that for many schools this integration remains a significant challenge.

Many teachers still had questions about how STEM subjects can be integrated within the constraints of school timetables and rigid structures that pervade. Realistically, as noted at the outset of this project, the school curriculum is still largely structured to deliver education in single subject areas and this was constantly raised by teachers as a barrier.

Where there is a school desire to provide integrated STEM, it is often dependent on, firstly, support from the principal and school leaders, but also on the capacity and desire for teachers in various STEM disciplines to collaborate. The autonomous nature of schools still determines what gets

<sup>14</sup> Gitta Siekmann, What is STEM? The need for unpacking its definitions and applications, NCVET, 18 October 2016.

<sup>15</sup> www. <http://www.abc.net.au/radionational/programs/scienceshow/stem-phds-have-skills-for-tomorrow%E2%80%99s-work-place/7767620#transcript>

supported and prioritised. Conflicting priorities and performance measures may challenge some of the objectives in the STEM arena.

Throughout this project it was apparent that cross-faculty collaboration in schools is by no means guaranteed. Initiatives continue in the main to be delivered by individual teachers within single disciplines. Other observers say that unless the single subjects are integrated we cannot refer to STEM in any meaningful fashion.

This finding has been confirmed by research which highlights these difficulties:

*“...there are many factors mitigating against changes in traditional school discipline curriculum structures, including assessment, parental pressure for traditional standards and subject-based qualifications, instructional periods, textbooks, curriculum guides and staff who are trained in their disciplines and have developed long standing attachments to them.”<sup>16</sup>*

As the mapping exercise showed in mid-2015, many competitions, programs and initiatives were generally single-subject focused – or at least badged that way. It is doubtful that many programs or competitions are fully integrated STEM. However, many competitions in practice, especially those with an engineering focus, incorporated a more integrated approach and included a range of STEM and workplace skills development as a by-product. Programs such as the FIRST Robotics, the ME Program and the F1 in Schools initiatives are examples.

None of the schools approached by Ai Group initiated any discussion about digital skills and the potential for school-industry pilots to be focused in this area. The only school that undertook a digital technologies focused project in this pilot was initiated by Ai Group and not by teachers. Ai Group encountered at least one science teacher who did not see that schools had anything to teach students about digital technology. He was unlikely to be alone.

In only two schools assisted with industry connections have mathematics teachers been drivers of STEM school-industry engagement. Both were involved in the Queensland QSTEM pilot. One was looking to partner with an Ai Group member, Cubic Defence in Townsville, to unpick the mathematics in coding Unmanned Aerial Vehicles (UAVs).

This noted absence of mathematics teachers engaging with the STEM initiatives in discussions with schools is of concern, with declining numbers of students studying advanced mathematics nationally. It is, however, in line with findings from other reports such as the UK Government’s STEM Cohesion Programme Final Report in 2011, which found that in the third and final year of the STEM Cohesion Programme many challenges persisted including “a continuing lack of understanding and appreciation of the role of maths in STEM”.<sup>17</sup>

<sup>16</sup> Professor John Williams, University of Waikato, New Zealand, STEM Education: Proceed with Caution, Design and Technology Education: An International Journal 16.1 (2011).

<sup>17</sup> National Foundation for Educational Research, Research Report DFE-RR147: The STEM cohesion programme: final report, July 2011.



### 2.2.3 STEM in School Systems

In the process of mapping it was interesting to discover that STEM was seldom mentioned on most public education systems' websites. In some instances, it was extremely difficult to discover where there was any focus in this area. This is not to say that there is not a focus at all within jurisdictions or systems, but it was not clear in many cases. At times, it was very difficult to find the relevant staff.

Even if the curriculum does not inhibit better coordination across STEM subjects there is a concern that many teachers perceive that it does. Some subject specialists do not believe integration works. The demands of curriculum can leave many teachers struggling to go beyond their subject areas. The sheer volume of resources is proving difficult for many teachers to both evaluate and access. Tools that link to curriculum are critical. Better coordination is clearly needed.

In 2015 it seemed that the New South Wales Department of Education was almost unique in its implementation of the Integrated STEM Program to state schools across New South Wales. However, during 2016 it has become very apparent that there is a growing focus on STEM and a noticeably increased awareness by education systems, schools, teachers and parents about the importance of STEM education and skills. There is a growing interest in embedding a stronger focus on STEM education into school systems.

The Queensland Government has devoted considerable resourcing to a major focus on STEM in 2016. The Schools of the Future: A Strategy for STEM<sup>18</sup> in Queensland state schools and associated initiatives such as the 2016 QSTEM initiative and a strong focus on coding across its education system are illustrative of the growing attention to STEM education at the system level. A review into STEM education in Queensland State schools is underway and due for completion by the end of 2016.

In September 2016, the Victorian Government launched STEM in the Education State “that outlines the Government’s commitment to STEM education in Victoria across the early childhood, school and higher education and skills sectors. It provides our overall direction for STEM support; lists existing actions and pending commitments; and outlines some longer-term reform directions.”<sup>19</sup>

This was accompanied by the VicSTEM website “which brings together a range of resources, activities and programs, to help educators, students and families”.<sup>20</sup>

In July 2016, the South Australian Government announced a \$250m investment in facilities to support STEM education in South Australian Schools – STEM Works. This commitment means that “139 government schools are receiving \$250 million investment in facilities upgrades through the STEM Works program. The non-government school sector can also currently access an additional \$250 million loan facility for infrastructure projects.”<sup>21</sup> Subsequently the South Australian

<sup>18</sup> Schools of the Future: <http://advancingeducation.qld.gov.au/Pages/Downloads.aspx>

<sup>19</sup> <https://www.education.vic.gov.au/vicstem>, STEM IN THE EDUCATION STATE

<sup>20</sup> <https://www.education.vic.gov.au/vicstem>

<sup>21</sup> DECD web site: <https://www.decd.sa.gov.au/sites-and-facilities/stemworks>

Government launched its STEM strategy in November 2016 as DECD-STEM Learning – Preschool-Year 12.<sup>22</sup>

So, an early finding of the mapping exercise that schools are not generally driving STEM programs has started to change. Several education systems have now made STEM education a priority.

#### 2.2.4 Student Access to STEM

A key finding of the mapping exercise concerned the issue of student access to STEM.

Notwithstanding the extensive range of STEM programs and initiatives, in some instances student access to STEM initiatives is restricted. Some programs are specifically targeted to gifted and talented students, a smaller number are focused on girls' education and some target low socio-economic students and/or indigenous communities.

Some programs operate out of school hours and may rely heavily on parent availability/commitment and involvement. Programs that operate out of school hours, on school holidays, are expensive or located in CBD-based university campuses are unlikely to reach low SES and remote and regional communities.

By the end of this project it still seems that those schools that have embraced the opportunity to become involved with this pilot are in the main higher SES schools. While beyond the scope of this project there is an extensive body of research that indicates that this is an education issue. Lower SES schools and rural and remote schools are 'missing out' on development of the skills flagged as most critical by 21st century employers. The Australian Council for Educational Research has noted:

*“Students from a disadvantaged background are much less likely to report that they enjoy mathematics, are less likely to recognise its importance for their future, and are more likely to suffer from maths anxiety than their advantaged peers. Disadvantaged schools report more problems with resourcing and student discipline; have fewer confident teachers; and have less of an emphasis on academic success. All of these factors are associated with poorer performance in reading, mathematics and science. If Australia is to reverse the decline in maths, science and reading literacy achievement, funding needs to be targeted to programs in schools that have high numbers of students from lower-socioeconomic backgrounds. OECD research has shown that the systems that have been most successful in reducing the gaps between low and high achievers are those that direct more resources to schools in this way.”<sup>23</sup>*

It was also noted by a principal of a regional school that many of the parents he encountered had little or no idea of the ways in which technology and digital skills and literacy are increasingly essential in the modern workforce. He said some still thought technology was a “fad”.

<sup>22</sup> [www.decd.sa.gov.au/stem](http://www.decd.sa.gov.au/stem)

<sup>23</sup> The Conversation April 13, 2016: Sue Thomson, Director, Educational Monitoring and Research Division; Research Director, Australian Surveys Research Program, Australian Council for Educational Research.

The Smith Family, amongst others, has long drawn attention to the stark reality that poverty excludes many students from learning on many levels – not least of which is access to the internet and technology.

*“Only 68% of children aged 5 to 14 in Australia’s most disadvantaged communities access the internet at home, compared with 91% of students from the most advantaged communities. Without the internet to research and complete homework, disadvantaged students fall further behind at school. Later in life, they lack the skills they need to take part in our digital world.”<sup>24</sup>*

### **2.2.5 Industry Driven Programs**

The mapping exercise revealed that the number of companies interested in or involved in supporting STEM initiatives is significant.

The mapping exercise did not seek to include the multiplicity of small very local initiatives with local company involvement or support. It captured what involvement major companies in Australia have in STEM programs, where they took place and the focus and nature of the involvement. Larger companies are likely to be better placed to engage in national programs, in part because at a local level STEM ‘activities’ such as competitions/challenges are often supported by companies in terms of sponsorship and low level engagement such as work experience or workplace tours and talks.

There are many ways in which industry engages with STEM initiatives and only a few are ‘driven’ by industry. What has emerged is that a wide range of companies are engaged in or support community/corporate social responsibility programs. Not all of these are linked to education. Most reflect the objectives of the companies and several can be considered as being within the ‘social license to operate’ category. A number have been operating for many years and represent a considerable resource commitment by companies.

There is no single model and the following themes in industry support for STEM programs emerged:

- a) Alignment to the core business of the company**
  - Telstra supports Code Clubs Australia (an offshoot of Code Clubs UK)
  - Shell supports programs in WA in science focused on Indigenous students
  - CISCO supports mentoring teachers focused on programming and networking.
- b) Industry support in specific locations where the company has major activities**
  - BAE Systems in SA
  - Lockheed Martin in SA and ACT
  - Cotton Australia in NSW and Queensland.
- c) Support for third party organisations that align with corporate objectives and have a well-established structure and reach**
  - The Origin Foundation supports The Smith Family focus on education for disadvantaged communities
  - BHP Billiton supports girls in mathematics through its partnership with AMSI

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<sup>24</sup> [www.thesmithfamily.org.au](http://www.thesmithfamily.org.au)

- Orica supports the ATSE STELR program
- Northrop Grumman supports the Australian Science Teachers' Association (ASTA) and the Australian School Science Information Support for Teachers and Technicians (ASSIST) program
- Others support the Beacon Foundation's programs
- CISCO has embarked on a partnership with CSIRO to implement their mentoring program through the Scientists and Mathematicians in Schools program.

It is not clear how much, if any, involvement many companies have had with school systems to determine whether their STEM programs or initiatives are aligned with school curricula. This is changing but it is important to remember that the objective for involvement in some cases is driven by offshore headquartered programs and in others by social license to operate objectives.

Multiple organisations expressed concern at the burgeoning numbers of programs, events and initiatives on offer with a sense that there are often unfocused efforts that may not be achieving the desired outcomes. At least one major corporate expressed the view that various governments were not abreast of the urgent need for digital skills and that companies had to find ways to manage this without waiting for the systems to 'catch up'. Firms expressed concern with the apparent decline in digital education and issues with the currency of curriculum and many teachers' skills.

It has been encouraging to note the willingness of many companies to engage with schools in developing school-industry pilots in this project. Almost every company approached by Ai Group has welcomed the opportunity for meaningful engagement with schools and to link with what is being taught. The process and outcomes are discussed in the pilot program section below.

What has also emerged in the latter part of 2016 are approaches to this project from major companies interested in involvement and participation in STEM initiatives.

For successful engagement, approaching companies with a clearly defined process and project scale enables them to know from the outset what exactly is required. However, it is essential to acknowledge that school-industry partnerships do have limitations and challenges.

### **2.2.6 STEM Competitions and Events**

In addition to a recent growing interest at system levels in STEM, there has been over several years an increasing level of interest from companies, educators and parents. This has led to a plethora of events/programs and initiatives connected to STEM or being rebadged as STEM. Several competitions have been underway for many years. Much of this activity is largely uncoordinated and is at times unfocused and haphazard across states, schools and teachers. Many are subject focused rather than integrated as STEM. The Mathematics Trust competitions are one such example of single subject focus.

As this project progressed it was also apparent that many teachers we encountered do not become involved in more than a few key programs. Teachers and parents frequently are confused by the array of initiatives and how to select what is best for them. Many teachers were unaware of programs and initiatives and did not seem to seek them out. Among the most frequently mentioned were:

- Re-Engineering Australia Foundation supported programs such as F1 in Schools, Subs in Schools
- Newcastle University supported Science and Engineering Challenge
- Macquarie University supported FIRST suite of competitions including FIRST Robotics, FIRST LEGO League
- Mathematics Trust competitions
- The National Youth Science Forum
- STELR
- The Oliphant Science Awards and
- State specific initiatives such as the ME Program (NSW) and C2C (SA)

Many of these programs are operated outside of school hours. Others are heavily reliant on single dedicated individuals such as teachers and/or parents. Even in schools where leadership is supportive of extra initiatives it is usually one or two champion teachers/parents who drive such initiatives. This may always have been the case of course, but reliance on individuals can make sustainability of such initiatives difficult.

In addition, many schools also link with the CSIRO Scientists and Mathematicians in Schools program by inviting professionals into schools to support either teachers or students.

On one level the multiplicity of uncoordinated and unconnected STEM activities and programs is not necessarily a problem as they theoretically all contribute to the greater awareness and interest on the part of students to pursue STEM subjects and associated pathways. However, it must be questioned if the majority attract already interested students.

### **2.2.7 University Driven Programs**

What was also apparent from the mapping exercise was that many programs or initiatives are driven by universities, primarily the science and engineering/computing faculties. Throughout the initial phase of consultation an extensive range of competitions/in-school events/teacher and student resources and tools emerged. Some are specifically focused on individual subjects such as chemistry/physics/environmental science. However, there were a number that are combined e.g. engineering and technology.

Some universities are beginning to provide teacher professional development focused on STEM initiatives – the University of Sydney, Deakin University and the University of South Australia are but a few examples. Some universities (and organisations and companies) align their STEM initiatives very closely with the curriculum in specific states. Nonetheless, overall it seems that many of the university driven initiatives are focused on exposing students and teachers to opportunities and courses at universities.

Several universities also provide access to facilities such as laboratories in recognition that schools would be unlikely to have such facilities available. Others lend equipment and provide courses for teachers in specific subject areas to enable them to enhance their skills in newer subjects such as photonics. Although universities manage or provide many STEM programs, the interface with industry is not always clear.

More than 40 major competitions were identified as being linked to universities and it is expected more will emerge in the future. Many are national and operate in multiple states or locations, such as the Conoco Phillips Science Experience operating in 35 universities and F1 in Schools and the Science and Engineering Challenge operating from the University of Newcastle across multiple locations including rural areas. Others are based in one location such as the annual National Youth Science Forum held in Canberra. Some are operated from schools until the finals, which might be held in a central location such as the University of Sydney or the ANU.

Diminishing funding for a widely held program such as the Science and Engineering Challenge is increasingly pushing the costs back to schools. Not all schools will be able to find funds for such initiatives. Some STEM programs can be very costly and many programs rely on government funding.

The university centric focus of many STEM initiatives implies that STEM skills are only required for those students following university pathways. Yet we know that companies require these skills for 21<sup>st</sup> century business operations and university education is not the only way to gain essential STEM skills.

### **2.2.8 Importance of the VET Sector**

In all the consultations conducted there was seldom a reference to STEM education that linked it to the Vocational Education and Training (VET) sector. There seems to be an exclusion of the VET sector from the consideration of STEM skills. It is critical to recognise that STEM skills are essential for VET as much as for degrees like engineering and science. This is also the case for delivery of technical content within schools including several of the VET in Schools offerings.

This is connected to the issue of how STEM is defined. The importance of STEM skills to the VET sector is frequently missed. The National Centre for Vocational Education Research (NCVER) highlights the important role of VET in any worthwhile STEM discussions:

*“This definition recognises that the boundaries between STEM and non-STEM education and training are not as clear as rhetoric and statistics sometimes claim, and that STEM education and training occurs across all sectors and levels of education. While producing a single statistic to represent all STEM activity risks misrepresenting its multidisciplinary nature, it is still important to measure VET’s contribution to STEM, as often the focus is just on STEM education in schools and universities.”<sup>25</sup>*

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<sup>25</sup> Patrick Korb, Measuring STEM in vocational education and training. NCVER, 2016.

## Chapter 3: BACKGROUND TO THE SCHOOL-INDUSTRY PILOT

### 3.1 Conclusions from Mapping Exercise

The mapping exercise identified key issues to be addressed and informed decisions on the focus, aims and structure of the proposed pilot options. As a result of the mapping exercise, potential pilot options were considered against the following criteria:

- Potential to be supported across multiple jurisdictions and education sectors to enable sustainability beyond the life of the STEM Skills Project
- Capacity to integrate STEM into the school curriculum or link to the curriculum (enhance student learning outcomes)
- Manageable scale for schools (adequately resourced)
- Potential for industry role (to benefit both school and industry and with support of business and school leadership)
- Teachers' and students' involvement and support (support of the school community/benefit both school and industry/enhance student learning outcomes).

The analysis of the mapping exercise informed development of the pilot program component of the project and the criteria to be used. Three broad conclusions emerged:

- **No new initiatives:** given an already crowded market of STEM-related initiatives, especially competitions and university focused support programs, there was little benefit in introducing more, especially given that this volume of activity has had little impact on expanding STEM participation. An alternative approach would be to select existing programs or partners that indicate a great deal of success and bring them to more extensive levels of implementation.
- **Focus on school programs:** it would be beneficial to focus on school-industry initiatives that are integrated into the school curriculum and have achieved some degree of systemic support. These will have greater success for schools. It will be necessary to ensure that such programs have engaged industry and that resulting programs have real meaning for workplaces as well as schools.
- **Focus on teacher education:** school-industry STEM programs will have little chance of success without the engagement of secondary teachers. It will be important to include teacher professional development as a component of school-industry programs. Further, consideration needs to be given to supporting existing industry programs that provide STEM mentoring services to teachers.

Within the time frame, resources and consultation available, Ai Group concluded that the missing elements in terms of effective STEM school-industry engagement related to:

- Teacher understanding of industry and partnerships (as opposed to the donor-recipient and or/work experience model); and

- Meaningful connections between curriculum and real-world industry focus. i.e. enabling students to be involved in what is often referred to as ‘project-based learning’ type models.

Consultation with systems and teachers confirmed that many teachers struggled to see how they could link STEM initiatives with real-world applications. Without clear articulation with the curriculum many are not interested in or confident to undertake activities outside their daily responsibilities. This consideration informed the decision to contract the Australian Curriculum Assessment and Reporting Authority (ACARA) to offer professional development for schools and teachers to assist in addressing the perceived gap between curriculum and the world of work. The use of ACARA also added a national schools approach to the project.

### 3.2 Pilot Overview

It was initially proposed that up to 12 schools be selected across at least three states to implement a STEM skills project during 2016. Because of extensive consultation there were up to 30 schools that participated in various models in the project.

A multi-pronged approach was adopted in recognition of the following:

- The limited project resources meant it was not feasible to undertake effective school-industry pilots across every state and territory.
- While many individual school partnerships could be brokered this had minimal potential to be expanded beyond individual schools without ongoing brokering and support.
- It was anticipated that not all schools that became involved at the outset would necessarily complete the pilot journey.
- As the project progressed there was growing interest from groups of schools/teachers in preparing their STEM engagement for 2017 and in learning how to undertake STEM school-industry partnerships.
- With a view to sustainable options it was essential to build partnerships with stakeholders and systems that had the capacity and interest to expand the model beyond the duration of the project.



### 3.3 School Selection

Most of the schools included in the pilot were the result of the extensive consultations undertaken by Ai Group where a degree of readiness and preparedness was demonstrated. This was achieved in consultation with a range of stakeholders including education systems and local initiatives.

The schools that participated were from state education systems except for two Catholic schools from Victoria. Discussions took place with other schools but the time frame and resources available limited participation to those that responded and were not already committed to other initiatives.

- In Victoria, Catholic Education Melbourne approached Ai Group on behalf of schools in the Melbourne Diocese.
- QUT approached Ai Group in terms of involvement and support for the QSTEM Hubs in Queensland.
- Deakin University through its participation in the SS-STEM Project in Geelong sought to have some of its project schools involved.
- In South Australia two business partnership managers and two senior leaders – Student Pathways, from the SA Department for Education and Child Development brokered introductions and provided ongoing support throughout the project.
- In NSW, initial approaches and keen interest from schools in the Catholic system did not eventuate in any projects in 2016.
- In mid-2016 the coordinator of the Dapto Learning Community in the Illawarra brokered an opportunity for the project to engage with the seven schools in the Learning Community. From that introduction Ai Group provided a day workshop with ACARA for all seven schools and one of the primary schools embarked on a school-industry project with a local firm introduced by Ai Group.

It was known from the outset that many schools, stakeholders or systems would need to be approached to develop a pool of schools that would participate. Ai Group recognised that school-industry partnerships are not mandated in any jurisdiction and participation was highly dependent on interest and capacity for schools and companies. It was also acknowledged from the outset that not all who expressed keen interest or were committed would complete the journey. This has indeed been the case and the reasons and challenges are discussed in following sections.

While the project directive was to focus on secondary schools, as the project progressed it was very clear that if an opportunity arose it would be valuable to include primary school participants. Accordingly, following approaches from schools and discussion with the Office of the Chief Scientist it was agreed to incorporate some primary schools if possible.

Focusing on single schools would have not only limited the reach and impact but would also be a vulnerable strategy as it too often is heavily reliant on individuals. Accordingly, Ai Group adopted a multi-pronged approach in recognition that:

- School engagement is challenging and it is difficult for outsider organisations to effect change within schools. Internal school and educational priorities will always ‘trump’ external interests.

- Development of individual school-industry partnerships almost always involves intensive and prolonged one-to-one interaction with schools and companies. In a small, limited-term pilot project this could only deliver a small number of individual projects.
- It was recognised that some schools had little if any idea about how to incorporate industry links into the classroom. Ai Group was therefore keen from the outset to incorporate opportunities for system engagement or linking with complementary projects.
- Ai Group recognised that focussing on a limited number of individual school-industry pilots would be unlikely to lead to replication of the model when Ai Group no longer had a role in intensively brokering such engagement.
- Sustainable and ongoing outcomes would need to be derived from allies and partners within education systems and universities with capacity to keep driving school-industry partnerships across multiple schools.

### 3.4 Program and Model Features

Recognition of the limitations of single school-industry pilots also informed the focus on incorporating opportunities to expand the reach of the pilot to wider cohorts of teachers who were just beginning the STEM-industry journey. One vehicle was to utilise the ACARA workshops to offer support to schools that were undertaking pilots in 2016 and schools that were planning beyond 2016.

In addition, partnering with other projects and institutions provided an excellent vehicle to extend the reach of connecting schools and industry.

The models that emerged can be summarised as:

- **Single school – single company pilot projects:** There were seven projects that consisted of a single school with an industry partner. One of the schools was a primary school. These projects occurred in New South Wales, Victoria and South Australia.
- **Multiple school – multiple company projects with a university co-ordinator:** There were two projects that featured both multiple schools and multiple companies. The Skilling the Bay SS-STEM initiative included four schools and five companies in the Geelong area of Victoria. The QSTEM Hub project included three schools in Brisbane, three schools in Townsville and five companies. In both cases co-ordination was undertaken by a university partner: Deakin University for the Skilling the Bay initiative and Queensland University of Technology (Brisbane) and James Cook University (Townsville) for the QSTEM Hub project.
- **Multiple organisation model:** In this model a group of schools has combined with a leading company, a key industry organisation and Department of Education network to extend teacher professional development to an expanded number of teachers. While potentially the most complicated model it has the possibility of the greatest reach.

**Table 1: Summary of Project Models**

<b>Model</b>	<b>Schools</b>	<b>Industry Partner</b>	<b>Other Partners</b>
<b>Single School – Single Company Model</b>	Banksia Park International High School	BTG Australasia	
	Blackwood HS	Haigh’s Chocolates	
	Brighton SC	Rising Sun Pictures	
	Henley HS	Comace	
	Sacred Heart College Kyneton	Lambley Nursery	
	Marymede Catholic College South Morang	Seqirus	
	Dapto Learning Community: Lakelands Public School	Mountain Range	
<b>Multiple School – Multiple Company Model</b>	<b>Skilling the Bay SS-STEM Project</b> Grovedale College Matthew Flinders Girls HS Oberon HS	Baum Cycles Barwon Water (2 schools)	Deakin University Skilling the Bay
	<b>QSTEM Hub</b> incorporating: Pine Rivers State HS Murrumba State SC North Lakes State College Townsville State HS William Ross HS Charters Towers School of Distance Education	Thales Townsville Engineering Services Cubic Defence Wilmar Sugar Meat and Livestock Australia	Queensland University of Technology (Brisbane) and James Cook University (Townsville)
<b>Multiple Organisation Model</b>	Adelaide High School Charles Campbell High School Glenunga International High School Hallett Cove School (R-12) Hamilton Secondary College Marden Senior College Mitcham Girls High School Reynella East High School Wirreanda Secondary School	Hewlett Packard Enterprises	Australian Information Industries Association  SA Department of Education and Childhood Development  Digital Technologies Network

### 3.5 Student Cohort

The year levels for the individual school-industry pilots resulted in two schools targeting Year 8, another two targeting Year 9 and two others Year 10. One primary school directed its focus to a combined Year 5 and 6 class.

Only one primary school participated in 2016 with another deciding that they were not ready to begin the process of developing STEM industry engagement until 2017.

Depending on the degree of organisation, schools have nominated a range of student groupings for participation in the project. In some cases, many classes have been nominated. Other schools have nominated between 10 and 50 students.

### 3.6 Co-ordination and Support

The co-ordination of the participation by schools was undertaken by Ai Group and included:

- formal communications with the schools
- identification of industry partners
- brokering partnerships and ongoing support as needed
- development and administration of surveys.

From the beginning, it was clear that many teachers would experience difficulty incorporating school-industry engagement into their curriculum. As a way of addressing this issue Ai Group contracted the Australian Curriculum Assessment and Reporting Authority (ACARA) to formally liaise with participating schools, to provide national professional development for teachers and industry, to provide curriculum and methodology assistance as required, to participate in the pilot evaluation and to collaborate with Ai Group on pilot project matters. A sample professional development program is provided at Appendix 3.

**Table 2: Ai Group-ACARA Professional Development Workshops**

No	Dates	Location and Activity
1	June 16	South Australian Professional Development Activity Professional Development Activity for participating schools conducted in Adelaide.
2	August 1	Victoria: Catholic Schools Professional Development Activity Professional Development program for participating Catholic schools and staff from the Catholic Education Office.
3	August 19	Dapto Learning Community (NSW) Professional Development Activity This activity focused on the professional development for schools within the community in preparation for the introduction of STEM programs in 2017.
4	November 11	Banksia International High School and North East Secondary Network curriculum leaders (28 staff), Modbury High School, The Heights High School, Valley View High School, Roma Mitchell High School, Golden Grove High School and Windsor Gardens Secondary College, DECD and University of Adelaide staff.

All professional development activities were conducted jointly by Ai Group and ACARA staff. The professional development workshops were delivered to 22 schools, 66 teachers and 12 representatives of educational jurisdictions.<sup>26</sup>

The participation in Queensland through the QSTEM Hubs initiative was of a different nature and did not require a professional development program. The schools in Geelong that are supported in a three-year program by Deakin University also declined the offer to participate as they were undertaking professional development with Deakin on STEM. Equally, in South Australia, Blackwood High School had undertaken an intensive program with the Australian Science and Mathematics High School. Ai Group provided support and industry assistance as required.

Almost 80 teachers and educators attended four workshops in New South Wales, Victoria and South Australia. In all states Ai Group included a wider cohort of teachers than were participating in actual projects. This was in recognition that the conversations and planning for STEM projects were still in their infancy for many teachers and this would enable a much broader base of teachers to have experienced the same learning.

### **3.7 Engagement with Industry**

Ai Group worked closely with schools and allies to provide appropriate industry partners across a wide cross-section of STEM-related industry areas. A very clear process was followed to broker direct school-industry partnerships for the projects/activities.

#### **3.7.1 Discussions with schools/teachers**

It was essential that discussions with schools took place first, to establish the level of school interest and potential commitment prior to contacting companies. Based on Ai Group experience from similar projects it was recognised that there was no guarantee of securing appropriate school partners if companies were approached first. It was also recognised that even with this approach there would be schools that would subsequently withdraw from the project for a variety of reasons.

#### **3.7.2 Identification of the STEM subject areas of focus for the schools**

Equally critical was determining what subject-area focus the specific teachers had. As mentioned, most teachers were focused on a science or technologies curriculum and it was at times challenging to find a suitable company and focus area that engaged the schools. Investigations of potential target companies occurred so that there was a tangible basis for discussions with schools.

#### **3.7.3 Targeting and contacting companies**

The process of identifying possible companies could be prolonged especially in terms of aligning potential target firms with school focus and interest. One of the key challenges was identifying specific companies that aligned with the curriculum interests of teachers. In most cases schools had

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<sup>26</sup> Final Project Report: ACARA and the Australian Industry Group, Australian Curriculum, December 2016.

no prior engagement with industry nor knew what companies might exist in terms of potential engagement. Companies were identified, researched and proposed to schools.

Only after discussions had taken place with schools and a reasonably strong expression of interest (along with time frames, year levels and subject[s] focus) had been clarified were companies contacted.

A standard process was followed for contacting target companies. In most the method of contact was an initial phone call to establish a personal connection followed by an email to the identified company representative. Most companies approached have been interested, co-operative, helpful and willing to participate. The company participants agreed to provide advice about real world projects, support for teachers and other classroom support as required. Several subsequently provided more support than was originally requested.

#### **3.7.4 Securing company support**

The process for engaging company support ranged from a very simple and quick process to the more extended exercises that involved working through several layers of management in larger companies.

The companies engaged ranged from multinationals to small local companies and the challenges in each are quite different. In a small owner-operated company the chief executive is able to decide and often engage and make all decisions. In larger companies the involvement was very dependent on willing volunteers from staff. Often, but not always, access was via the Human Resources manager. With a STEM project, it was also necessary to have operational staff willing to volunteer time.

The nature of the possible engagement and the process was outlined. This clarity was essential in enabling companies and schools to frame the type and amount of involvement. In many cases, it might be no more than 3-4 hours in total. This was of value in helping companies calculate the amount of time and resources that might be required rather than some loose and potentially demanding involvement.

#### **3.7.5 Brokering school meeting(s) with identified companies**

This component of the process was critical as it was at this stage that potential projects were identified or confirmed. In several cases the companies played a key role in suggesting alternative approaches and although it is not the role of companies to seamlessly identify curriculum-ready projects their unique understanding of the complexity of their operations was invaluable in helping teachers see what was possible in the classroom. Education systems and industry do not align perfectly and it was obvious at times that this was challenging. Equally challenging was the coordination of school timetables and company schedules. These constraints certainly prolonged negotiations.

In most cases once schools progressed to meetings with companies they continued to deliver or plan projects, although in several cases the projects shifted in line with school schedules. In others, such as the schools in the QSTEM project, the meetings were the beginning of the process for 2017 projects. In the case of the digital technologies network in South Australia, the teachers involved and

the Department of Education and Child Development (DECD) are progressing from a workshop to a planned series of professional development workshops throughout 2017, involving a state-wide cohort of digital technologies teachers in partnership with the AIIA.

One school has discussed a 10-year evolving partnership with the company it is interested in and is planning to incorporate VET courses as well as science and other STEM subjects with students beginning in 2016 and following classes as they progress.

In other instances, a few schools withdrew on the verge of securing identified companies. Again, timetables may have played a part but also it is possible that the concept of tackling a project became daunting in terms of the curriculum.

## Chapter 4: CASE STUDIES

### 4.1 Introduction

Considerable variety was achieved in many respects in the individual school-industry pilot projects. Individual schools participated from three States and included six secondary schools and one primary school. The participating students came from Years 5-6, Year 8, Year 9 and Year 10. The number of participating students also varied with groups of 23, 26 and 50 being the largest cohorts.

Similarly, the nature and size of participating companies was diverse. Smaller companies were represented by local nurseries, Lambley Nursery and Mountain Range Nursery. The companies increased in size from Comace, Rising Sun Pictures, Haigh’s Chocolates and BTG Australasia to the very large such as Seqirus. The participating companies came from a wide range of STEM-related fields including agricultural/horticultural science, building, media production, food production and medical science.

This diversity continued into the specific STEM projects that were undertaken which included:

- design and cabinet building project
- media promotion of vaccinations
- breeding tomatoes
- design of a new confectionary item for children
- contamination in laboratory environments
- game design and robotics
- construction of a greenhouse to support the school garden

### 4.2 Individual School-Industry Pilots

#### 4.2.1 Case Study 1: Henley High School, South Australia and Comace Pty Ltd

##### Pilot Summary

<b>School</b>	<b>Henley High School (Secondary), South Australia</b>
<b>Industry Partner</b>	<b>Comace Pty Ltd</b>
<b>Year Level</b>	<b>Year 10 VET Program Certificate 1 in Furnishing Skills</b>
<b>No of Students</b>	<b>11</b>
<b>Project:</b>	<b>Cabinet building project</b>
<b>STEM Focus</b>	<b>Mathematics (calculations) and Technology (design, materials selection)</b>

##### Introduction

The VET furnishing skills teacher at Henley High School wanted the students to have exposure to what is happening in the 21st century world of cabinet making and joinery. As he was a cabinet maker himself by background he knew how much the industry has changed and become far more linked to technology. Initially the school hoped to embark on a cabinet building project for the school but budget and timing in 2016 meant this element had to be deferred to 2017.



Comace Pty Ltd was established in 1981 and provides high quality commercial joinery and maintenance services to South Australian businesses operating in the commercial, retail and institutional markets. This is an award-winning design and manufacturing operation with state of the art equipment and processes and provided an excellent opportunity for students to see and experience how a modern joinery operates. Comace had been involved in a previous STEM project with Ai Group that operated in South Australia.

The connection with the company provided an excellent opportunity for students to spend half a day in the company onsite. This engagement also enabled students to see that furnishing skills in the 21<sup>st</sup> century go beyond woodworking and require not only maths but also strong digital skills as almost every part of the process is computerised.

The owner and Managing Director, Paul Williams, is committed to helping young people succeed and after the extensive site visit and workshop with students:

*“It was all good and I think we may have convinced some of the students to go down the trade career path... Proud to be a part of such a great initiative.”*

Students in this VET program clearly enjoyed being part of seeing a company like Comace and most commented on the scale and sophistication of the machinery. One said that the best thing about being involved was “being able to be involved with the production line”.

#### **Project: Preparation for Cabinet Construction**

Students gained an insight into current modern construction methods and the use of a wide range of innovative design software to plan and develop an industry standard product. The visit started with a short presentation on the history of the company and an insight into the landmark projects that Comace has worked on. This was followed with a tour of the facility which included the costing department. Students were given a short talk by the company’s costing analyst and developed an understanding of the tendering process and what is involved in costing out a large-scale project.

In the design suite, the students could watch the drafts people draw and manipulate designs in a 3D drawing program. It was at this point where they watched a small unit developed specifically for the site visit being drawn and then sent on to the Computer Numerical Control (CNC) for cutting. In the workshop students watched the CNC mill cut the cupboard that had just been sent through. The students watched as the CNC cut all the components to size and bored all the required holes.

The next stage involved ‘edging’ the components – putting a high impact PVC edge on all the components. The students were all able to operate this machine under supervision. Finally, there was a brief talk from Jack, a fourth year apprentice, who had just completed his training. He talked about the process of beginning your trade training while still completing his South Australian Certificate of Education (SACE). Jack then demonstrated the process of assembling a cupboard, using a variety of tools and hardware.

Both the school and the company are delighted with the connection and are committed to working on a more intensive project for students in 2017. The company has offered to provide support in cutting material and sourcing materials at cost for the teacher.

The skills focus for the students included:

- developing an insight into current industry standard production processes;
- developing an understanding of how technology is integrated into the design of high volume furniture production;
- developing students’ knowledge in flat pack furniture assembly;
- designing a range of storage solutions as required;
- selecting a range of hardware suited to application;
- developing an accurate cutting list; and
- developing a series of industry standard working drawings using a range of CAD programs.

#### 4.2.2 Case Study 2: Marymede Catholic College, Victoria and Seqirus

##### Pilot Summary

<b>School</b>	<b>Marymede Catholic College (Secondary), Victoria</b>
<b>Industry Partner</b>	<b>Seqirus</b>
<b>Year Level</b>	<b>Year 9 Media and Science</b>
<b>No of Students</b>	<b>23</b>
<b>Project:</b>	<b>Media promotion of vaccinations</b>
<b>STEM Focus</b>	<b>Science (health) and Technology (media production)</b>

##### Introduction

Initial interest from Marymede Catholic College in a possible STEM project followed a presentation given by Ai Group to a science teachers’ forum organised by Catholic Education in Melbourne. Following an approach from the science faculty at Marymede, Commonwealth Serum Laboratories (CSL) was suggested by the teacher as a potential partner. For a variety of mainly scheduling issues in 2016, the science department was unable to take up the opportunity. There were discussions about vaccinations and science communication with the media and visual arts teachers who were interested in the potential to incorporate a science message into an assignment that the Year 9 students were required to undertake – the production of a TV advertisement. The students are of course studying science at this level as well.

CSL is an Ai Group member and contacts led to CSL’s offshoot company Seqirus, formerly bioCSL, which manufactures and distributes flu vaccine globally. An interested staff member who was a scientist and manager from their operations area volunteered to be part of a school-industry STEM engagement. There was clear interest from Seqirus in such an engagement as a way of encouraging more students to look at science pathways.

Ai Group brokered a site visit to Seqirus with science and media teachers from Marymede. Approval was given for a project for year 9 students with a focus on science communication via a TV advertisement targeting young people. Ai Group and company representatives attended the presentations by the students of their advertisements and posters in late October 2016.

The school and the science faculty were delighted with the connection and all student teams researched science data and incorporated it into their advertisements. The science faculty and the school have also commented that they have seen how a STEM-industry project can be wrapped into the normal classes and can be an enhancement without needing to be large and costly. The school is very keen to continue to work with CSL and to develop a longer-term relationship with a stronger focus on science. This may take place via the CSIRO Scientists and Mathematicians in Schools program that CSIRO manages across Australia and which includes CSL.

The other advantage of this project was that technology was a key tool in conveying science messages and the interrelationship of different elements of STEM could be demonstrated, particularly the use of technology as an integral tool. The role of media in science communication was also appreciated.

Teachers made the following comments:

*“At first the scale of the project felt quite daunting, but now I feel it has opened up lots of opportunities”*

*“I found the students took the project to a higher standard knowing they were creating something for a ‘real’ industry.”*

A common thread with this group of students was about expectations of working independently but also in groups.

*“We were able to work as a group and have a little bit of freedom with what we could do”*

#### **Project: Media-Advertising Unit – Press Kit promoting flu vaccinations**

The following program summary is provided from the *Marymede Newsletter*.

*“This semester, the Year 9 Media students completed a STEM (Science, Technology, Engineering & Mathematics) project as part of their assessment for the unit on ‘Advertising’. In small teams, they were required to develop and produce a press kit that promoted flu vaccinations in Australia in the form of a television commercial and a print advertisement. This STEM project was developed in collaboration with Seqirus Australia (one of the world’s largest influenza vaccine manufacturing companies), the Australian Industry Group (Ai Group), and Catholic Education Melbourne (CEM). It was piloted at Marymede Catholic College and the project was quite unique in that it explored Science in the field of Media and Communications. Further to this, the students’ work was being created for a real audience and a real client, and it addressed a real issue in our society.*

*The final phase required students to present and pitch the work they created to the client. Representatives from Seqirus and Ai Group visited Marymede on Friday October 28 to speak with the Year 9s, watch their presentations, and give them feedback.”*

### 4.2.3 Case Study 3: Sacred Heart College, Kyneton, Victoria and Lambley Nursery

#### Pilot Summary

<b>School</b>	<b>Sacred Heart College Kyneton (Secondary), Victoria</b>
<b>Industry Partner</b>	<b>Lambley Nursery</b>
<b>Year Level</b>	<b>Year 9 Agricultural and Horticultural Studies</b>
<b>No of Students</b>	<b>14</b>
<b>Project:</b>	<b>Breeding tomatoes</b>
<b>STEM Focus</b>	<b>Science (horticulture and agricultural science), Mathematics (problem solving and calculations) and Technology (spreadsheets)</b>

#### Introduction

The approach from Sacred Heart College came via the Science coordinator who had attended the science teachers' forum in Melbourne. Ai Group attended a meeting at the school in Kyneton with the science faculty and the Principal and discussed several options in terms of researcher-business connections. After discussion, the school expressed interest in linking with a nursery in the region that was also involved in plant breeding and propagation. As the school was teaching horticulture and agricultural science it was decided to look at a 'paddock to plate' project that would also incorporate food technology and preparation. Ai Group brokered a meeting with Lambley Nursery and the Science Coordinator to discuss potential project options and the school decided to focus on breeding tomatoes.

#### Project: Paddock to Plate

The students:

- researched the origin of the tomato and its growing requirements.
- grew five different tomato varieties from seed.
- researched cross-pollination techniques for the tomato and developed a practical task on this with the tomatoes they had grown.
- identified reasons why developing a new tomato could be beneficial.
- researched tomato-based products and decided what to produce with the assistance of the canteen manager.
- designed labels finalised when the product to be made had been selected.
- undertook conversion of materials for scaling up recipes.

At the end of the project the students produced a range of chutneys for sale.

The company provided advice with regard to tomato breeding and the students had a site visit. This class is based on the unit 1 Agricultural and Horticultural study design which has the following underpinning knowledge requirements:

**Mathematics:**

- Solve problems involving direct proportions, graphs and equations.
- Solve problems involving profit and loss, with and without digital technologies.
- Sketching linear graphs.
- Calculate areas, surface and volume.
- Data analysis.

**Science:**

- The values and needs of contemporary society can influence the focus of scientific research.
- Ecosystems and the flow of matter and energy through a system.
- Independently plan, select and use appropriate investigation types including field work and lab experiments to collect reliable data.

**Technologies:**

- Use of spreadsheets.
- Investigate and make judgements on the ethical and sustainable marketing of food and fibre.
- Investigate and make judgements on how the principles of food safety, preservation, preparation, presentation and sensory perceptions influence the creation of food solutions for healthy eating.
- Analyse how food and fibre are produced when designing managed environments.

Teachers welcomed the opportunity for staff to utilise STEM from a pedagogical perspective within a diversity of subjects. Feedback also noted “the increased engagement of students due to participation in real-life applications of skills and learning”.

*“Most of the Sacred Heart students enjoyed the hands-on approach to this project and noted that as a highlight, along with working in groups.”*

And although for most the outdoor work was their favourite part of the project, one student said “it was fascinating cross-pollinating tomatoes and learning all about them when doing fact sheets”.

The second semester saw a focus on tomato production and use. The company provided advice with regard to tomato breeding and the students had a site visit.

**4.2.4 Case Study 4: Blackwood High School and Haigh’s Chocolates, South Australia**

**Pilot Summary**

<b>School</b>	<b>Blackwood High School (Secondary), South Australia</b>
<b>Industry Partner</b>	<b>Haigh’s Chocolates</b>
<b>Year Level</b>	<b>Year 8</b>
<b>No of Students</b>	<b>36</b>
<b>Project:</b>	<b>Design new confectionery item for children</b>
<b>STEM Focus</b>	<b>Science (food technology), Mathematics (problem solving and calculations) and Design and Technology (food design)</b>

## Introduction

The school approached Ai Group via one of the Department of Education and Child Development's Business Partnership Managers, hoping to link with Haigh's Chocolates in a project for students. A meeting was brokered and connections made with two managers with a keen interest in supporting students. Instead of the planned project focused on chocolate production, the Plant Engineer and the Production Manager discussed the more challenging project of making marshmallow.

The key classes utilised were Design and Technology, Food Technology, Science and Mathematics. Teaching staff were from these areas and 36 students were involved.

Haigh's provided:

- a separate visit with teachers and Ai Group to the factory discussing production and likely challenges for the students;
- ongoing advice to teachers;
- flavourings for students to test and trial in their project;
- a site visit to the school to brief students;
- a tour of Haigh's production facilities; and
- attendance at the final presentation to the company and Ai Group (on 30 November 2016).

The school staff at Blackwood High School had undertaken a previous problem-based learning program with the Australian Science and Maths School in Adelaide. Several staff had industry backgrounds. As a result, this project was thoroughly planned and structured prior to the school approaching Ai Group.

### Project: Haigh's PBL (Problem Based Learning) Project

There were two classes involved:

- Class One: Food Design (19 students)
- Class Two: Packaging & Mould Design (17 students)

Students were divided into teams of 4-6 members with half of the team focusing on food design and manufacture and the other half focusing on mould and packaging design (2-3 students in each area). All students collaborated on all aspects of the project.

The Haigh's PBL (Problem Based Learning) project commenced in Week 9 Term 2 (27/6/2016) and concluded in Week 6 Term 4 (27/11/2016). Weeks 7 and 8 in Term 4 were allocated to a school-based project debrief and PBL exit survey.

### Project overview:

- Problem Based Learning with an industry link (Haigh's)
- Defined brief aligned with industry partner
- Semester long project (18 weeks)
- Team teaching between Food Tech, Design & Tech, Science and Maths
- Focus on food manufacturing, supply chain management and financial scenarios
- Real product testing and development

- STEM focused (Maths, Engineering and Science focus)
- Students work in teams of 4-6, half will focus on food manufacture, and half will focus on mould design and packing. All will focus on aspects of STEM and manufacturing principles
- Teams will collaborate on a regular basis through various means (forums, team meetings, email); however will spend the majority of their time in their key area
- Students present final design solutions in a professional manner to a board of Haigh's representatives.

**Design Challenge:** Design a new confectionery product item for children.

The product must align with the Haigh's brand and values, and complement its existing product portfolio. Considerations must be made towards supply chain management and cost analysis, nutritional information, branding and packaging.

**Design Brief:** The specific design brief was determined by the student groups based on their research. Within their brief they identified their design goal and the target audience. For example, the product could be targeted at adults who purchase for children.

**Outcomes:** At the end of this project, teams presented a well-refined product that addressed all aspects of the brief and design challenge. They presented a product to a panel in its completed form; the product (detail of its production), its packaging and its marketing/ justification.

The aim of this problem-based learning project is that through an industry partnership, students develop a greater real world understanding of advanced manufacturing and manufacturing processes from a product development stage through to production. Strong consideration must be given to all aspects of the production cycle and manufacturing process.

At the end of November 2016 students presented their products and projects to not only Haigh's and Ai Group but also the South Australian Minister for Education and Child Development. The mini-expo format meant that all teams not only produced product for tasting and judging by the visitors but also posters, and discussed their challenges and processes.

This was a highly successful outcome and the Managing Director of Haigh's, Alistair Haigh, and his two engineering managers who had supported the students were very impressed. Not only were they impressed by the standard of product produced by Year 8 students but also the focus and type of school engagement that enabled a much deeper link to understand the STEM requirement of a modern manufacturing company.

The company has said they are willing to continue this type of engagement with Blackwood High School and possibly other schools. The company engineers volunteered considerably more time to this project than had been requested and one said "participating in this type of activity is a natural part of the engineering profession".

## 4.2.5 Case Study 5: Banksia Park International High School and BTG Australasia, South Australia

### Pilot Summary

<b>School</b>	<b>Banksia Park International High School (Secondary), South Australia</b>
<b>Industry Partner</b>	<b>BTG Australasia Pty Ltd</b>
<b>Year Level</b>	<b>Year 8</b>
<b>No of Students</b>	<b>41</b>
<b>Project:</b>	<b>Contamination</b>
<b>STEM Focus</b>	<b>Science (biology, laboratory operations), Mathematics (problem solving and calculations) and Technology</b>

### Introduction

Following conversations with an interested school in Adelaide in late 2015 the contact with BTG was established. BTG is a global biopharmaceutical company located in the Barossa Valley.

*“Our growing portfolio of Interventional Medicine products is designed to advance the treatment of cancer, severe emphysema, severe blood clots, and varicose veins, while our Specialty Pharmaceuticals portfolio offers antidotes that alleviate toxicity and treat rare conditions.”<sup>27</sup>*

The facility in South Australia consists of laboratories in the Barossa Valley and a sheep property of 4,000 ha in the Clare Valley with 6,500 sheep. The Australian operation is focused on producing serum from sheep’s blood that is used to produce CroFab® rattlesnake antivenom for the US market. [CroFab® is the only U.S. Food and Drug Administration (FDA) approved treatment indicated for the management of patients with North American crotalid envenomation. Crotalids, also known as pit viper snakes, include rattlesnakes, copperheads, and cottonmouths/water moccasins].

It was planned that a school would undertake a project with BTG in July 2016. Unfortunately, the original school withdrew in June 2016. Fortunately, the company was still interested in a link with another school. With support from key Department for Education and Child Development (DECD) regional managers in the north-east suburbs of Adelaide a meeting was brokered with the Principal and Science Coordinator at Banksia Park International High School in August 2016.

The interest and support from the school was very clear from the outset as was a focus on developing a long-term industry relationship. In addition to a focus on science there was equal interest in further development of the Certificate III in Laboratory Operations through TAFE SA that is co-located in the school site. The school sees that student exposure to a real company’s laboratories will be invaluable.

A site meeting at BTG was organised in early September by Ai Group that was highly productive and set the scene for collaboration. Following the meeting the school and company continued discussions and refined the first project for Year 8 students to undertake in the final term of 2016. The Science Coordinator said that he wanted to see this entry level project as the introduction to

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<sup>27</sup> BTG website.



industry engagement for the school and hopes to progress STEM projects with BTG as this class moves up through the school, in addition to the Cert III already mentioned. The Principal indicated they were keen to start with small steps and develop methodically.

The school brokered a site visit for the students and some 50 students attended a two-hour site visit with staff at BTG in early November. Ai Group and other DECD representatives as well as teachers also attended.

It was an extensive and thorough visit and many of the messages and information provided by the six company staff who enthusiastically managed the influx of some 50 students were absorbed by most students. A regional DECD Manager who also attended provided the following feedback to the company after the visit:

*“Experiencing the company’s daily scientific work has blown away many students and staff. The students’ conversations have ranged from ‘I would like to be a scientist’ to ‘this is amazing’ and ‘who would think this farm had a lab in it, sheep’s blood’.”*

BTG were equally pleased with the site visit and have provided the following initial feedback from the site visit:

*“The pleasure was ours. The staff who were involved got such a buzz out of their interaction with the students and were equally impressed with the standard of questions coming from some of them. I’m glad that the students had some takeaways from the presentation and tour; that’s what it’s all about... Happy to continue the support in this development of future talent.”*

### **Project: Contamination in a Laboratory – BTG Pharmaceuticals**

In collaboration with BTG the school prepared a project based on a scientific problem/issue that BTG may face in its industry. Contamination avoidance is a major issue, especially for an FDA accredited laboratory.

One of the further benefits that the school is hoping for is the development of a Certificate III in Laboratory Operations through TAFE SA. Links with industry will allow students to observe lab operations in a scientific context. Students worked through the project with a STEM/problem-solving approach, working together in small groups over a 3-4 week period.

Students presented their findings in a *Shark Tank* style presentation, involving employees from BTG and other external panellists.

The school will assess the project against several Australian Curriculum standards integrated from science and maths. The students also undertook self-assessment-reviewing their role and contribution to their respective teams and the project. The students were expected to develop STEM skills such as group work, problem solving, analysing data and oral presentation. Additional STEM teaching pedagogies were advanced through liaison work with University of Adelaide and their project-based learning model.

Success criteria included the following:

1. Each group completes the project and presents their final product to a panel of 'experts'.
2. Students demonstrate an understanding of STEM in the presentation of their product.
3. Each student can present and articulate their role in the project.

The following Curriculum learning areas will be addressed:

**Mathematics:**

- Solve problems involving profit and loss, with and without digital technologies

**Science:**

- Describe situations in which scientists collaborated to generate solutions to contemporary problems
- Consider safety and ethics when planning investigations, including designing field or experimental methods
- Construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions
- Use appropriate language and representations to communicate science ideas, methods and findings in a range of text types.

**Technologies:**

- Investigate the ways in which products, services and environments evolve locally, regionally and globally through the creativity, innovation and enterprise of individuals and groups.
- Use project management processes individually and collaboratively to coordinate production of designed solutions.

In early December 2016 student teams presented their findings on their contamination project to representatives from BTG Australasia, Ai Group, the University of Adelaide and managers from the Department of Education and Child Development. This was done as a marketing 'pitch' to 'sell' their solutions to dealing with contamination to BTG at a competitive price.

This was clearly an excellent project and the teachers supported by BTG had delivered a high-quality learning experience for the Year 8 students within a very short time frame. Many students expressed nervousness about presenting to an outside audience but conveyed a high level of professionalism and ability to articulate what they had undertaken. Another particularly impressive element was that the two teachers involved required every team to articulate their STEM applications throughout this project. The company was equally impressed and its support for an ongoing engagement is warmly welcomed by the school and teachers involved.

The Principal provided the following comment:

*“I heard very exciting feedback about changes in students’ engagement from the initial stage to the end result. For example, one of the students I heard present was quite disinterested initially and her engagement changed entirely to that of high level interest and participation.*

*I am very delighted with the way this collaboration has been working despite its tentative beginnings (as one might expect with a new initiative) and I look forward to the program continuing. All of the staff and students have accepted the opportunity and challenges with positivity and determined actions. Thank you for your ongoing leadership, enthusiasm and support to help us on our way.”*

*Lyndall Bain, Principal*

Most students liked that they worked in groups, although several noted issues within their individual groups. Many more found presenting to ‘important people’ stressful and this for the majority would have been the first time they had to speak publicly to outsiders. Most enjoyed the experiments and knowing they had a real-world application:

*“It was cool to do the experiments”*

*“I think what I liked most was seeing what bacteria was growing after we put it on the agar plate”*

*“The learning was deeper (info as well). We got straight into it as well”*

*“The project allowed me to come forward and contribute in ways I didn’t think I could do. It was really interesting and engaging”*

BTG was equally pleased with this involvement and provided the following comments after participating in the student presentations:

*“The student presentations were amazing, the thought, preparation and coordination that went into them was great to see and Chirag and I were fortunate to have had the opportunity to hear their presentations.*

*“We would relish the opportunity to be involved again; the thought of mixing industry with education really excites me. We have an obligation to ensure we manage our recruitment future and through this program we are preparing this path by creating an awareness for kids about the employment opportunities they have in their regions.”*

## **5.2.6 Case Study 6: Brighton Secondary School, South Australia and Rising Sun Pictures**

### **Pilot Summary**

<b>School</b>	<b>Brighton Secondary College (Secondary), South Australia</b>
<b>Industry Partner</b>	<b>Rising Sun Pictures</b>
<b>Year Level</b>	<b>Year 10</b>
<b>No of Students</b>	<b>21</b>
<b>Project:</b>	<b>Animatronics and Robotics</b>
<b>STEM Focus</b>	<b>Digital Technology</b>

## Introduction

There is a concern that not one school encountered in this project initiated any discussion about a digital technologies focused project. This was addressed in part by brokering professional development with Hewlett Packard Enterprises. In addition, Rising Sun Pictures (RSP), a global firm developing highly sophisticated visual effects for films and television, was approached about its potential involvement. This company is all about high-end computing skills and art and visual skills. RSP has a partnership with UniSA and collaborates with TAFE in terms of developing the programs and graduates they need for their business. The skills they need are in short supply in Australia and to reduce reliance on international hiring they have a very strong focus on education and a desire to communicate to students the variety of jobs available to graduates with maths, science and computing studies.

Principals from two South Australian high schools expressed keen interest in pursuing a connection with RSP. The company considered ways to engage more meaningfully with schools and a briefing session at the offices of RSP was arranged for teachers from the two schools that wanted to proceed. RSP offered a free place in their in-house training in Houdini for one of the teachers who was keen to utilise it in his Year 10 game design course. These teachers also attended the professional development day that Ai Group conducted in conjunction with ACARA representatives.

Unfortunately, several months later one school had to withdraw.

### **Project: Year 10 Animatronics and Robotics**

Two teachers from Brighton Secondary School proceeded to develop projects for their students. One looked at Year 10 game design and the other at Year 10 robotics, particularly animatronics.

A site visit to the school was arranged at which RSP's education manager presented to several classes of students and showed a video about RSP and samples of its work in films. Many students clearly were excited by the opportunities in an industry they were not aware of. The opportunity to see how special effects are utilised was best illustrated by a high-end video production and presentation to students in the school theatre. This was considered to be more appropriate than students undertaking a site visit to RSP.

Unfortunately, RSP's education manager left the company to take up a new job shortly after and there was a considerable gap before a replacement was appointed. Confidentiality agreements for post-production film contracts blocked the potential of site visits. Staff absences have also impacted on the school and although one project has been completed for students studying animatronics the disruptions for staff in both organisations have impacted on the opportunity to utilise the connection fully. In addition, the demands of the film industry have limited access to individual RSP staff who could provide advice to the teachers.

The benefit of this teacher training was transmitted to the students through an animation project that incorporated art and design as well as computing skills. The opportunity to visit RSP meant that the teachers could see how computing, special effects and robotics could all come together and generate more interest for students. This was of particular interest for Brighton Secondary College which has a strong school focus on arts, especially performance.

In 2017 RSP’s new education manager is planning some full-day teacher educator days, in addition to continuing the school visits. It was also suggested by the school that it would be useful for teachers to have some assistance with the mathematics involved in the computer programs such as Houdini and Nuke. A meeting was arranged with DECD, Brighton Secondary School, RSP with the Australian Association of Mathematics Teachers (AAMT). AAMT is a partner in the national re-Solve Project to discuss potential for an industry collaboration with RSP in terms of a real world industry linkage between maths and digital technologies. AAMT is considering this opportunity in 2017.

The teacher for the animatronics project noted that they would have benefited from more one-to-one time with the company to fully utilise the connection and technologies but also said:

*“Overall students have demonstrated greater engagement and enthusiasm towards units that are STEM designed.”*

In addition to many appreciating the inclusion of art and creativity in animatronics, most enjoyed a more hands-on approach to learning, as well as freedom to be more creative. A common thread running through students’ comments can be captured by the following observations:

*“I learnt a lot of new things that I would never learn in other classes. I also like that this subject is a combination of multiple subject areas so you get a lot of variation with the tasks that you completed in class.”*

*“More creative and using such interesting new mediums like programming, 3D modelling and sculpting.”*

*“Learning how computers and programming works, and incorporating art into it to make it more enjoyable and not as threatening.”*

Students’ comments ranged across many areas and some found this introduction to a new style of learning challenging and missed a more structured approach. This also emerges in feedback from some students in most projects in this pilot.

This was the only project that not only incorporated digital technologies but also quite deliberately the arts – STEAM. The marriage of technology and creative arts was a clear success for the teacher and it was obviously engaging for most students.

#### **4.2.7 Case Study 7: Lakelands Public School, Dapto (Illawarra, NSW) and Mountain Range Nursery**

##### **Pilot Summary**

<b>School</b>	<b>Lakelands Public School (Primary), NSW</b>
<b>Industry Partner</b>	<b>Mountain Range Nursery</b>
<b>Year Level</b>	<b>Years 5 and 6</b>
<b>No of Students</b>	<b>24</b>
<b>Project:</b>	<b>Construction of a greenhouse to support the school garden</b>
<b>STEM Focus</b>	<b>An integrated project involving Science (biology, climate, sustainability), Mathematics (calculations) and Technology (design, materials selection)</b>

The teacher in this primary school in the Illawarra was looking at ways to engage some disengaged students and started a school garden. The teacher realised this was an excellent opportunity to link the teaching of STEM subjects to an activity the students were clearly enjoying and initiated a small project and secured some funding to build a greenhouse to complement the garden.

The school sought help to identify an industry partner to provide technical and business knowledge and advice. Ai Group sourced and contacted a local export nursery with a strong community focus and the Chief Executive agreed to support the school. A key part of any school-industry pilot has been to not only link the curriculum to real world examples but also to enable students to visit and meet with a company. The first site visit to the company with the students in mid-November was a success and the teacher advised it exceeded their expectations. The students have visited the nursery and will present their designs to the company and other companies for 'judging' and advice. In addition, the teacher has connected with the local high school and students have visited and had some mentoring from the students at the high school.

The students became so interested in the garden that they started coming to school earlier to work in the garden and wanted to spend extra time there during lunchtime and recess. An added benefit has also been increased parent engagement and involvement.

### **Project: Building a Greenhouse**

Throughout this unit, students explored sustainability and energy with a specific focus on creating and building their own school greenhouse. Students have developed their own knowledge and understanding through STEAM 'challenges', independent research and specific lessons. The students investigated the concepts of sustainable design, what plants need to grow, photosynthesis and how the analogy of the microclimate within a greenhouse relates to the global greenhouse effect.

Students have engaged in local, national and global issues that are relevant to their lives and the maintenance of a sustainable future. They will be able to discuss how science and technology directly affect people's lives and are used to solve problems.

During this unit students examined the scientific principles of climate change and energy. They used that knowledge to design their own greenhouse. There is a significant sense of practicability when designing the greenhouse as one (or more) will be built in the school.

A builder, teacher, principal, real-estate agent and horticulturalist decided which student proposal and design was the most practical, well researched, investigated and structurally sound. Students used the mathematical skills to research and investigate where to place the garden in the school. They needed to create and observe their own tests to ensure that their selected location is the best in the school. Students designed a blueprint for their greenhouse and justified and explained their chosen materials. Throughout the unit students engaged and utilised a variety of technologies to assist in creating a comprehensive proposal.

The school had a very clear goal in terms of what they were hoping to gain from the link with Mountain Range Nursery.

*“We would like to seek assistance and knowledge from Lance and the local community garden group. We would like them to help us establish our greenhouse plants and watering systems and support us in the future.” – Lakelands Teacher*

The project finished in early December and the school sees this as an ongoing connection. What began as a tool to interest disengaged students has become not only an effective STEM project but also a vehicle for engaging families and community in a low SES region. The community gardeners based at Mountain Range Nursery have also become involved with the school through this project. The garden will continue to be a source of learning for future students in the school as will the greenhouse as different plants are selected and established. As mentioned, the school is considering building more greenhouses with future classes.

The teacher has also spent considerable time in developing this structured approach to the curriculum and clearly is interested in sharing this experience with other schools that form part of the Dapto Learning Community of seven schools (five primary and two secondary).

At the end of the project one of the teachers said that *“students all want to take part in STEM and the garden group”*

He also noted increased engagement by students in teams and projects as well as cognitive engagement.

One student commented: *“I like it because I’m learning something new and spending time with other people.”*

All seven schools in the Dapto Learning Community attended the ACARA workshop organised and funded by Ai Group that was held in Dapto in August 2016.

### 4.3 Multiple School-Industry-University Models

In addition to the single school-industry pilots a further model emerged which comprised multiple schools and companies as well as a key university presence. There were two main examples of this:

- **QSTEM Pilot: Queensland University of Technology (QUT), James Cook University (JCU), Queensland**
- **Skilling the Bay-SS-STEM: Deakin University, Victoria**

The support provided to QUT and JCU with their delivery of the QSTEM pilot initiative funded by the Queensland Department of Education and Training illustrated a good potential model of a tripartite STEM industry-university-school engagement (Appendix 4: QSTEM Hubs Flyer).

The engagement with Deakin University and Skilling the Bay also evolved to include a similar role with the SS STEM Project in Geelong, Victoria (Appendix 5: Geelong Region Schools STEM Curriculum Industry Link Scoping Paper). In these models the university faculties of education provided intensive support to selected schools to develop STEM strategies. Deakin University is continuing to do so in partnership with Skilling the Bay in Geelong. Teacher educator institutions are ideally placed to provide pedagogical support for teachers in the education systems, notwithstanding that their core business is research and teaching students at university.

The role of Ai Group in both engagements with the universities above was to:

- provide support as a Reference Group member in Queensland and as a Steering Committee member on the SS-STEM project in Geelong;
- provide advice to teachers about how to engage with industry through initial setting of the scene and awareness raising of the value of industry;
- provide advice to teachers about how to approach and establish industry partnerships;
- provide information to teachers about examples of school-industry partnerships; and
- identify and broker industry partnerships based on focus and interests of schools and teachers.

In the case of the six Queensland schools in Brisbane and Townsville, Ai Group identified potential industry partners and brokered introductions based on either general areas of interest such as science or technology, or a specific focus such as “the maths involved in coding Unmanned Aerial Vehicles (UAVs)”. Ai Group recruited the following companies to the project: Thales Australia, Wilmar Sugar, Cubic Defence, Townsville Engineering (TEi Services Pty Ltd) and Meat and Livestock Australia.

In the case of the engagement with Deakin University and Skilling the Bay, initially it was intended that four schools in Geelong would be involved in individual school-industry partnerships. However, structural or staffing changes in 2016 in two schools meant that the discussions failed to progress beyond the concept stage where Ai Group had identified potential industry partners. In the cases of the two schools that did embark on industry projects both did so without further Ai Group involvement beyond the initial meetings with companies. In both cases the individual teachers felt confident and utilised their involvement in the Deakin STEM project to suit their own circumstances. One teacher did say that industry partnerships can be difficult and very time consuming. What was also clear is that in both latter cases these teachers were heavily involved in the Deakin SS STEM initiative and focused their efforts in that direction.

Deakin University and Skilling the Bay have begun discussions about possible assistance in brokering industry engagement for their schools in 2017 and consider that there is more work to be done in developing schools’ capacity to engage with industry. One comment was that for many of their schools the first time that most schools had contemplated industry engagement was in meetings with Ai Group in late 2015 and several felt unprepared to embark on industry projects in 2016. This has been noticed elsewhere. It seems that without support from systems or extensive professional development this will continue to be an issue for many teachers.

The clear advantage of such a tripartite involvement between an industry group, university and schools is that it has the potential to address the very real issues around STEM and pedagogy and can bridge the gap between industry and curriculum.

Given that STEM or industry initiatives are increasingly coupled with project-based learning, this compounds the challenges for many teachers who are unsure of how to implement these elements.

But neither university education faculties nor schools have the connections with, understanding of or ready access to industry. The role of an intermediary industry organisation such as Ai Group is significant given such organisations’ connections with and understanding of industry. However, such



school supporting roles are not their core business. There are certainly advantages in setting up engagements of this nature in a structured way; however, the issue of funding such initiatives needs to be considered.

#### 4.4 Multiple Organisation Model

The project has uncovered a potential third model of school-industry engagement in STEM. This model not only involves multiple schools and companies, but other key organisations as well. The specific example in this project is the combination of Ai Group, the Australian Information Industries Association (AIIA), Hewlett Packard Enterprises (HPE), the South Australian Department of Education and Child Development (DECD) and one of its teacher networks, the Digital Technologies Network.

Given the centrality of teachers to any school-industry partnerships, there was recognition that brokering engagements between industry and networks of teachers in particular disciplines were likely to produce more sustainable models of engagement.

The introduction of the new digital technologies curriculum was the reason to reach out to digital technologies companies with a view to bringing industry needs and focus to digital technologies teachers. In part this was in recognition of the reality that many schools and teachers were experiencing difficulties with how to bring 21<sup>st</sup> century digital relevance to their classes. It was also in recognition that student numbers in computing and related studies, especially among females, had declined just as skills shortages were escalating in Australia. Finally, this also acknowledged that across Australia there were shortages of trained digital technologies teachers and connection with contemporary industry requirements would be of value.

It was suggested that Ai Group contact the Chief Technologist of Hewlett Packard Enterprises (HPE) in Adelaide who was also the South Australian chair of the AIIA's Special Interest Group on Education. This initial contact focused on HPE and the potential for a workshop with digital technologies teachers in the DECD who were part of a regional network. The company had a focus on education, primarily at the university level where they support an Honours degree in IT with the University of South Australia (UniSA). But HPE were receptive to the request to trial outreach to groups of teachers as a useful vehicle to extend engagement and aid in addressing the student pipeline by encouraging interest in the early and middle high school cohort of students. They were also receptive to the argument that there were efficiencies to be gained by reaching out to and informing teachers who would in turn impact on many students, rather than student centred initiatives that may not engage as many teachers.

This would not have occurred without the support of the DECD and its involvement in a digital technologies network of teachers. This professional development also extended to another region via DECD. Digital Careers (CSIRO) was invited to also participate and promote the outreach and support available to teachers and students via CSIRO.

Over 20 teachers from nine schools attended the half-day workshop at HPE. The workshop was supported by the UniSA and HPE included several of their interns from their annual intake of the Bachelor of IT (Honours) degree at UniSA.

HPE were so pleased by this initial professional development they encouraged the South Australian branch of AIIA's Special Interest Group on Education to adopt this approach to school engagement. This has led to agreement by AIIA to support an ongoing series of four workshops for digital technologies teachers across South Australia through 2017 and potentially beyond (Appendix 6).

A professional development program consisting of four presentations delivered by members of AIIA will take place in 2017. The focus areas support students' dispositions, skills and understandings to prepare them for work and pathways in a rapidly changing world with an unpredictable future. The program will be open to schools across South Australia and will include at least one regional component.<sup>28</sup>

This model suggests that with support and drive from the relevant education system personnel and the support of an industry body (in this case HPE and AIIA), there is the potential for similar models to be replicated across other states and education systems and potentially into other industry areas. It is noted that the drive and passion from both the individuals in HPE and DECD were essential in moving this beyond a single event.

Many industry associations and organisations have a strong focus on education and produce resources for both teachers and students. Industry bodies by their nature have a broad range of companies among their membership. Frequently they are at the forefront of emerging industry developments in their sectors along with key issues including workforce and skills issues.

#### **4.5 Industry Associations and Research Organisations**

A further development resulting from the project was the establishment of a partnership between Ai Group and CSIRO through the Scientists and Mathematicians in Schools (SMiS) program. The aim is to increase the number of industry professionals to showcase real-life science, technology, engineering and maths skills and careers.

This program links practising scientists, mathematicians, engineers and IT professionals with classroom teachers and their students to generate interest and motivation in STEM through real-world exposure. Of the 1,972 active program partnerships across Australia, only 13 per cent of STEM professionals came from industry and corporate businesses. Cisco, an Ai Group member, is involved in the SMiS program as part of its organisational commitment to tackle Australia's STEM skills shortage.

This initiative between a major peak industry association (Ai Group) and a major research organisation (CSIRO) has potential to promote the value of STEM skills and knowledge to an increasing number of school teachers (Appendix 7).

In their review of the CSIRO Scientists and Mathematicians in Schools Program, the authors concluded that:

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<sup>28</sup> The following dates were proposed: Thursday 16th Feb 2017 8:30 - 12:30, Wednesday 15th March 2017, Wednesday 24th May 2017 and Thursday 15th June 2017.

*“Commitment to the partnership, clear and active communication, flexibility and effective management of expectations are important for partnerships to prosper. We have become convinced that engaging students with STEM professionals, under the right conditions, can be a highly effective feature of school STEM curriculum. We need, however, to develop a clearer understanding of the specific knowledge, skills and orientations that the STEM professionals bring to a school setting. This involves finding ways in which they can interact with students and teachers to make effective use of their expertise and time. We need also to frame the curriculum to encourage and support teachers to create space to make the most of such partnership opportunities.”<sup>29</sup>*

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<sup>29</sup> The Conversation: Partnering with scientists boosts school students' and teachers' confidence in science – Russell Tytler, Coral Campbell, David Symington, Gaye Williams-Deakin University: April 27, 2016.

## Chapter 5: PROJECT EVALUATION

### 5.1 Overview of Methodology

The evaluation methodology for the pilot was based on:

- consultation with key partners/stakeholders to ensure consistency and comparability of measures across the schools involved in the proposed pilot(s);
- research into other STEM school-industry programs/initiatives conducted elsewhere; and
- the scale and duration of the pilot(s).

Ai Group undertook considerable research to identify suitable options for evaluation for a small limited duration pilot. Notwithstanding the interest in engagement with industry as a model to drive higher STEM interest among students, there were very few reports identified that specifically highlighted the methods of evaluation for school-industry pilots. However, Research Council UK's *Evaluation: Practical Guidelines* document provided a very useful guide for evaluation of small projects.<sup>30</sup>

Information shared by staff from the New South Wales Department of Education's Integrated STEM Program and by ACARA based on their STEM Connections Project also informed the model of evaluation to be undertaken.<sup>31</sup>

There is a focus to ensure that as far as possible outcomes, not outputs, would be measured. It was also acknowledged that although guidelines could be given to schools and partners there were no guarantees that all projects would be measured in the same way. Although Ai Group developed and provided surveys the manner of distribution and timeliness of this was in the hands of the teachers.

### 5.2 Qualitative Evaluation

This involved a mapping of STEM projects/initiatives across Australia in parallel with extensive and ongoing consultation with:

- Industry;
- Education systems and educators including schools and universities; and
- Key stakeholders including industry associations and companies.

This process identified key issues to be addressed and informed decisions on the focus, aims and structure of the proposed pilot options to be considered.

As a result of the mapping exercise several potential pilot options emerged and all were considered against the recommended evaluation criteria:

- Potential to be supported across multiple jurisdictions and education sectors if possible to enable sustainability beyond the life of the STEM Skills Project

<sup>30</sup> Evaluation: Practical Guidelines, Research Councils UK, April 2011.

<sup>31</sup> ACARA STEM Connections Project report, ACARA, June 2016.

- Integrated STEM into school curriculum or linking to curriculum (enhance student learning outcomes)
- Manageable scale for schools (adequately resourced)
- Potential for industry role (ideally national) (benefit both school and industry and support of business and school leadership)
- Teachers' and students' involvement and support (support of the school community/benefit both school and industry/enhance student learning outcomes).

### 5.3 Evaluation Surveys

Based on research and consultation, the survey questions in Appendix 8 were developed.

Consultation has taken place with the following:

- Deakin University
- New South Wales Department of Education
- South Australian Department of Education
- Associate Professor Terry Lyons, Queensland University of Technology
- ACARA regarding the 2014-15 STEM Connections Project

Research included consideration of the Research Council UK's *Evaluation: Practical Guidelines*<sup>32</sup> and *School-industry STEM links in the UK: A report commissioned by Futurelab*.<sup>33</sup>

From the outset, it was determined that it was important as far as possible to ensure consistency with similar projects/programs and their evaluation in terms of the survey questions. The NSW Department of Education's Integrated STEM Program survey questions were shared and were particularly relevant. ACARA was also consulted and provided input regarding the survey approach.

It was clear that in a small, limited duration project the major focus for measurement is any attitudinal change on the behalf of participants after undertaking the activity/project.

It was also acknowledged that real issues exist in terms of getting survey responses from teachers and students. There has been discussion about managing these issues for pre- and post-activities surveys for both teachers and students and whether it is worth compromising by seeking only post-activities surveys.

The issue of survey fatigue must be acknowledged. For example, in the case of the Deakin University SS STEM schools, the participants had been extensively surveyed by Deakin University already.

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<sup>32</sup> Research Councils UK, *Evaluation: Practical Guidelines*, Department for Business Innovation and Skills, April 2011.

<sup>33</sup> Anthony Mann and Adrian Oldknow, *School-industry STEM links in the UK: A report commissioned by Futurelab*, March 2012.

However, notwithstanding these challenges it was decided to commit to pre- and post-surveys for students and aim to do the same for teachers. Additionally, post-activity reviews with teachers, and hopefully with a selection of students, were planned.

For industry, it was planned to use pre- and post-surveys and individual reviews with the companies. Teachers will participate in these post-activity reviews with companies wherever possible.

### 5.4 Student Survey Evaluation

All participating students were administered with a pre-program survey. The following table indicates the gender and total student participation by school. With the exception of some schools, overall the gender balance was relatively even. There were 170 student responses overall to the survey.

**Table 3: Number of survey respondents by school**

School	Male	Female	TOTAL
Banksia International High School	18	23	41
Brighton Secondary School	5	20	25
Marymede Catholic College	12	9	21
Sacred Heart College	9	5	14
Henley High School	9	2	11
Blackwood High School	24	10	34
Lakelands Public School	11	13	24
<b>TOTAL</b>	<b>88</b>	<b>82</b>	

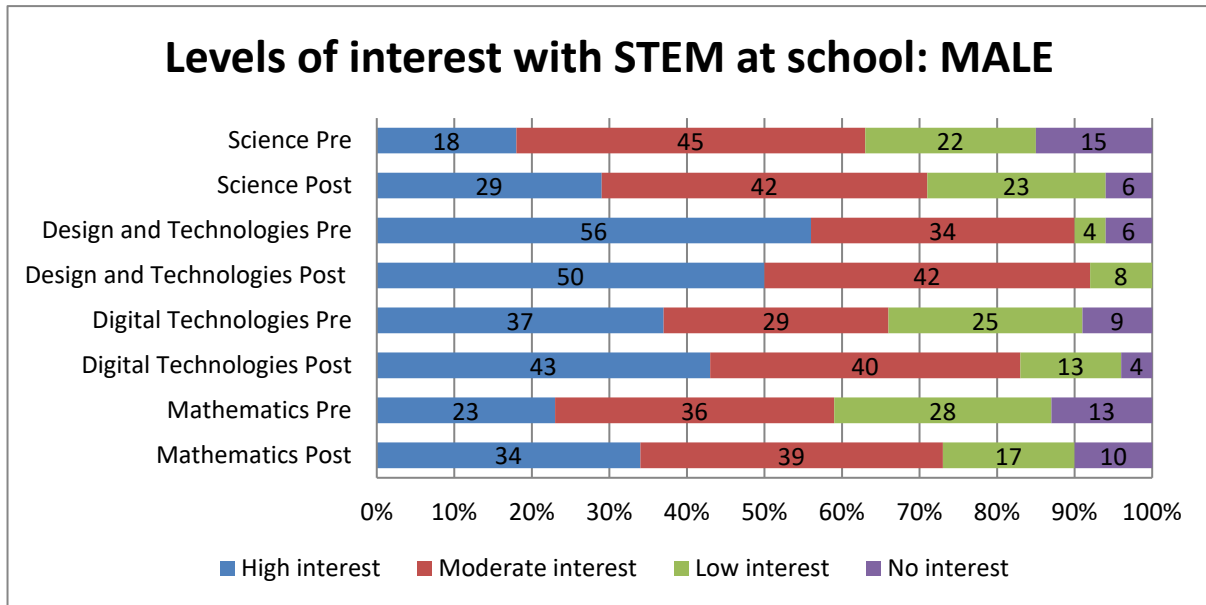
In terms of participation by year level, Year 8 had the largest grouping (75 students), followed by Year 10 (36 students) and Year 9 (35 students). There were no participants from Years 7, 11 or 12. There was one participating primary school with combined students from Years 5 and 6.

**Table 4: Number of survey respondents by year level**

School	Male	Female	TOTAL
Years 5 and 6	11	13	24
Year 8	42	33	75
Year 9	21	14	35
Year 10	14	22	36
<b>TOTAL</b>	<b>88</b>	<b>82</b>	

The pre-pilot program survey sought information about student interest in each of the STEM disciplines. Students were asked to classify their interest as 'high', 'moderate', 'low' or 'no'.

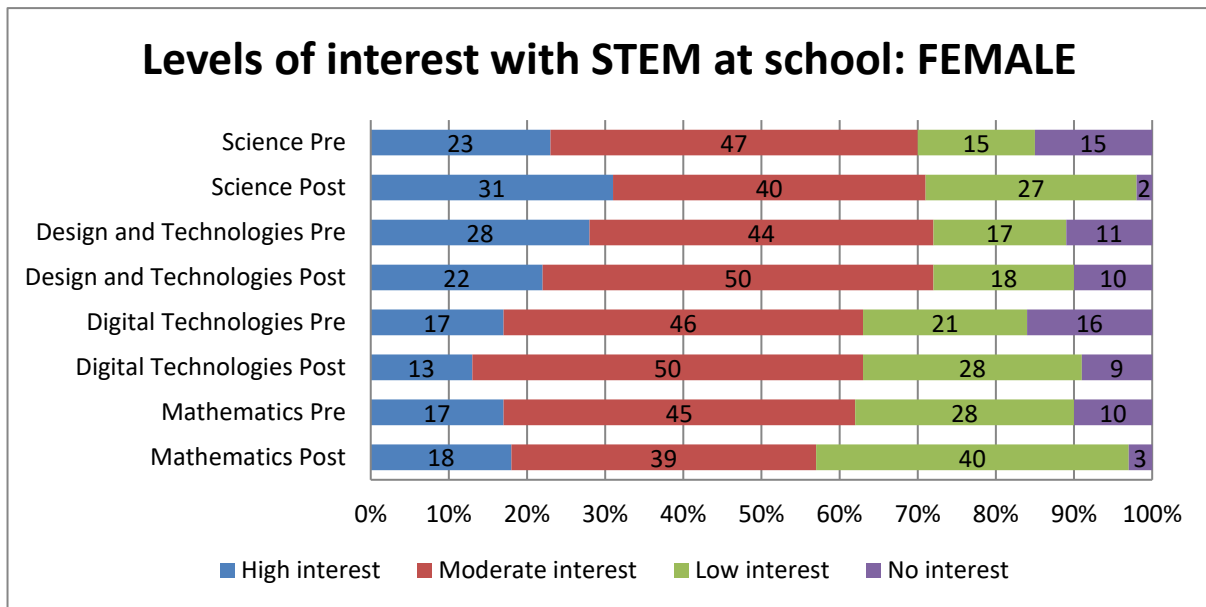
Chart 1: Level of STEM interest at school: Male



Male students recorded the greatest levels of interest in Design and Technologies and Digital Technologies, and the lowest in Science and Mathematics.

All four STEM-related subjects showed an increase in total interest (high interest and moderate interest combined), with the biggest changes recorded for Digital Technologies (from 66 per cent to 83 per cent) and Mathematics (from 59 per cent to 73 per cent) in post-pilot compared to pre-pilot testing.

Chart 2: Level of STEM interest at school: Female

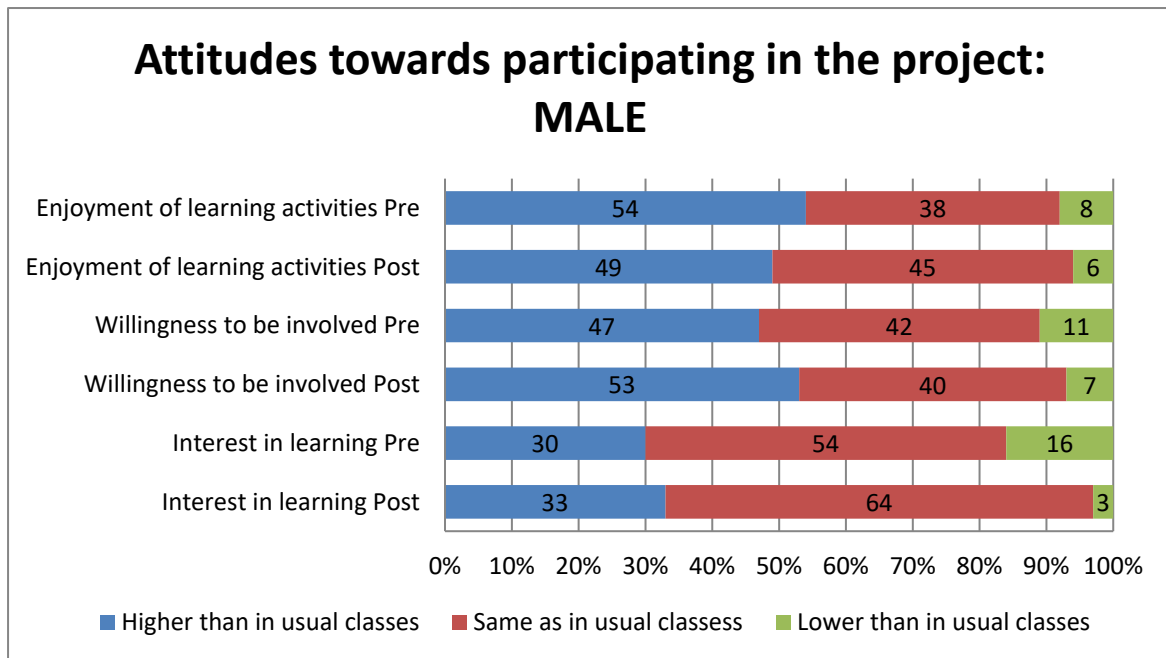


Responses from female students were more evenly spread across the subjects, with noticeably fewer ‘high interest’ responses than the male students. Highest total interest was recorded for Design and Technologies, and Science.

Mathematics recorded a slight drop in total interest in post-pilot compared to pre-pilot (62 per cent to 57 per cent) for female students. While total interest in Science remained relatively unchanged, more students recorded ‘high interest’ in the post-pilot phase (from 23 per cent to 31 per cent). The opposite was recorded for Digital Technologies, also unchanged on a total level, where ‘high interest’ recorded fewer responses post-pilot. Design and Technologies also remained relatively unchanged.



**Chart 3: Students' attitudes about project participation: Male**

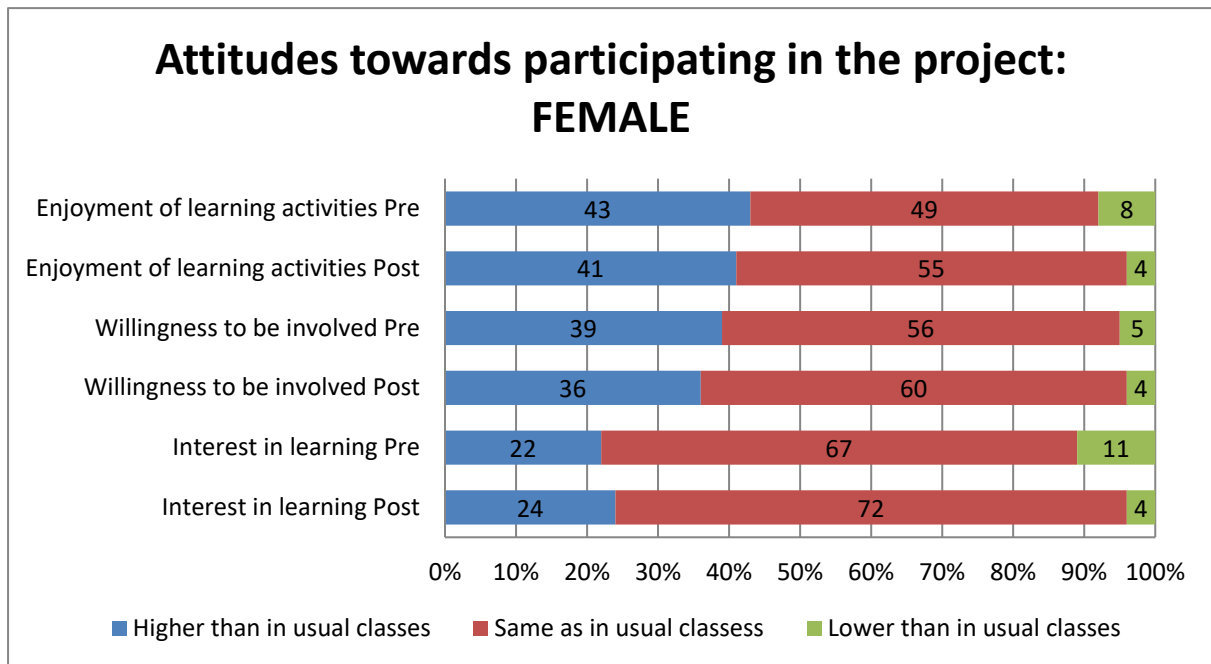


All students were asked about their attitudes across three areas compared to other classes: enjoyment in project-based learning activities, willingness to be involved in group activities and interest in learning.

About half of the male students reported enjoyment of learning activities as ‘higher than in usual classes’, though this fell slightly in post-pilot (49 per cent compared with 54 per cent at pre-pilot). The opposite occurred for willingness to be involved, with more students noting this as ‘higher than in usual classes’ in post-pilot testing (47 per cent and 53 per cent).

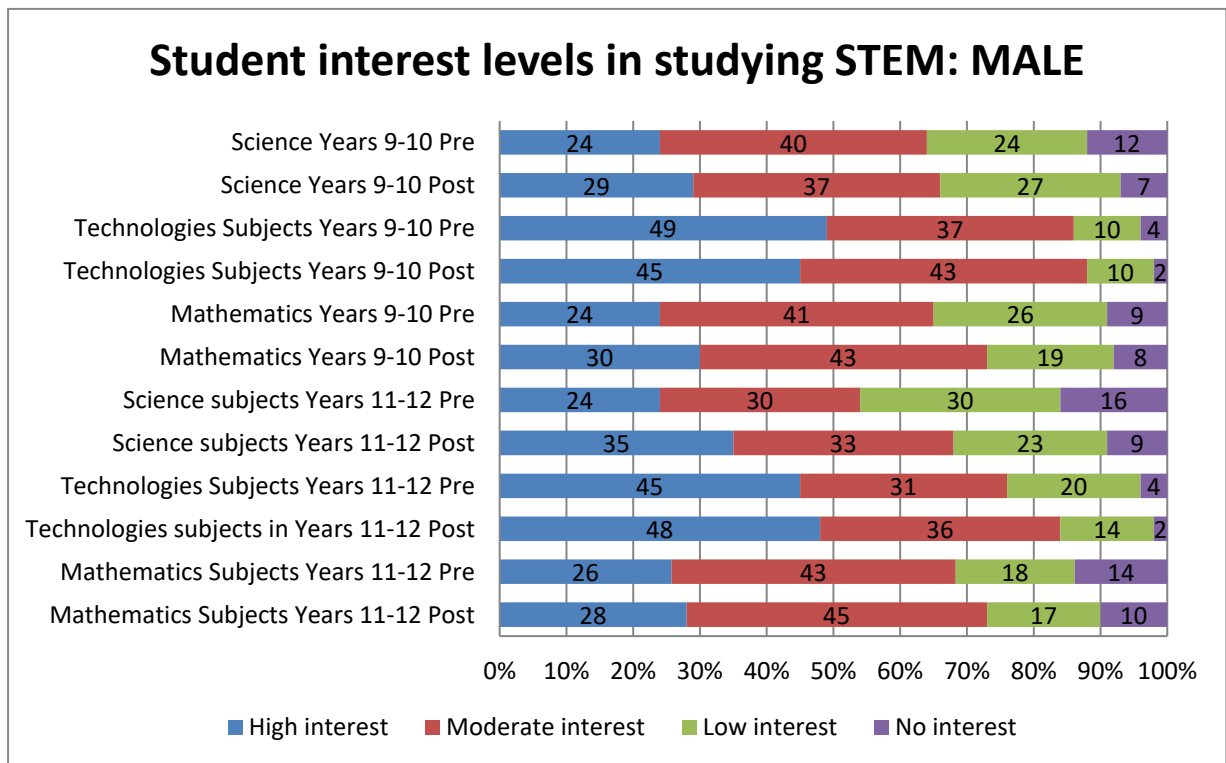
In comparison, only about a third of students rated Interest in learning in the project as ‘higher than in usual classes’ (30 percent in pre-pilot and 33 per cent in post-pilot). However, fewer students rated interest in learning as ‘lower than in usual classes’ post-pilot as compared to pre-pilot (3 per cent from 16 per cent).

Chart 4: Students' attitudes about project participation: Female



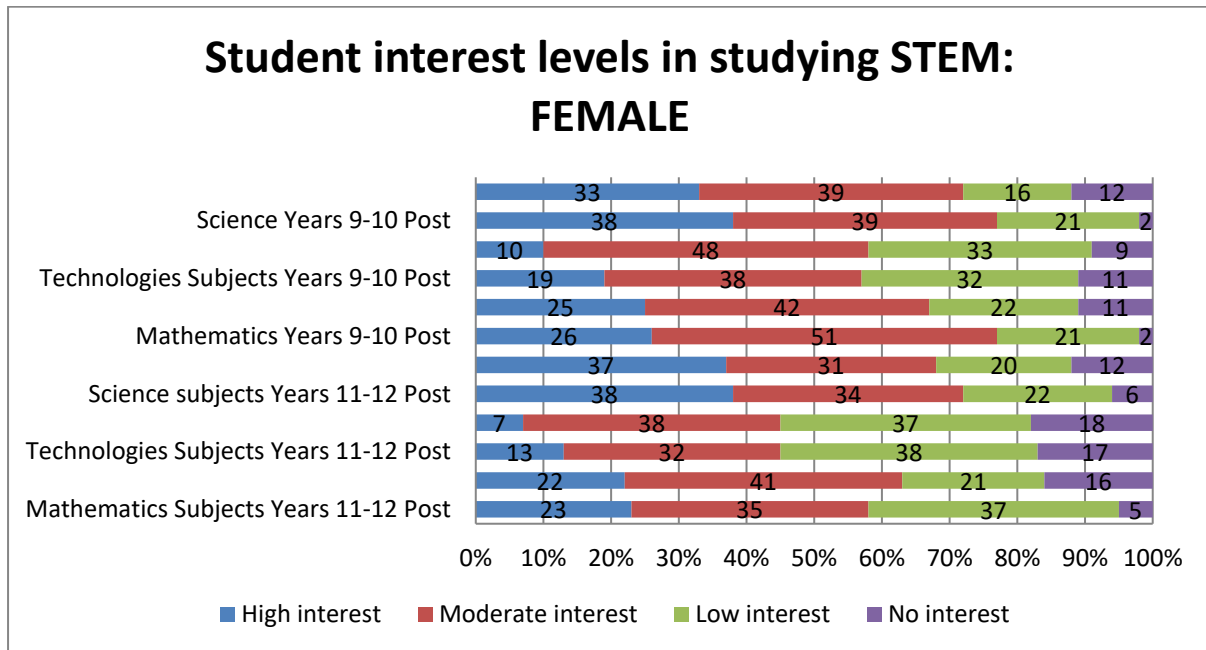
Across the board, attitudes towards the project by female students were less favourable than for male students. Among female students ratings of the program as ‘higher than in usual classes’ in terms of enjoyment of learning (from 43 per cent to 41 per cent) and willingness to be involved (from 39 per cent to 36 per cent) both dropped slightly in post-pilot testing. As with males, ratings of the project as ‘higher than in usual classes’ in interest in learning slightly increased in the post-test phase for female students, and ratings of ‘lower than in usual classes’ for this measure dropped noticeably (from 11 per cent to 4 per cent).

Chart 5: Student interest levels in studying STEM: Males



For males, levels of interest in studying STEM were similar between Years 9-10 and Years 11-12, with almost all subjects achieving over 60 per cent total interest (high and moderate interest combined). For both groups, total interest levels ('high interest' plus 'moderate interest') increased across subjects from pre-pilot to post-pilot. 'High interest' in studying increased in almost all subjects, with the exception being Technologies Subjects for Years 9-10, which recorded a slight drop (from 49 per cent to 45 per cent).

Chart 6: Student interest levels in studying STEM: Females

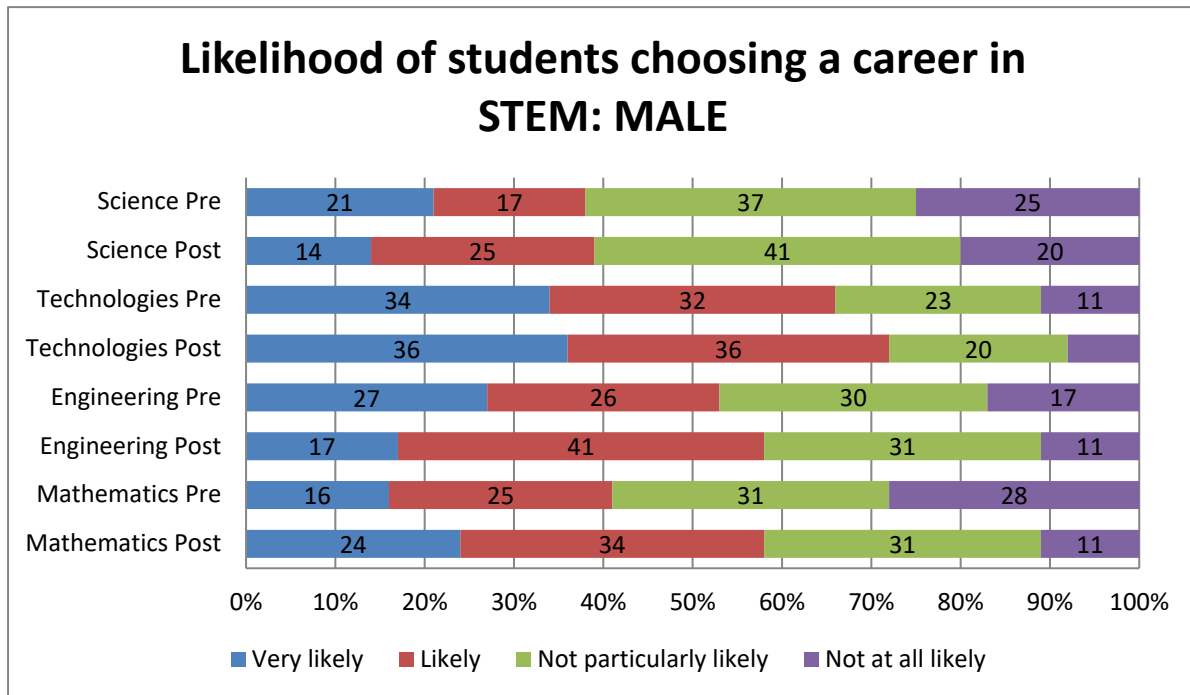


Although interest levels for female students were quite different from the male students, interest rates of studying STEM subjects were again similar for Years 9-10 and Years 11-12. Total interest levels were higher in general for Years 9-10 than Years 11-12, particularly so with Technologies Subjects and Mathematics.

For these students, all subjects recorded increases in ‘high interest’ in post-pilot compared to pre-pilot. Total interest in Science increased for Years 9-10 (from 72 per cent to 77 per cent) and Years 11-12 (from 68 per cent to 72 per cent) and remained relatively stable for Technologies Subjects in both year groups.

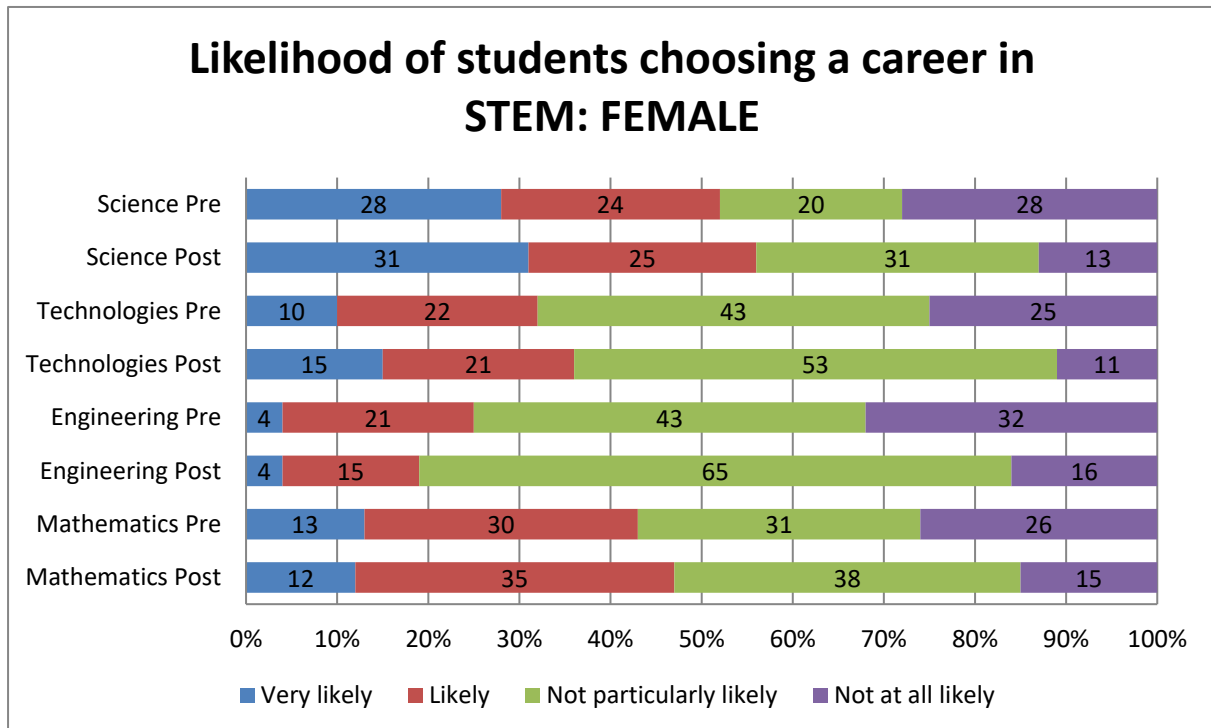
Total interest in Mathematics dropped slightly for Years 11-12 (from 63 per cent to 58 per cent) in post-pilot compared to pre-pilot, but rose notably in Years 9-10 (from 67 per cent to 77 per cent).

Chart 7: Likelihood of students choosing a career in STEM: Males



Finally, students were asked about their likelihood of choosing a career in a STEM field. For male students, total reported likelihood (‘very likely’ plus ‘likely’) increased in post-pilot compared to pre-pilot. Slight increases were recorded for Science (from 38 per cent to 39 per cent), Technologies (from 66 per cent to 72 per cent), and Engineering (from 53 per cent to 58 per cent). Mathematics recorded a 17 per cent jump in total likelihood (from 41 per cent to 58 per cent). Interestingly, fewer students were ‘very likely’ to choose a career in science in post-pilot (from 21 per cent to 14 per cent), with the opposite recorded for Mathematics (from 16 per cent to 24 per cent).

Chart 8: Likelihood of students choosing a career in STEM: Females



Female students recorded a lower likelihood of pursuing careers in Technologies and Engineering, and a higher likelihood in Science, than did male students.

Total likelihood levels were generally higher in post-pilot, with Science (from 52 per cent to 56 per cent), Technologies (32 per cent to 36 per cent), and Mathematics (43 per cent to 47 per cent) recording more ‘very likely’ and ‘likely’ responses compared to pre-pilot testing. Only Engineering recorded lower total interest in the pre-pilot phase (from 25 per cent to 19 per cent). Notably, across all four subjects, ‘not at all likely’ recorded noticeably fewer responses in post-pilot compared to pre-pilot for female students.

### 5.5 Teacher Evaluation

Altogether there were 12 teacher survey responses, predominantly classroom teachers of science, mathematics and technology subjects. In some circumstances, some of the teachers were teaching in areas where they were not qualified. For example, there was an unqualified teacher teaching the Essential Mathematics subject. This practice was not widespread among the surveyed teachers.

Teachers were asked whether they were likely to undertake the following activities.

**Table 5: Teacher likelihood of undertaking STEM activities**

	Pre-Pilot Attitudes			Post-Pilot Attitudes		
	Not Likely	Somewhat Likely	Very Likely	Not Likely	Somewhat Likely	Very Likely
Team teach with colleagues	1	4	7	0	3	8
Collaborate with staff from other subject areas	2	3	7	0	2	9
Use computer technology with the class	0	3	9	0	0	11
Use STEM Technologies with the class	1	4	7	0	1	10
Collaboratively plan units of work with other subject teachers	2	3	7	0	2	9
Seek innovative ways to assess students	0	6	6	0	2	9
Engage with Industry in classroom projects	2	7	3	0	2	9

Encouragingly, teachers’ reported likelihood to undertake these activities notably increased from pre-pilot, with no teachers indicating they were ‘not likely’ to undertake these activities in post-pilot testing. Particularly strong differences were recorded for ‘engage with industry in classroom projects’, ‘seek innovative ways to assess students’, ‘use computer technology with the class’, and ‘use STEM technologies with the class’.

**Table 6: Teacher confidence in STEM activity**

	Pre-Pilot Attitude			Post-Pilot Attitude		
	Not Confident	Somewhat Confident	Very Confident	Not Confident	Somewhat Confident	Very Confident
Teach Integrated STEM units	2	7	3	0	3	6
Lead Integrated STEM Projects	4	5	2	0	3	6
Approach companies to connect to STEM-related curriculum	4	6	2	0	4	6

Teachers were then asked to rate their confidence levels in relation to some STEM activities. Overall, reported confidence levels increased for teachers at post-pilot compared to pre-pilot, with a strong increase in 'Very Confident' responses in post-pilot testing and none recorded for 'Not Confident'.

In terms of the level of collaboration in the school project team, 90 per cent of the teachers rated 'very high' or 'high'. The teachers were also asked how important they believed STEM to be to secondary education: 80 per cent rated this 'very important' and the remaining 20 per cent rated this as 'important'.

**Table 7: Changes in student behaviour in relation to certain measures**

	Increased	No Change	Decreased	Not Applicable (non-teaching position)
Completion rates for assessment tasks	4	5	0	1
Levels of participation in activities	8	1	0	1
Engagement with peers, such as willingness to work in groups	9	0	0	1
Cognitive engagement, such as willingness to ask questions	7	2	0	1
Reported levels of satisfaction with project-based learning	8	1	0	1
Company engagement	6	2	0	1

Teachers were also asked to rate how student behaviours have or have not changed on a range of measures during the STEM pilot project. Teachers strongly indicated increases in all measures except for 'completion rates for assessment tasks', for which the most common response was 'No change'. No teachers indicated a decrease in any of the measures.

**Table 8: Changes in student learning**

	Increased	No Change	Decreased	Not Applicable (non-teaching position)
Number of students achieving learning outcomes as indicated by performance on in-school assessments	6	3	0	1
Level of understanding of high-level concepts	9	0	0	1
Level of understanding of application in future career paths for students	9	0	0	1



Teachers were also asked student learning changes in certain areas following participation in the STEM pilot program. All teachers reported that ‘level of understanding of high-level concepts’ and ‘level of understanding of application in future career paths for students’ increased post-pilot compared to pre-pilot. Two-thirds of surveyed teachers reported an increase in ‘number of students achieving learning outcomes as indicated by performance on in-school assessments’. Again, no decreases in these measures were recorded.

**Table 9: Rating of Ai Group support**

	Very useful	Somewhat useful	Not very useful	I did not attend
Identifying and brokering industry partnerships	10	0	0	0
Assisting with project development	6	4	0	0
Co-ordinating company visits	8	2	0	0
Assisting through ACARA training	6	2	0	2

Teachers were asked to rate the usefulness of a range of support types provided by Ai Group for the pilot STEM project. All identified types of Ai Group support were rated as ‘very useful’ or ‘somewhat useful’. The most positive responses were received for ‘Identifying and brokering industry partnerships’ and ‘Co-ordinating company visits’.

**Table 10: Rating of company support**

	Very useful	Somewhat useful	Not very useful	Did not attend
Willingness to become involved in school-based project	5	5	0	0
Mentoring teacher(s)	1	8	1	0
Mentoring/supporting students	4	3	2	1

Similarly, teachers were asked to rate the usefulness of several support types provided by companies for the pilot STEM project. The teacher ratings were generally, but not universally, favourable. The mentoring of teachers and the willingness of companies to be involved in school-based projects were rated the most highly.

Many teachers also made additional comments:

*“The STEM pilot aligned very well with our existing Design curriculum that focuses on using the design cycle to solve real world design contexts. The pilot gave us increased opportunities*

*to co-teach across subject areas and engage with an industry partner that would have been more challenging to establish.”*

*“The students are more willing to be involved in group work, and are more willing to express their opinions.”*

*“The support of ACARA through the professional development day that was provided by Ai Group was highly beneficial. This is due to the fact that there were specific examples from successful STEM projects.”*

*“It was a thoroughly enjoyable program that provided endless opportunities for both teachers and students. We really appreciate the support of Ai Group.”*

### 5.6 Industry Evaluation

Prior to the project, participating employers were asked about the nature of their engagement with schools.

**Table 11: Company engagement with schools**

	Select all that apply:
Sponsor events/activities/resources	1
Provide work experience opportunities	4
Offer internships	1
Offer apprenticeships	0
Offer scholarships	0
Offer awards	0
Volunteer to speak to classes of students	2
Participate in career events	2
Host site visits at my company	3
Provide resources for students	2
Provide resources for teachers	2
Participate in STEM curriculum lessons	0

The most common engagement activities were providing work experience opportunities (4 responses) and hosting site visits (3 responses).

In relation to supporting STEM activities in schools the main responses were: hosting school visits (4 responses), talking with students (3 responses), providing teacher resources (2 responses) and supporting school projects (2 responses).

**Table 12: Reasons for project involvement**

	Select all that apply:
I am concerned about the declining STEM skills in the workforce	3
I am struggling to recruit the skills I need in my business	1
I might find opportunities for future recruitment	3
I want to engage with my local school: <i>replies said ANY school</i>	3
I like the idea of real world projects for students to do	6
My firm has a corporate responsibility objective focused on education	3
My firm’s corporate head office wants us to engage with community	3
I think a school project is more practical than sponsorship	3
I want to support teachers to know more about the world of industry	4
I want teachers to know more about what we need for future workforce	4
Doesn’t seem too onerous in terms of my firm’s time and resources	3
Other ( <i>please describe</i> ): Example response: “I am involved in a range of STEM activities outside of work. This was a good opportunity to expand these.”	

Employers were asked why they agreed to be involved in the pilot project. A wide range of responses were received with the most prominent being support for real world projects for students (6 responses), support for teachers to know more about industry (4 responses) and wanting teachers to know more about the needs of the future workforce (4 responses).

In terms of how employers became involved the most common response was being approached by Ai Group (4 responses). Other responses included volunteering (2 responses) and the manager asking for volunteers (2 responses).

**Table 13: Nature of industry involvement**

	Select all that apply:
Meeting with Ai Group and teacher(s)	4
Assisting with project development	4
Factory/facility tour for teachers/Ai Group	4
I suggested the project	1
I approved the school nominated project/activity	1
Provided research materials/web links to teachers	1
Provided research material to students	0
Provided other materials/samples	3
Participated in STEM lesson(s) at the school	1
Hosted class at business premises	2

Ongoing mentoring through the project to teacher/students-in person/via email etc.	1
Training in-house	0

Employers were also asked about their nature of involvement in the project. The most common responses were ‘Meeting with Ai Group and teachers’, ‘Assisting with project development’, and ‘Factory/facility tour for teachers/Ai Group’, followed closely by ‘Provided other materials/samples’. The range of responses reflected the diversity of industry involvement. These responses also indicate the potential role of industry in partnerships with schools.

Some employers made additional comments such as:

*“Time requirements for the project were less than expected.”*

*“I want our industry to be visible and attractive to graduates and school leavers. STEM has often been associated with capital intense manufacturing and mining, which have appeared risky as employment options. I am keen for students to see alternatives.”*

Employers were also asked to estimate their commitment in terms of time and other resources. The most common responses were 4-8hours and 8-12 hours. Employers found it difficult to estimate costs. One response indicated the cost of a staff member for three days at a cost of \$800. Another cited \$200 worth of product samples and another \$20 in awards and prizes.

**Table 14: Involvement and expectations**

	Responses
Ai Group clearly explained the involvement	3
I was welcomed and our company’s involvement was clearly appreciated	4
The teachers were professional and committed	4
The teachers communicated with me	4
The students were polite	4
The students were interested and asked questions	4
The final presentations were good	4
Other comments: <i>“The student presentations were amazing: the thought, preparation and coordination that went into them and we were fortunate to have had the opportunity to hear their presentations (Year 8 class).”</i> <i>“All went extremely well and had a great day with student involvement (Year 10 class).”</i> <i>“The final presentations were creative and demonstrated a really good understanding of the project. The students were very enthusiastic (Year 9).”</i>	

Employers were asked about whether their involvement in the project met their expectations.

In all cases it was reported as a positive experience. It was a benefit to have the nature of the involvement explained before the engagement and employers found it rewarding to work with both teachers and students.

Finally, the employers were asked if they would participate in a similar project again. This produced a range of positive responses:

*“We would relish the opportunity to be involved again; the thought of mixing industry with education really excites me. We have an obligation to ensure we manage our recruitment future and through this program we are preparing this path by creating an awareness for kids about the employment opportunities they have in their regions.”* **BTG Australasia**

*“In 40 years of involvement with schools this is the first time we have had an engagement like this with schools. Happy to do so again and to look at other schools.”* **Haigh’s Chocolates**

*“I think we got to teach the students what actually happens in a working environment. Very much a hands on practical sense that they wouldn’t learn from books or in a class room. Happy to do so again.”* **Comace Pty Ltd**

*“Thanks to the students and teachers and Ai Group for allowing Seqirus to participate in this project. Very rewarding.”* **CSL-Seqirus**

## Chapter 6: SUMMARY OF RESULTS AND IMPLICATIONS

### 6.1 Project Findings

#### 6.1.1 STEM Programme Index 2016 (SPI 2016)

The first part of the project, mapping STEM programs and initiatives across Australia, led to the production of the SPI Index 2016, a resource that has been widely disseminated across states and territories. It has provided a comprehensive guide to some 250 programs and initiatives across Australia.

The enthusiasm with which it has been received by schools highlighted a real gap in information about STEM programs. Clearly such an index is a very useful tool for many teachers to get information about what is available in terms of STEM engagement programs, competitions and resources across Australia.

The SPI index 2016 has proven to be a welcome and useful resource for teachers although it was always recognised that it did not capture all the programs that exist around Australia. As with all resources of this type, currency is a challenge and ongoing resourcing is always essential for this.

It also needs to be recognised that such a resource, while providing a rich variety of information, may be mostly for the already interested students and teachers. The challenge is to reach the less interested and motivated so that program implementation can reach a critical mass.

#### 6.1.2 Nature of Industry Commitment

In overall terms, most of the companies approached to be involved in the project were keen and interested in connecting with schools. In most cases support relied upon senior management approving engagement and keen staff who volunteered. Both elements were essential for effective industry engagement. It was the specialists, usually scientists/engineers/technologists within the companies who were key to engagement because of their understanding of STEM.

Informed by previous Ai Group STEM engagement it was clear that senior management interest alone was not sufficient. Finding enthusiastic individual staff was critical to a successful engagement with schools. In more than one instance the staff volunteers had a history of volunteering in other projects, some in STEM competitions.

It was interesting to see how the local, national and/or international focus of companies affected the engagement. In some ways, it was easier to negotiate with small local companies which often had more flexibility in terms of time. In some larger companies, especially with existing STEM initiatives, the only way to engage was through employees volunteering for programs. This was openly acknowledged by several managers.

In at least one case, although operations staff were very enthusiastic, it is not certain if the engagement will be ongoing with individual schools as the company already is involved in and supports major national STEM initiatives. The decision will be made at a corporate level.

This issue is not uncommon. The logistics and costs of releasing individual staff for involvement in single school initiatives can be challenging for companies. In many ways support, for example, for a

competition/initiative organised by a third party, can be much simpler. In addition, corporate social responsibility objectives and social licence to operate objectives come into play. Realistically higher profile engagements may serve these objectives better than one-to-one involvement with individual students and classes.

An additional dilemma exists as while it is often inspiring for companies to interact with keen, bright students, it is less so when the students are less engaged or not engaged at all. In reality, it is the less engaged who are in greater need of being enthused and inspired to see how STEM studies, or any studies, are important for their futures. Interacting with reluctant students can be very disengaging for companies and staff volunteers. In one instance in this project, the students were very poorly behaved on a site visit and the company involved will never deal with that school again. In an earlier project, an enthusiastic company volunteer openly stated that he only maintained his commitment and engagement because the students were clearly interested.

Again, the role of intermediaries and teachers can assist with this but it is more rewarding dealing with enthusiastic and articulate students.

The report into the EU inGenious project found motivations for industry engagement were primarily driven by the need to see higher numbers of STEM skilled workers in the future. A paper presented at the 2013 ESERA (European Science Education Research Association) Conference noted when examining the ECB/inGenious project, a range of obstacles including time, motivation, personnel changes and different motivators between schools and industry can all be factors.

*“School collaboration is performed by enthusiastic people. If there will be changes in the positions the co-operation will soon die out. Only in very well planned and large projects the collaboration will survive the change of personnel”. (Finnish Report)<sup>33</sup>*

### **6.1.3 Teacher Confidence**

One of the issues to emerge from the school-industry pilots was the matter of teacher confidence. This was important in two key areas: confidence to tackle STEM-related curriculum, including potentially in an integrated way with other colleagues; and the confidence to embark on school STEM projects in concert with an industry partner.

For most teachers, there seemed to be an interest in enhancing students’ engagement in subjects and bringing real world scenarios to the classroom as a way of driving engagement. All teachers who were involved spoke about STEM being important and a key focus. Others were aware that STEM was being widely discussed but openly expressed concern about what exactly would be expected of them as teachers. There was concern expressed about how to implement STEM projects by many teachers. Certainly, most if not all expressed interest at the outset in partnerships with industry. Equally clear was that most teachers found this type of engagement unfamiliar and lacked any training in how to proceed.

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<sup>33</sup> Establishing and Maintaining STEM-Related School-Industry Partnerships: Opportunities and Obstacles: Raquel Rios Font, Anna Artigas Roig and Roser Pinto Casulleras, CRECIM, Universitat Autònoma de Barcelona, Bellaterra, Spain 2014 [https://www.esera.org/media/esera2013/Raquel\\_Rios\\_13Feb2014.pdf](https://www.esera.org/media/esera2013/Raquel_Rios_13Feb2014.pdf)

Many schools and systems were interested in STEM and looking for new ways to interest students. Possibly some teachers were curious rather than interested. Certainly, many found the road unclear. Some teachers viewed the project as 'extra' rather than as providing an alternate delivery mode or as a way of enhancing existing programs.<sup>34</sup> Others said that in the main, industry engagement projects only work effectively as extra-curricular activities. However, in at least three schools this was not the case (but in all three the teachers involved utilised the industry connection to enhance what was already being taught). Considerable work had been undertaken by individual teachers to map the curriculum linkages.

The schools connected with had a mix of experiences and expertise in terms of STEM initiatives. Some teachers clearly felt very comfortable with STEM and the concept of industry links although how that played out varied considerably.

And a further comment was made that school-industry engagement is time consuming and difficult for schools. It seems that there may have been a missed opportunity to experiment with a different approach, notwithstanding the very clear competence and expertise of the teacher in a range of STEM subject areas.

One school with staff with strong industry backgrounds clearly was confident in terms of developing a relationship with a company they identified, and in managing curriculum to support the engagement. Another equally saw engagement as a tool to illustrate to students what the 21<sup>st</sup> century industry they were studying looked like.

Several teachers commented that the ACARA Workshops provided useful tools, especially in terms of mapping the achievement standards. One teacher said that it was a pity this resource could not be available in 2017 as many more teachers are just beginning to explore how they can integrate STEM into their classrooms beyond 2017.

One school spoke about interest in industry engagement as a way of illustrating the importance of mathematics in construction. Others saw project-based learning as a way of engaging students. One teacher who participated had certainly started his project with a view to engaging disinterested students and found that project-based learning had benefits not only for student engagement in STEM subjects but also for parental engagement. Another teacher spoke of the unexpected benefit of students "lifting their game" because they would be presenting to an outside company.

But others were unclear. Many teachers are not ready for effective industry engagement and some are resistant to using real-world opportunities.

Given the critical role that teachers play, it may be far more effective to focus on empowering teachers through professional development and capacity in terms of bringing real world examples into the classroom.

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<sup>34</sup> Final Project Report: ACARA and the Australian Industry Group, Australian Curriculum, December 2016



#### 6.1.4 Structural barriers: Resources

A frequently given reason for schools not engaging is that teachers are too busy and overloaded. The cost of teacher relief time is also cited as a barrier to activities that go beyond the school, as are budgets for students to travel/buy equipment/attain software licences.

On many occasions, inflexible timetables were given as a reason for not undertaking cross-curriculum work and project-based learning. Several teachers commented that project-based learning is difficult to incorporate into school structures. In the instances where teachers aligned industry projects with existing coursework it was much more straightforward.

The change of personnel or their roles and responsibilities led to at least two projects not proceeding. In at least one school that withdrew it seemed that the champion teachers were moved to other positions or were on leave and they had no colleagues who were available or interested in carrying an industry pilot forward.

In a couple of schools the champion teachers were over committed with other initiatives. In others, the progress was slower than the champion teacher had wished and engaging support from colleagues was delayed until 2017. Some teachers who had been very enthusiastic at the outset subsequently did not pursue the opportunity (without giving any clear reason).

#### 6.1.5 Motivational Factors: Goals/Partners/Continuity/Commitment Issues

As schools and industry can have different goals it is critical for all parties to clearly articulate their respective goals. It is unlikely that there will be perfect alignment and the skill in effective engagement is identifying commonalities.

In at least one location there was limited interest from the schools in the range of companies that dominated the region. In some locations, it is challenging aligning the companies that exist with teachers' interests as well as the fit between the type of companies and the curriculum and year level. Ai Group was in most cases able to identify suitable partner companies both from within or outside of Ai Group company membership.

Staff mobility across schools is a major factor and is a reality of education systems. In this project, several schools withdrew from company interactions in one instance due to staff movements. In one case where a staff member left the school the company was happy to connect with the new keen teacher. Equally, changes in company staff, corporate focus or even the continuing presence of a company will affect their ability to participate in projects.

It was observed that some teachers across multiple educational forums had little if any interest in engagement in this project. There were some teachers who attended workshops with ACARA who also demonstrated very little interest. While this is understandable, any expansion of STEM awareness and participation needs to go beyond the group of committed teachers. There is limited value if STEM programs only target the already interested and engaged teachers. This is clearly an issue for schools and education systems as much as it is for students and parents.

As Ai Group progressed through the project there were common characteristics observed with successful schools:

- Passionate and motivated teachers;
- Skilled teachers who could articulate the learnings and objectives;
- Teachers whose school leadership was supportive and;
- A staff culture that was collegiate with colleagues who collaborated on or supported the project.

Some schools and teachers may prefer to assist students with external non-curriculum linked competitions because this is simpler than trying to accommodate a curriculum linked project, especially if it involves cross-curriculum teaching. In several schools teachers said that it was often challenging “persuading” colleagues to engage beyond their own subject areas.

### 6.1.6 Cultural differences

There still seems to be a prevailing tendency on the part of schools and education systems to separate the role of VET and STEM which may arise from a misconception as noted earlier that STEM is for academic students. This suggests some outdated stereotypes about the nature of industry and business in the 21<sup>st</sup> century. This seems to arise from the fact that so few teachers have had exposure to 21<sup>st</sup> century industry and many do not understand its changing requirements. In some instances, it seems that schools had only a limited understanding of how a partnership with industry could enrich the STEM curriculum in schools.<sup>35</sup>

Some European research illustrated this by discussing the need for industry to have staff with techno-mathematical literacies and that traditional mathematics as taught in schools was no longer sufficient for industry’s needs in a digital world.

*“New work practices increasingly require what we term Techno-mathematical Literacies (TmL), that is, being able to reason with quantitative or symbolic data processed by information technology as part of decision making or the communication process.”<sup>36</sup>*

From an industry perspective, there are still views about the lack of work readiness of many students and young people. Many companies were more positive which may reflect that these overall were ready to engage with students. In Queensland, the companies that met with students from Pine Rivers High School’s Wombat Warriors Team who had undertaken and won the world Land Rover 4x4 in Schools Technology Challenge, were amazed and impressed by the skills and poise of the students who could articulate complex design and management issues.

### 6.1.7 Project Attrition

As anticipated there was some attrition from the project. In early-mid 2016 commitments or strong interest was secured from 15 schools across New South Wales, Victoria and South Australia. However, as the year progressed several withdrew from the project. The reasons varied. In two

<sup>35</sup> Final Project Report: ACARA and the Australian Industry Group, Australian Curriculum, December 2016.

<sup>36</sup> Hoyles, C., Noss, R., Kent, P., and Bakker, A. (2010) Techno-mathematical Literacies in the Workplace, Full Research Report ESRC End of Award Report.

cases the teachers stopped responding to any correspondence and failed to communicate why they withdrew.

In others, it was only after persistent and repeated contacts that schools eventually advised that they would no longer be able to proceed. This impacted on the ability to recruit more schools in the time frame available for the project.

This poor communication is a significant impediment to any development of successful school-industry partnerships and without the framework of a project such as this it is highly unlikely a company would pursue engagement.

Other identified reasons for withdrawal included:

- A school unexpectedly faced with amalgamation and significant disruption including staff losses was unable to proceed.
- A key teacher took extended leave and no colleagues could be found as a replacement. The school eventually advised that they had been unable to “gain traction” to proceed with the project.
- In two cases, enthusiastic teachers were new to their schools and one was heavily committed with external activities.
- In at least one case a new teacher was struggling to win the support of key colleagues.
- Two schools proceeded to develop their own involvement with the companies and did not seek or require any further input from Ai Group although it was offered.

As industry engagement and project-based learning requires effort and persistence in at least some instances this was to prove daunting for some teachers. In other schools, colleagues developed their own commitments well in advance and had no capacity to take on further initiatives even if interested. As has been mentioned before most teachers are not measured on such activities. Although in late 2016 an increasing number of states are implementing STEM policies and seeking to engage industry, it is not clear as yet whether professional development has been provided for teachers. Nor is it clear if industry engagement will be required or will remain an option.

It is interesting to note that no companies withdrew from the project. This suggests that the challenges of participation are greater for schools than they are for companies.

#### **6.1.8 Procedural issues: Communication/Regulations**

The ongoing issue in terms of many schools’ communications seems to represent a failure to understand basic protocols for industry engagement. This must be noted as an impediment. Without a broker to pursue and manage the interface there is a very strong risk that many companies would decide that interaction with schools is too difficult.

Increasingly stringent child protection regulations may impose potential constraints in terms of participation by industry in on-site activities at schools. What may be more constraining are potential work, health and safety issues for companies who may be reluctant to have students on site. The pilot project engagements did not have work experience and students were only site visitors and so presented no issues in this project.

### 6.1.9 Digital Technologies Curriculum

Digital Technologies rests within the STEM umbrella but there were difficulties engaging schools in this area. There were only two types of engagement. Rising Sun Pictures, a predominantly digital company, has formed a partnership with Brighton Secondary College in Adelaide with a view to implementing a project in 2017. Secondly, there is the initiative of the multi-organisational model which features the participation of Hewlett Packard Enterprises, and the Australian Information Industries Association which has planned activities with the Digital Technologies Network of teachers in 2017.

ACARA has commented on the declining national performance in this area as reported through NAPLAN. In November 2015 ACARA released the 2014 National Assessment Program (NAP) ICT Literacy Report. The report shows

*“There is a significant decline in the mean performance of Year 6 students in 2014, compared with the last assessment in 2011. Similarly, the mean performance of Year 10 students is significantly lower than the mean performance in all previous NAP-ICT literacy assessments (2005, 2008 and 2011). The report also shows that in each year level, there has been a reduction in the percentage of students meeting the NAP-ICT literacy proficient standards.”<sup>37</sup>*

Several teachers participating in the project acknowledged that there are skills shortages within many schools to deliver the new Digital Technologies curriculum at secondary level. Others have also noted that students entering secondary school do not have the necessary foundation skills to tackle the Year 8 digital technologies curriculum.

There were and still are concerns that many teachers lack the skills to teach contemporary technology and computing. It is expected that this will change with the introduction of the new Digital Technologies curriculum. Increasing support for digital technologies teaching is being implemented through, for example, the Digital Technologies Hub and the 2016 Digital Literacy School Grants announced on 19 September 2016 by Minister for Education and Training the Honourable Simon Birmingham.<sup>38</sup>

It is likely to take some time for this initiative to be bedded down before teachers have the confidence and expertise to deliver digital technologies curriculum as part of their STEM offerings.

### 6.1.10 Involvement of Mathematics Teachers

It is apparent that mathematics teachers have been less engaged in the school-industry STEM pilots compared with science and technology teachers. Mathematics seems to be the subject area that is most described as ‘inflexible’ but it is critical in sciences, engineering and technologies. There may well be issues about the curriculum itself and with alignment of mathematics curriculum and the mathematics in science-based projects at particular levels.

<sup>37</sup> ACARA News, November 2015.

<sup>38</sup> <https://www.digitaltechnologieshub.edu.au>

This relative lack of engagement by mathematics teachers was also reported in the final report into the STEM Cohesion Programme in the UK<sup>39</sup> and in the ACARA STEM Connections Project report which noted:

*“School reports indicate that mathematics was the most difficult learning area to plan for in the project. Some teachers commented that they found it hard to integrate mathematics effectively into those projects that were focused on science or technologies.”<sup>40</sup>*

## **6.2 Analysis of Models**

### **6.2.1 Individual School-Industry Partnerships**

The model of a single school working with a single company is in many ways relatively simple to establish and has the advantage that it can be local which increases the program relevance to participants. The examples of two schools working with local nurseries illustrate this benefit. The localised basis of these programs also increases awareness of and interest in the local economy and employment opportunities.

There is the further advantage of the potential of developing an enduring school-industry partnership so that programs can be conducted over several years. Haigh’s Chocolates and Blackwood High School in South Australia, for example, intend to continue their association next year. Banksia Park International High School and BTG Australasia see the partnership in terms of providing programs as students move through the school including involvement in the Certificate III in Laboratory Operations provided by the school.

These partnerships require commitment and initiative to be driven by the school. In addition to the interest in and capacity to identify and seek out industry partners, the following are also essential criteria for effective industry engagement:

- Support of the principal and other key school leaders.
- Skilled teachers who can articulate the learnings and objectives of industry connections.
- Staff culture that is collegiate with colleagues who collaborate on or support the project connections.
- Schools and teachers that understand and respect industry protocols around engagement and partnering.
- Motivated teachers willing to try new initiatives.

While in principle this is a relatively uncomplicated model to establish, there are challenges to overcome.

Many teachers lack the experience of working with industry in this way. Despite the experience of schools working with industry in school VET programs this has not transferred to STEM-based programs. This may reflect the existence of silos within subject areas and different school personnel with experience of VET arrangements. Schools needed the assistance of an intermediary to identify

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<sup>39</sup> Research Report DFE-RR147: The STEM cohesion programme: final report, Department of Education, July 2011, National Foundation for Educational Research (UK).

<sup>40</sup> ACARA STEM Connections Project Report, ACARA, June 2016, page 10.

and broker suitable industry partnerships and this level of support is not readily available. Fundamental protocols are missing from many schools in terms of developing and sustaining professional industry partnerships.

Despite increasing discussion about STEM, many schools are only just beginning the journey and have not even considered how to link with industry. As indicated previously there was relatively little school system support for STEM initiatives at the start of this project and several systems only released STEM policy during 2016.

Two of the schools in the pilot saw the potential of STEM projects in the school VET area. However, there remains an erroneous assumption by many schools that STEM relates only to academic pathways. The focus on science and mathematics within the STEM umbrella can give the impression that these programs are more focussed on university than VET pathways. Many science and mathematics teachers encountered tended not to consider what their VET colleagues were doing.

The absence of the essential criteria listed above is likely to prove a major impediment to successful STEM industry partnerships, even if schools can overcome the hurdles of finding and maintaining suitable and willing industry partners.

### **6.2.2 Multiple School-Multiple Companies-University Model**

The multiple school and multiple company model has many important features. The program operates like a hub and seems particularly suited to regional areas such as Geelong, Victoria and Townsville, Queensland in this project. A further key feature is the use of a university, as an external body, to provide overall co-ordination and management.

In this model the central focus is on teacher education rather than immediate student classroom activity. This is based on the notion that the key to any successful school-industry link is the teacher. Pedagogical support is essential for many to develop confidence to form these links. So, the model is based on sustained professional development for teachers about implementing STEM education and developing industry partners. This has the benefit that university education faculties and academics become involved with a focus on supporting both in-service and pre-service teachers.

It has become very clear to Ai Group throughout the duration of this project that the pedagogical challenges for implementing STEM and industry engagement cannot be underestimated. The role of university educators can be invaluable in not only having recognised credibility for teachers but also for providing real tools for skill enhancement delivered in the language of teachers.

The Successful Students STEM (SS-STEM) partnership between Deakin University and the Skilling the Bay initiative in Geelong illustrates how teacher educators can assist teachers with curriculum development. The QSTEM Hub pilot delivered by Queensland University of Technology and James Cook University also illustrated how the support of educators for hubs of schools and teachers, effectively addressed the challenges of marrying curriculum with pedagogical support.

Such partnerships enable groups of schools, regions, or hubs to potentially come together and develop a learning community. The use of a hub already represents an expansion of scale compared to the single school-single company model. There is mutual support across the hub and so less reliance on individual teacher drivers. There is also potential to build powerful community

connections via this community of activity. This model has the potential to be replicated across all states and territories and many regions.

The price of greater reach is greater complexity. Models such as these involve more parties and so the arrangements are necessarily more complex.

To the extent that universities play a central co-ordination and management role it is important to remember that not all universities will see that such engagement is part of their core business.

The use of universities as hub managers also contributes to the notion that STEM programs are about university destinations which would discourage some students.

Although these models developed multiple industry partners they were not the original drivers. The initial focus was on school teachers through the university link. Although universities have industry linkages, education faculties did not necessarily have them or bring them to the project. It was left to Ai Group to recruit employers to the program in both project examples.

### **6.2.3 Multiple Organisations Model**

The key feature of this model is the focus on school teacher professional development. There was a recognition of a STEM education need in digital technologies by a key company and industry association. This led to the provision of a professional development workshop for secondary school teachers. Based on collaboration with the relevant education system, in this case the DECD, a comprehensive and extensive professional development plan has been developed for many teachers on a state-wide basis.

The clear benefit of such a program is the increased scale. This model can reach more teachers than the other models. It also has the benefit of using a key company expert, Hewlett Packard Enterprises, with the support of key industry associations Ai Group and the Australian Information Industries Association. Teacher participation is encouraged by the support of the system.

The challenge related to this model is the complexity because of the increased number of parties. It is also unclear whether this model can be replicated given its highly specific focus. Potentially, the use of key players such as a major enterprise, a key industry association and an education system with the aim of delivering comprehensive teacher professional development can be replicated for other issues.

This analysis has been summarised in the following table.

**Table 15: Summary of Model Analysis**

Model	Strengths	Weaknesses
Single School and Single Company	<ul style="list-style-type: none"> <li>• Simple model and easiest to establish.</li> <li>• Model has local and relevant focus.</li> <li>• Emphasis on the development of student STEM programs.</li> <li>• Can be used in several school year levels.</li> <li>• Potential for development of long-term partnership with company.</li> </ul>	<ul style="list-style-type: none"> <li>• Dependence on key school individual(s) to drive programs.</li> <li>• Limited focus on teacher professional development.</li> <li>• Lack of familiarity engaging industry.</li> <li>• No driver for establishing integration across subjects.</li> <li>• External support is resource intensive.</li> </ul>
Multiple Schools and Multiple Companies	<ul style="list-style-type: none"> <li>• Broader reach and focus on teacher development.</li> <li>• Mutual support provided within the regional hub.</li> <li>• Suitable for regional communities.</li> <li>• Less dependence on individual drivers.</li> <li>• Use of external university co-ordinator builds project commitment.</li> <li>• University education faculties provide teacher curriculum assistance.</li> </ul>	<ul style="list-style-type: none"> <li>• Model is more complex with more parties.</li> <li>• Need commitment from regional university.</li> <li>• Strengthens perception that STEM programs are linked to universities.</li> <li>• Need mechanisms to ensure industry involvement.</li> </ul>
Multiple Organisations	<ul style="list-style-type: none"> <li>• Use of many organisations is more strategic and harnesses greater expertise.</li> <li>• Focus on teacher development.</li> <li>• Expanded reach of model to larger base of teachers.</li> <li>• School and teacher engagement enhanced through education system support.</li> </ul>	<ul style="list-style-type: none"> <li>• Increased complexity means model is more difficult to establish.</li> <li>• Increased number of parties can hinder implementation.</li> <li>• Specific model focus difficult to replicate.</li> </ul>

The analysis of the models indicates firstly that there is more than one approach. Given the complexity of STEM and the potential number of parties it is not surprising that there are multiple models of engagement. It is also apparent that the three models that emerged in this project have strengths and weaknesses, and could produce outcomes depending on the context in which they are applied.

Teacher professional development is central to the achievement of progress in school-industry STEM skills partnerships. There will be no systematic implementation of STEM programs without this. A key component of any professional development for teachers needs to include how to engage with industry and develop partnerships with them. This applies to the future implementation of all models of school-industry STEM partnerships.



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## Appendices

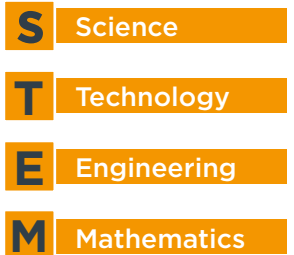
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2. **Project Plan**
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# Working together to build Australia's STEM workforce

*STEM Skills Partnerships* is a national collaboration uniting business and educators in the challenge of building the future workforce.

75 per cent of the fastest growing occupations require STEM knowledge and skills. Yet participation is declining in these subjects at senior levels in schools. Australia's Chief Scientist, Professor Ian Chubb AC, has called on governments, education authorities and the private sector to work together to address the gap.

This programme, funded by the Office of the Chief Scientist and supported by the Australian business community, will identify and encourage partnerships between business and school education that prepare our students for rewarding STEM careers.



## Why do we need a coordinated approach?

Across Australia, many companies are already working with schools and education authorities to promote STEM education and careers. But these initiatives are often piecemeal, localised and short-term. We know that many more companies, large and small, would like to be involved but don't know where to start, who to approach, or how to ensure the best outcomes for students. *STEM Skills Partnerships* will examine highly effective school-industry partnership models that can be expanded right across the education system, so many more students can benefit.

## What are we doing?

<i>Mapping what is happening in school-industry STEM skills programmes</i>	<i>Bringing companies together to support STEM activities in schools</i>	<i>Identifying and documenting the key factors for success</i>	<i>Developing best practice models of partnership</i>	<i>Coordinating and implementing a schools-industry STEM skills national initiative for 2016</i>
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## Get involved

Is your business or school part of a STEM skills partnership?

We need your help to find out:

- What programmes are operating and where
- Who is involved
- How projects are managed and funded
- What factors promote success

Are you ready to take the next step? During the second half of 2015 we will be looking for companies and education authorities to be involved in a breakthrough national initiative. This initiative will:

- Help businesses enter or expand their involvement in successful, sustainable and scalable programmes
- Raise the level of participation by schools and industry in STEM skills programmes
- Recognise business as a crucial partner in education
- Open doors for talented students, and
- Address key needs in the education system. Take a critical step towards securing the STEM skills pipeline for our future.

*For more information or to register your interest contact:*

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 Manager-STEM Skills Project  
 Ai Group

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 08 8394 0004

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Australian Government  
 Chief Scientist

## Appendix 2: Project Plan and Methodology

<b>TASK</b>	<b>APPROACH</b>	<b>TIMELINE</b>	<b>OUTCOMES</b>
Establish Reference Group Project Plan developed	Methodology endorsed. Reference Group established and meetings scheduled.	February-March 2015	Project plan, methodology, timelines, evaluation framework and criteria approved.
Industry Consultation	Consultation with peak industry associations commences.	March-April 2015	Completed.
Identification and mapping existing school-industry partnerships in STEM related activities nationally	Desktop research of major STEM initiatives. Consultations with key program stakeholders. Consultations with appropriate State Education Departments.	March-June 2015	Working document provided to Reference Group.
Identification and documentation of key success features of school industry STEM Skills partnerships	<ol style="list-style-type: none"> <li>1. Consultation with existing programs eg. <ul style="list-style-type: none"> <li>• Re-Engineering Australia-F1 in Schools and related programs</li> <li>• Hunter RDA (NSW) ME Program</li> <li>• ATP Program (Australian Technology Program)</li> <li>• Digital Careers (NCITA)</li> <li>• CSIRO</li> <li>• Schools Connect Australia (Vic-Business in the Community)</li> <li>• Uni SA Connect</li> </ul> </li> <li>2. Consult with key universities re: research on STEM programs and linked partnerships. eg. Monash/Deakin/University of Sydney</li> <li>3. Consult with State and Territory education departments and industry departments.</li> <li>4. Consult with Independent schools and Catholic schools systems.</li> <li>5. Consult with key teachers' associations eg-AAMT (Australian Association of Mathematics Teachers), Science Teachers Association</li> </ol>	March-June 2015-ongoing	Initial evaluation completed.  Case Studies of best practice developed.

	<p>6. Identify and utilise any existing evaluations of current programs: Input from schools/school systems/university researchers/other allies</p> <p>7. Industry feedback from existing partners</p>		
1 <sup>st</sup> PROGRESS REPORT	Project Plan, Methodology, Evaluation Framework, Mapping Exercise	JUNE 2015	Contract Milestone
Identification and documentation of existing and potential industry partners	<p>Collate and document existing STEM industry partnerships nationally.</p> <p>Ongoing consultation with Ai Group members.</p> <p>Ongoing consultation other peak industry bodies.</p> <p>Ongoing consultation with schools and other organisations.</p>	February – August 2015	Initial documentation completed.
Development of transferable models of school-industry STEM skills partnerships	<p>Evaluate transferability/replication options.</p> <p><i>NB evaluation to be informed by the Australian Government's Guiding Principles for School-Business Relationships (2013)</i></p>	September-October 2015	Examples of transferable models considered.
STEM Model Consultations re: Pilot Programs	<p>Enlist interest and commitment from schools.</p> <p>Consultation with potential partners in industry.</p> <p>Industry participation in proposed pilot program secured.</p>	November 2015	Participation in pilot secured with agreed number of schools and firms.
Pilot Program	Ai Group to identify funding		Funding secured
2 <sup>nd</sup> PROGRESS REPORT	Commitment to Pilot Program, Funding Finalised for Pilot Implementation	DECEMBER 2015	Contract Milestone
Roll-out school-industry STEM skills partnership models in selected schools with industry partners		February-October 2016	
3 <sup>rd</sup> PROGRESS REPORT	Progress on Outcomes from Pilot	May-June 2016	Contract Milestone
Determination of mechanisms for coordinating the funding for the continuing application of	<p>Review funding requirements Government (State and Commonwealth) Schools</p> <p>Peak Bodies/Industry associations</p>	Ongoing-July 2016	

models deriving from the pilot program			
DRAFT FINAL PROJECT REPORT	<p>Final Report incorporating</p> <ul style="list-style-type: none"> <li>• project plan and methodology</li> <li>• results of mapping exercise</li> <li>• evaluation methodology</li> <li>• documentation of successful industry-school STEM skills partnerships</li> <li>• detailed examples of transferable models</li> <li>• documentation of the pilot program</li> <li>• documentation of co-ordination of companies supporting or interested in STEM related initiatives</li> <li>• documentation of progress seeking funding for continued application of partnership models</li> <li>• recommendations, and</li> <li>• dissemination/communications plan.</li> </ul>	November 2016	



## AI GROUP SCHOOL – INDUSTRY STEM SKILLS PARTNERSHIP PROJECT

## Workshop agenda – Friday 11 November 2016

Time	Item	Presenter
8:30-9:00 am	Tea/coffee	
9.00 am	Welcome and Acknowledgement of Country Plan for the day	Deborah Palmer Maggie Farrell
9:15 am	Introductions and background Schools representatives to introduce themselves	School teams
9:30 am	What is STEM <ul style="list-style-type: none"> <li>• The big picture</li> <li>• Some agreed positions across Australia</li> <li>• STEM and industry</li> <li>• Where it exists in the Australian Curriculum</li> </ul>	Deborah Palmer Maggie Farrell
10:45 am	Morning tea	
11:00 am	Ways of doing STEM <ul style="list-style-type: none"> <li>• Same, same but different</li> <li>• Just plain different</li> <li>• STEM projects and what they look like</li> <li>• Your school and STEM</li> </ul>	Deborah Palmer Maggie Farrell School teams
12:15 pm	STEM partnerships <ul style="list-style-type: none"> <li>• The possibilities</li> <li>• The realities</li> <li>• Establishing and maintaining relationships</li> <li>• Partnerships and your school</li> </ul>	Deborah Palmer Maggie Farrell School teams
1:00 pm	Lunch	
1:45 pm	Planning a STEM project <ul style="list-style-type: none"> <li>• The criteria</li> <li>• The process</li> <li>• The connecting idea</li> <li>• Targeted curriculum content</li> <li>• The common student task and its assessment</li> <li>• Teaching and learning activities</li> </ul>	Deborah Palmer Maggie Farrell School teams
3:15 pm	Sharing your ideas	School teams
3:45 pm	Next steps	Deborah Palmer Maggie Farrell
4:00pm	Close	

# Queensland STEM Hubs

## Building partnerships to develop STEM capital in classrooms and communities

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**Project partners: Queensland Department of Education and Training (including the DET STEM Team & regional STEM Champions); Associate Professor Terry Lyons, Dr Donna King, Professor Les Dawes, Associate Professor Peter Hudson, Queensland University of Technology (QUT); Dr Tanya Doyle, James Cook University (JCU).**

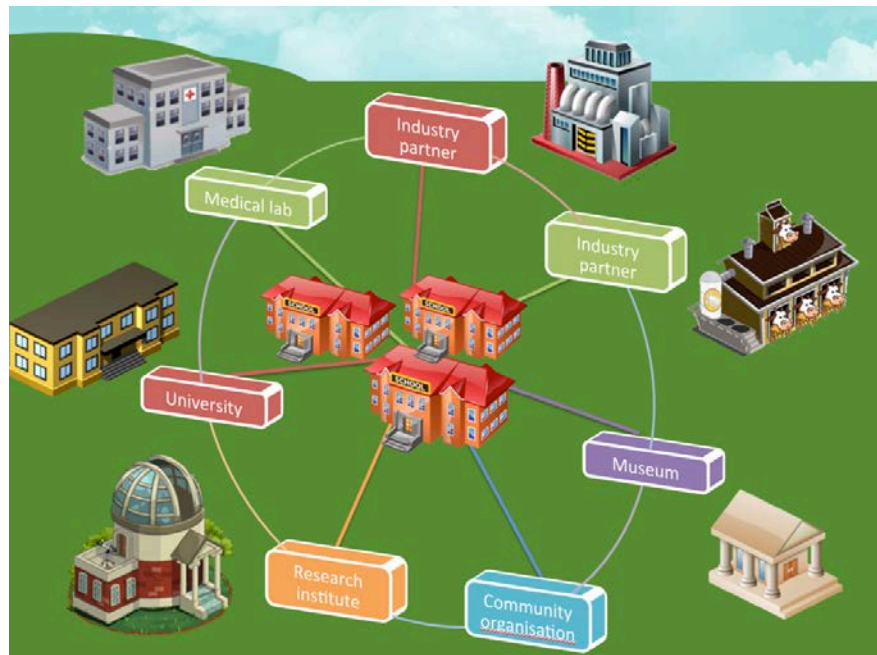
The Queensland Department of Education and Training is commissioning QUT and JCU to establish, pilot and evaluate two QSTEM Hubs in order to assess their potential for harnessing school-industry partnerships across the state for the benefit of teachers, students, industry and other stakeholders.

### Why QSTEM Hubs?

- Many science, mathematics and technology teachers ask: “how can I draw on STEM industry and community organisations to make lessons more relevant to my students without adding too much to my heavy workload?”
- Industry representatives often ask: “how can we have greater input into schools so that teachers and students are more aware of how STEM is applied in our field?”
- Museum and library educators often ask: “how can our resources and expertise articulate more closely with the needs of schools and industry?”
- University pre-service teacher educators often ask: “how can I provide my students with a real world context and authentic purpose for designing high quality STEM curriculum resources?”

## What is a QSTEM Hub?

A 'QSTEM Hub' is a model that responds to these questions by developing partnerships among stakeholders to identify the STEM capital within the community and employ it to the benefit of students, teachers and other partners. Local communities are rich in STEM-related resources and expertise, from airports to bakers, transport companies to farmers, from medical institutes to mines. However, our teachers are often too time-poor to seek these out, determine their educational value and to



integrate these into their lessons and units. While schools often have a number of short term or ad hoc partnerships, they tend to lack a framework for coordinating, sustaining and evaluating these partnerships.

We see three steps to building a QSTEM Hub.

**STEP 1.** Workshop of interested stakeholders within a community – teachers, industry representatives, the AiGroup, university staff, museum and library educators, and other relevant community members involved in STEM – to identify the educational needs and opportunities for schools, the benefits to each members of being part of the hub, what each can bring to the table in terms of resources and expertise, and what potential they see for the hub.

**STEP 2.** Project leaders and STEM teachers within the hub schools prioritise the ideas, resources and opportunities identified at the workshop in terms of applicability to the curriculum, the particular needs of the students, the feasibility of opportunities, and their own capacities and capabilities. They envision the curriculum elements (units, lesson plans, assessment tasks, etc.) required to integrate these resources and opportunities, including industry involvement, into their programs.

**STEP 3.** Incorporating ideas into teaching. This can proceed in many ways. One example is the STEMROD (Resources on Demand) initiative, in which teachers consult with industry partners to draw up the specifications of these curriculum elements they require, and pass these on to the pre-service teacher educators, who use them to tailor the assignments for their curriculum units. Pre-service students then use these specifications to build high quality bespoke STEM resources (lessons, units or assessment tasks) for particular classes or year levels.

## What are the benefits of a QSTEM Hub?

The QSTEM Hubs model is based on clear appreciation of mutual benefits. For teachers, these benefits include opportunities to:

- build capability by developing or refreshing their understanding of industry and research applications of curriculum concepts,
- incorporate this understanding into engaging lessons for their students,
- strengthen links between schools and across STEM discipline areas,
- establish or strengthen relationships with STEM educators in universities.

For students:

- increased relevance of class activities to life and industry;
- ability to see mathematics and science in context;
- ability to picture themselves in STEM careers;
- improved attitudes to school;

For industry partners, including museum and library educators:

- greater local recognition of their important role and potential within STEM education;
- opportunities to nurture the future STEM workforce;
- opportunities to shape the science, mathematics and technology curricula to better reflect industry applications;
- closer links with other partners (e.g. universities, businesses, community groups, etc.)

For pre-service science and mathematics students:

- opportunities to design curriculum with reference to real school situations;
- closer links with schools and teachers;
- potential for teacher and industry feedback on the curriculum materials they design for schools;

# Geelong Region Schools STEM Curriculum / Industry Link Program - Scoping Paper



## Background

1. Arresting the decline in STEM attainment in schools along with awareness raising of STEM pathways to future employment remains a key focus for Skilling the Bay.
2. The consultation process undertaken in a recent Skilling the Bay review revealed an opportunity for collaboration with the AiGroup, ACARA, Deakin University, the *Skilling the Bay Successful Students – STEM Program* and selected “smart” Geelong businesses.
3. The advantages of such a collaboration include:
  - An alignment with the *Successful Students - STEM Program* aims for enhancing STEM teacher capability in schools and raising students’ awareness of STEM pathways to future employment.
  - Builds on the *Successful Students – STEM Program* established school partner relationships (10 schools). These schools are committed to and working towards enhancing their STEM capability.
  - Supports the AiGroup’s *STEM Skills Project* aspirations for a regional pilot trialling STEM programs in schools with industry partners.
  - Integrates with the ACARA Curriculum framework including the new Technologies curriculum for implementation in schools in 2017.

## Program Overview

Working Title – *STEM into Industry: A Curriculum Program for Schools*

Program Description - Students in schools will experience a unit of curriculum encompassing science, mathematics and digital technologies inclusive of sustainability principles and applied to a local industry or business. The program will have the following elements:

- A STEM unit of curriculum with an authentic local industry link
- Alignment with the ACARA STEM related curricula
- Practical application of digital technologies in a technology rich “smart” local industry
- Application of leading pedagogy to the curriculum design
- Student outcomes can be progressed over an extended timeframe of at least two years. For example, a Year 8 unit is progressed in Year 9 and/or Year 10.
- Proposed number of school partners initially:
  - Two schools
  - 2 - 4 school classes
  - 50 - 100 students in the first year and expanded thereafter
- Target student cohort: any of Years 9 and/or 10
- Duration of the unit: 8 - 10 weeks
- Implementation: 2016 and if successful – expanded in 2017

## Benefits to Participants

- Supports teacher capability in teaching STEM
- Supports teacher development of programs linking to the ACARA STEM related curricula
- Supports teacher understanding of the link between STEM pathways and industry
- Provides authentic industry experience to overcome the disconnect between student pathways and real world career outcomes
- Applies STEM to real world challenges
- Applies advanced technology to an authentic local industry context
- Raises awareness of the importance of STEM to future economic prosperity
- Raises awareness of pathways to STEM related careers

### Next Steps

1. Consult with AiGroup to test the proposal for purpose, feasibility and approval to proceed to the next planning phase.
2. Consult with the *Successful Students – STEM Program* Steering Group to test feasibility and advise on purpose, program design elements and capacity constraints.
3. Consult with ACARA to identify collaborations which enhance program outcomes for schools.
4. Seek approvals from program partners to proceed with development of an amendment to the Implementation Plan for delivery in 2016 and 2017.
5. Submit the proposed amendment to the Implementation Plan to the Skilling the Bay Advisory Group.
6. Subject to Skilling the Bay Advisory Group's approval, proceed with program planning for implementation.

TEACHER PROFESSIONAL DEVELOPMENT

DEPARTMENT FOR EDUCATION AND CHILD DEVELOPMENT

Précis

A Professional Development program consisting of four presentations delivered by members of Australian Information Industry Association. The focus areas support students' dispositions, skills and understandings to prepare them for work and pathways in a rapidly changing world with an unpredictable future.

Presenters Time & Location	Overview	Professional Learning Outcomes	AITSL Standards
Presenters  Time & Location	Global STEM workforce STEM, and the connection to Digital Technologies, Soft Skills and Dispositions for pathway success Problem solving Critical thinking Communication Creativity Collaboration Social intelligence Negotiation	<ul style="list-style-type: none"> <li>➤ Have a workforce lens to explore the ever expanding world of STEM through inquiry –based learning</li> <li>➤ They can examine different applications of STEM soft skills to develop ideas with their students and use these to solve problems that interest or intrigue them.</li> <li>➤ Understanding of the importance of soft skills and dispositions to help students translate those hard skills to real –world use.</li> <li>➤ Cultivating Soft Skills through teaching and learning programs and pedagogic practice</li> </ul>	<p>Standard 3 Plan for and implement effective teaching and learning:</p> <p>3.1 Establish challenging learning goals</p> <p>3.3 Use teaching strategies</p> <p>Standard 6 Engage in professional learning:</p> <p>6.2 Engage in professional learning and improve practice</p> <p>6.4 Apply professional learning and improve student learning</p>



Presenters Time & Location	Overview	Professional Learning Outcomes	AITSL Standards
Presenters	<p>21C Workforce – Jobs &amp; Technology</p> <p>Are you ready for the jobs revolution? The revolution in work for young Australians will be driven by three economic forces [FYA Future of Work Report Pg.7&amp;22].</p> <p>Automation: Ever – smarter machines are performing ever–more human tasks - taking, replacing or eliminating the need for whole categories of employment.</p> <p>Globalisation: Our workforce is going global and the global workforce coming to us.</p> <p>Collaboration: Technology is increasing the potential for cooperation and collaboration across multiple platforms.</p>	<p>➤ Deeper understanding about careers in Digital Technologies now and those anticipated for the future.</p> <p>➤ Understanding the future of work for young Australians characterized by flexibility and continuous change in how, what and where young people will work and key forces that will shape the future of work.</p> <p>➤ Jobs</p> <p>➤ Technology</p>	<p>Standard 6 Engage in professional learning:</p> <p>6.2 Engage in professional learning and improve practice</p> <p>6.4 Apply professional learning and improve student learning</p>
Time & Location			





Presenters Time & Location	Overview	Professional Learning Outcomes	AITSL Standards
Presenters	<p>Digital Literacies in the workforce</p> <ul style="list-style-type: none"> <li>- Stories from the field</li> <li>Wikki– A digitally literate person will have the ability to engage in online communities and social networks while adhering to behavioural protocols, be able to find, capture and evaluate information, an understanding of the societal issues raised by digital technologies (such as big data), and possess critical thinking skills.</li> </ul> <p>What are Digital Literacies and what do they look like if you are a</p> <p>Lawyer Health Professional Landscape Cyber Security Officer</p>	<p>Understanding of digital literacy in the workforce in relation to the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers.</p> <p>Digital Literacy is awareness, of the attitudes and abilities of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media.</p> <p>Understanding the range of skills a digitally literate person will possess in a range of Industries including knowledge of the basic principles of computing devices, hardware and software and skills in using computer networks</p>	<p>Standard 2 Know the content and how to teach it:</p> <p>2.5 Literacy and numeracy strategies</p> <p>Standard 6 Engage in professional learning:</p> <p>6.2 Engage in professional learning and improve practice</p> <p>6.3 Engage with colleagues and improve practice</p> <p>Standard 7 Engage professionally with colleagues, parents/carers and the community:</p> <p>7.4 Engage with professional teaching networks and broader communities</p>
Time & Location			



DEPARTMENT FOR EDUCATION AND CHILD DEVELOPMENT

<p>Presenters Time &amp; Location</p>	<p>Overview</p>	<p>Professional Learning Outcomes</p>	<p>AITSL Standards</p>
<p>Time &amp; Location</p>	<p>Critical &amp; Creative Thinking, Innovation &amp; Entrepreneurship Economists have predicted that, over the next two decades, the jobs most unlikely to be automated are those that involve creative intelligence, social intelligence and problem solving. These skills comprise a broader set of skills that have variously been called 21st Century skills, enterprise skills and employability skills. Skills include confidence, communication, creativity, project management, enthusiasm for learning, critical thinking, team work, digital literacy, financial literacy and global citizenship. For our young people to secure the jobs of the future, be they manual or cognitive, they will need to exhibit skills in these areas.</p>	<ul style="list-style-type: none"> <li>➤ Unpacking and reflecting on the Critical and Creative Thinking Continuum to gain deeper understanding of how it fits pedagogic practices and the curriculum.</li> <li>➤ Understanding of the link between Critical &amp; Creative Thinking, Innovation &amp; Entrepreneurship the Digital Technology workforce and 21C Jobs.</li> <li>➤ Understanding of the economic changes that are transforming work through automation, globalisation and more flexible work and how innovation in IT can afford new opportunities to students.</li> <li>➤ Enterprise skills are the "key skills and personal attributes needed to enter, operate and thrive in the new world of work." These are the transferable skills from one workplace to another, just like a tradesperson 's toolbox.</li> </ul>	<p>Standard 6 Engage in professional learning: 6.2 Engage in professional learning and improve practice</p>



## Building productive partnerships for STEM education

Fostering science, technology, engineering and mathematics (STEM) education is critical to ongoing economic growth and productivity for Australia's future. It helps to build a pipeline of STEM professionals and prepares a dynamic skilled workforce needed to build future innovation.

Recent research highlights the imperative of fostering STEM skills in Australia:

- **Seventy-five percent**<sup>1</sup> of the faster growing occupations require STEM skill and knowledge;
- A STEM qualification fosters skills in areas such as creativity and critical thinking, and those businesses that make use of STEM skills are almost **60 percent more likely to be innovative**<sup>2</sup>;
- Yet **Australia is lagging behind** on a number of indicators – enrolments in science and maths continue to decline in Australian High Schools and the number of year 12 students studying STEM subjects is also declining<sup>3</sup>.

The Australian Industry Group (Ai Group) understands the importance of STEM being the future of Australia's workforce. Our regular industry research and ongoing collaboration with the Office of the Chief Scientist to support a strategic school – industry STEM partnership is part of a national action plan to support a STEM-strong Australian economy.

Expanding on this work, Ai Group has welcomed a collaboration with Scientists and Mathematicians in Schools (SMiS) program. Ai Group supports programs that bring together industry, universities, governments and science agencies that seek to connect students to STEM resources and mentors.

SMiS is operated by CSIRO on behalf of the nation to engage with schools and teachers alike, but with industry partners as well, ensuring members can contribute to the growth of participation in STEM subjects at school in a meaningful way.



With a national footprint complemented by a regional network, SMiS connects industry partners with educators to bring STEM subjects to life for teachers and students. Members who want to get involved can tap into a well-established framework of information and resources, and are supported by SMiS along their entire volunteer journey. The flexibility of the program allows industry members the opportunity to utilise their professional STEM expertise in a way that suits them.

The Ai Group and SMiS collaboration skilled industry partner volunteers the opportunity to have a positive impact and make a difference to STEM education.

<sup>1</sup> Source: [The Australian Industry Group – Progressing STEM skills in Australia](#), March 2015

<sup>2</sup> Source: [Australia's STEM Workforce Report by the Office of the Chief Scientist](#), March 2016

<sup>3</sup> Source: CSIRO Data61 Report: [Tomorrow's Digitally Enabled Workforce: Megatrends and scenarios for jobs and employment in Australia over the next twenty years](#), March 2016

## Benefits of SMiS

- *Access to industry mentors increases interest and engagement in STEM subjects*
- *Brings to life STEM subjects by showcasing real life STEM skills in the classroom, fostering critical thinking – a life skill beyond the classroom*
- *Alerts students to career options in science, mathematics and ICT*

## Benefits to Industry

- *Participation in this program enables industry to have a direct impact on the advancement of STEM education in Australia by inspiring and engaging teachers and students*
- *Industry mentors share their passion and enthusiasm for STEM improving their communication skills in the process*
- *Industry mentors promote STEM-related careers*

### Case study: How STEM professionals can make a positive impact on education

James Murray is a Manager at NAB based in Melbourne and has been involved with the SMiS program since 2011. During that time, he's partnered with teachers in both primary and secondary schools, and has covered a number of topics from astronomy to maths olympiads. As a mathematician by day and keen astronomer in his spare time, through SMiS James has been able to share his enthusiasm for science and maths with younger generations.

For one of his teacher partners, a Year 5-6 teacher at a regional primary school in Victoria, support received from James during the class's space unit was valuable. James provided assistance in the development of the unit, answered questions from staff and provided recommendations on different ways of teaching astronomical concepts. Given he lives a few hours away from the school, he also engaged in a live question and answer video conference to answer questions about astronomy and space direct from the students. James's expertise and depth of knowledge improved the quality of the unit for the teachers and the students.

"Being part of the program and working with teachers is extremely rewarding. I really enjoy brainstorming ideas with teachers on activities that can be done to make subjects, like maths, fun in the classroom. Ongoing communication – whether it's in person or virtual via emails and phone calls – is a crucial part of coming up with ideas," said James. "Ultimately though, it's about getting students interested and engaged in STEM subjects. Getting instant feedback from students on new ideas and concepts – seeing their enthusiasm and those 'aha' moments – as well as providing students with views of where their careers can go, is what I enjoy the most."

## How it works

Each partnership is unique and different with the STEM industry professional and teacher negotiating the nature of their relationship. Regular contact is desirable whether through face-to-face meetings, email or phone. The intention is for the STEM industry professional to share their career story, ways of working in STEM industries and information about contemporary practices and fields. This often, but not always, translates into activities with the teacher's students. A key strength of this program is the flexibility it offers to the style, content and frequency of interactions making them relevant and contextualised for the students.

To get involved, STEM industry professionals register online, providing contact details, Working with Children Check, preferred type of partnership and location. The CSIRO SMiS team match the industry professional and a teacher. The program team is also there to provide support and assistance to participants and partnerships to ensure success.

## Further Information

If you are interested in learning more about the SMiS program and /or to register to become involved, visit [www.csiro.au/SMiS](http://www.csiro.au/SMiS)



**Strengthening  
School – Industry  
STEM Skills  
Partnerships  
Reference Group  
Meeting**

Evaluation Paper

May 2016

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## Evaluation

All pilot activity in 2016 will be evaluated and reported upon. The evaluation methodology below has been selected based on

- consultation with key partners/stakeholders to ensure consistency and comparability of measures across the schools involved in the proposed pilot(s); and
- the scale and duration of the pilot(s).

### **Proactive Evaluation (or formative evaluation)**

This involved a mapping of STEM projects/initiatives across Australia in parallel with extensive and ongoing consultation with:

- Industry
- Education systems and educators including schools and universities and
- Key stakeholders including industry associations and firms.

This process identified key issues to be addressed and informed decisions on the focus, aims and structure of the proposed pilot options to be considered.

As a result of the mapping exercise several potential pilot options emerged and all were considered against the recommended criteria:

- Potential to be supported across multiple jurisdictions and education sectors if possible to enable sustainability beyond the life of the STEM Skills Project
- Integrated STEM into school curriculum or linking to curriculum (Enhance student learning outcomes)
- Manageable scale for schools (adequately resourced)
- Potential for industry role (ideally national) (benefit both school and industry and support of business and school leadership)
- Teachers and students involvement and support (support of the school community/benefit both school and industry/enhance student learning outcomes).

### **Surveys**

Based on research and consultation with the Survey questions below have been developed.

Consultation has taken place with the following:

- Deakin University
- New South Wales Department of Education
- South Australian Department of Education
- Associate Professor Terry Lyons, Queensland University of Technology
- ACARA with regard to the 2014-15 STEM Connections Project

Research included:

- The Research Council UK : Evaluation: Practical Guidelines
  
- School-industry STEM links in the UK: A report commissioned by Futurelab  
Prepared by: Dr Anthony Mann (Education and Employers Taskforce  
Professor Adrian Oldknow (University of Chichester)

From the outset it was determined that it was important as far as possible to ensure consistency with similar projects/programs and their evaluation in terms of the survey questions. The NSW Department of Education's Integrated STEM Program survey questions that they very kindly shared were particularly relevant and accordingly we have used them almost exclusively.

It was also acknowledged that real issues exist in terms of getting survey responses from teachers and students. There has been discussion with regard to managing these issues for pre- and post-surveys for both teachers and students and whether or not it is worth compromising by seeking only post activities surveys. The issue of survey fatigue must be acknowledged. In particular, in the case of the Deakin University SS STEM schools they have all been extensively surveyed by Deakin University already.

However, notwithstanding these challenges we have decided to commit to pre- and post- surveys for students and aim to do the same for teachers.

Additionally, it is also intended to conduct post- activity reviews with teachers, and hopefully with a selection of students.

In terms of industry it is intended to have pre- and post- surveys as well and individual reviews with the firms. Teachers will participate in the post activity reviews with firms wherever possible.

## STEM Pilot Project – Student Pre-Survey Questions

The AI Group is funded by the Office of the Chief Scientist to conduct a pilot study on STEM (Science, Technology, Engineering and Mathematics), with a particular focus on School Industry Engagement in Australia. We welcome your participation and appreciate your comments.

### Privacy Notice

The pilot STEM study will not identify your responses or that of any other student...

### Question 1

Which school do you attend?

### Question 2

Select your gender:

- Male
- Female

### Question 3

I am a student in:

- Year 7
- Year 8
- Year 9
- Year 10
- Year 11
- Year 12

### Question 4

Please select the response that best describes your level of interest at high school in each of the following **BEFORE** participating in this project:

	High interest	Moderate Interest	Low Interest	No Interest
Learning more about Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Design and Technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Digital Technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



**Question 5**

Please select the responses that best describe your thoughts around participating in this project:

	Higher than in usual classes	Same as in usual classes	Lower than in usual classes
Interest in learning, such as asking questions or contributing to group discussions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Willingness to be involved in group activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Enjoyment in project-based learning activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 6**

Please select the response that best describes your interest in studying:

	High interest	Moderate interest	Low interest	No interest
Mathematics in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maths subjects in Years 11 and 12 (e.g. General or Specialist Maths)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science subjects in Years 11 and 12 (e.g. Biology, Earth Sciences, Environmental Science, Physics or Chemistry)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology subjects in Years 11 and 12 (e.g. Information Technology)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 7**

Which statement best describes the way you think about your future career

- I don't know what job I would like
- I am thinking about a small number of specific jobs
- I am considering a specific job, but I'd like to explore other options before I make my decision
- I have already decided on the job I want. *(Please specify)*

**Question 8**

Thinking about your future career, how likely are you to choose a career in the following fields of work?

	Very likely	Fairly likely	Not Particularly likely	Not at all likely
Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engineering	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 9**

Are there any further comments you would like to make about your participation in this pilot?  
(Optional)

**Thank You!**

## STEM Pilot Project – Student Post-Survey Questions

The AI Group is funded by the Office of the Chief Scientist to conduct a pilot study on STEM (Science, Technology, Engineering and Mathematics), with a particular focus on School Industry Engagement in Australia. We welcome your participation and appreciate your comments.

### Privacy Notice

The pilot STEM study will not identify your responses or that of any other student.

### Question 1

Which school do you attend?

### Question 2

Select your gender:

- Male
- Female

### Question 3

I am a student in:

- Year 7
- Year 8
- Year 9
- Year 10
- Year 11
- Year 12

### Question 4

Please select the response that best describes your level of interest at high school in each of the following **AFTER** participating in this project:

	High interest	Moderate Interest	Low Interest	No Interest
Learning more about Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning more about Digital Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 5**

What did you like best about being involved in this project?

**Question 6**

What did you like least about being involved in this project?

**Question 7**

Please select the responses that best describe your participation in this project:

	Higher than in usual classes	Same as in usual classes	Lower than in usual classes
Interest in learning, such as asking questions or contributing to group discussions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Willingness to be involved in group activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Enjoyment in project-based learning activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 8**

What difference(s) did you notice about the way lessons were taught in this project and the way you worked with other students?

**Question 9**

Please select the response that best describes your interest in studying **AFTER** you completed the project:

	High interest	Moderate interest	Low interest	No interest
Mathematics in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology in Years 9 and 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maths subjects in Years 11 and 12 (e.g. General or Specialist Maths)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Science subjects in Years 11 and 12 (e.g. Biology, Earth Sciences, Environmental Science, Physics or Chemistry)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology subjects in Years 11 and 12 (e.g. Information Technology)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 10**

Which statement best describes the way you think about your future career **AFTER** completing this project?

- I don't know what job I would like
- I am thinking about a small number of specific jobs
- I am considering a specific job, but I'd like to explore other options before I make my decision
- I have already decided on the job I want. *(Please specify)*

**Question 11**

Thinking about your future career, how likely are you to choose a career in the following fields of work **AFTER** completing this project?

	Very likely	Fairly likely	Not Particularly likely	Not at all likely
Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engineering	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 12**

Has the pilot increased your interest in working in an area related to Science, Technology, Engineering or Mathematics?

- To a great extent
- Somewhat
- A little
- Not at all

**Question 13**

How important was the pilot in motivating you to try to achieve better results in Science, Technology, Engineering or Mathematics subjects?

- Very Important
- Fairly important
- Not very important
- Not at all important

**Question 14**

Are there any further comments you would like to make about your participation in this pilot?  
(Optional)

**Thank You!**

## STEM Pilot Project – Teacher Pre-Survey Questions

The AI Group is funded by the Office of the Chief Scientist to conduct a pilot study on STEM (Science, Technology, Engineering and Mathematics), with a particular focus on School Industry Engagement in Australia. We welcome your participation and appreciate your comments.

### Privacy Notice

The Pilot STEM study will not identify individual respondents to this survey. The responses from your school will be added to those obtained from other schools across Australia.

### Question 1

What is your substantive position?

- Classroom Teacher
- Head Teacher
- Deputy Principal
- Principal
- Other (*please specify*)

### Question 2

I am qualified to teach Science:

- Yes
- No

**Q. 2.1: Science** – The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Biology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chemistry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Earth and Environmental Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Physics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Senior Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
General Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Question 3

I am qualified to teach Technologies:

- Yes
- No

**Q. 3.1:** The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Agriculture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Design and Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engineering Studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Food Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Graphics Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Industrial Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information and Software Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information Processes and Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marine and Agriculture Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Software Design and Development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Textiles and Design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Subjects ( <i>please specify</i> ):			

#### Question 4

I am qualified to teach Mathematics

- Yes
- No

**Q. 4.1: Mathematics** - The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Essential Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
General Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mathematical Methods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Specialist Mathematics (or your State's equivalent)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Maths subjects (Years 7-10 courses) ( <i>please specify</i> ):			



**Question 5**

Currently I am likely to:

	Not Likely	Somewhat Likely	Very Likely	Not Applicable (non-teaching position)
Team teach with colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collaborate with staff from other subject areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use computer technology with the class	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use STEM Technologies with the class	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collaboratively plan units of work with other subject teachers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Seek innovative ways to assess students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engage with Industry in classroom projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 6**

Please rate your confidence to...

	Not Confident	Somewhat Confident	Very Confident	Not Applicable (non-teaching position)
Teach Integrated STEM units	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lead Integrated STEM Projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approach companies to connect to STEM related curriculum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 7**

Please rate how important you believe STEM to be in secondary education?

- Very important
- Important
- A little important
- Not at all important

**Question 8**

Are there any further comments you would like to make about the STEM Pilot Project? *(Optional)*

## STEM Pilot Project – Teacher Post-Survey Questions

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### Privacy Notice

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### Question 1

What is your substantive position?

- Classroom Teacher
- Head Teacher
- Deputy Principal
- Principal
- Other (*please specify*)

### Question 2

I am qualified to teach Science:

- Yes
- No

**Q. 2.1: Science** – The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Biology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chemistry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Earth and Environmental Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Physics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Senior Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generic Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Question 3

I am qualified to teach Technologies:

- Yes
- No

**Q. 3.1:** The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Agriculture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Design and Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engineering Studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Food Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Graphics Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Industrial Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information and Software Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information Processes and Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marine and Agriculture Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Software Design and Development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Textiles and Design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Subjects ( <i>please specify</i> ):			

**Question 4**

I am qualified to teach Mathematics

- Yes
- No

**Q. 4.1: Mathematics** - The subjects I am qualified to teach **and** the subjects I am currently teaching (*select all that apply*):

	I am qualified to teach this	I am not qualified to teach this	I currently teach this
Essential Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
General Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mathematical Methods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Specialist Mathematics (or your State's equivalent)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Maths subjects (Years 7-10 courses) ( <i>please specify</i> ):			

**Question 5**

Since being involved in the STEM Pilot, how likely is it that you will...

	Not Likely	Somewhat Likely	Very Likely	Not Applicable (non-teaching position)
Team teach with colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collaborate with staff from other subject areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use computer technology with the class	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use STEM Technologies with the class	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collaboratively plan units of work with other subject teachers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Seek innovative ways to assess students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approach and engage companies to support STEM curriculum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 6**

Please describe any changes to your teaching practice and/or attitudes that have resulted from the STEM pilot?

**Question 7**

What types of technologies did you use in the STEM units of work?

**Question 8**

Please rate your confidence to...

	Not Confident	Somewhat Confident	Very Confident	Not Applicable (non-teaching position)
Teach Integrated STEM units	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lead Integrated STEM Projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approach companies to connect to STEM related curriculum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 9**

How would you describe the level of collaboration in your school project team?

- Very high
- High
- Moderate
- Low

**Question 10**

Please rate how important you believe STEM to be in secondary education?

- Very important
- Important
- A little important
- Not at all important

**Question 11**

Please rate the following in relation to how student behaviours have or have not changed during the STEM Pilot Project:

	Increased	No Change	Decreased	Not Applicable (non-teaching position)
Completion rates for assessment tasks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Levels of participation in activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engagement with peers, such as willingness to work in groups	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cognitive engagement, such as willingness to ask questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reported levels of satisfaction with project-based learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Company engagement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 12**

Please rate the following in relation to how student learning has or has not changed following the STEM Pilot Project:

	Increased	No Change	Decreased	Not Applicable (non-teaching position)
Number of students achieving learning outcomes as indicated by performance on in-school assessments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of understanding of high level concepts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Level of understanding of application in future career paths for students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 13**

Please describe the changes that you have observed:

**Question 14**

Please rate the usefulness of the following types of support provided by AI Group for the Pilot STEM Project:

	Very useful	Somewhat useful	Not very useful	I did not attend
Identifying and brokering industry partnerships	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assisting with project development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Co-coordinating company visits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Assisting through ACARA training	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 15**

Please rate the usefulness of the following types of support provided by Companies for the Pilot STEM Project:

	Very useful	Somewhat useful	Not very useful	Did not attend
Willingness to become involved in school-based project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mentoring teacher(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mentoring/supporting students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 16**

What aspects of other support that was accessed were the most useful in developing, teaching and leading STEM? *(Please specify)*

**Question 17**

Is there any other support that you would have liked to assist you to be a more effective teacher or leader of the STEM work in your school? *(Please specify)*

**Question 18**

Are there any further comments you would like to make about the STEM Pilot Project? *(Optional)*

## STEM Pilot Project – Industry Survey Questions

The AI Group is funded by the Office of the Chief Scientist to conduct a pilot study on STEM (Science, Technology, Engineering and Mathematics), with a particular focus on School Industry Engagement in Australia. We welcome your participation and appreciate your comments.

This survey should only take a few minutes to complete.

### Question 1

Does your company currently engage with school(s)?

- Yes – (If YES please go to question 2)
- No – (If NO please go to question 3)

### Question 2

In which ways does your company engage with schools?

	Select all that apply:
Sponsor events/activities/resources	<input type="checkbox"/>
Provide work experience opportunities	<input type="checkbox"/>
Offer internships	<input type="checkbox"/>
Offer apprenticeships	<input type="checkbox"/>
Offer scholarships	<input type="checkbox"/>
Offer awards	<input type="checkbox"/>
Volunteer to speak to classes of students	<input type="checkbox"/>
Participate in career events	<input type="checkbox"/>
Host site visits at my company	<input type="checkbox"/>
Provide resources for students	<input type="checkbox"/>
Provide resources for teachers	<input type="checkbox"/>
Participate in STEM curriculum lessons	<input type="checkbox"/>

### Question 3

Reasons for **not** engaging with schools:

	Select all that apply:
Never been approached	<input type="checkbox"/>
Used to but no longer do	<input type="checkbox"/>
Too few staff to support activities outside the business	<input type="checkbox"/>
Support other community initiatives	<input type="checkbox"/>
Too bureaucratic dealing with school systems	<input type="checkbox"/>
Other ( <i>Please specify</i> ):	



**Question 4**

Do you support STEM activities at school(s)?

- Yes - (If YES – please answer question 4.1)
- No

**Q 4.1** How do you support STEM activities at school(s)?

	Select all that apply:
I host visits to my business	<input type="checkbox"/>
I talk to students	<input type="checkbox"/>
I offer scholarships	<input type="checkbox"/>
I provide/support teacher resources	<input type="checkbox"/>
I support school projects that are connected to subjects being studied	<input type="checkbox"/>
Other (Please specify):	

**Question 5**

Do you support school projects in the classroom?

- Yes - (If YES – please answer question 5.1)
- No

**Q 5.1** If you support school projects in the classroom are they: (please select all that apply)

	YES	NO
<b>SINGLE SUBJECTS ONLY:</b>	<input type="checkbox"/>	<input type="checkbox"/>
Science	<input type="checkbox"/>	<input type="checkbox"/>
Technology	<input type="checkbox"/>	<input type="checkbox"/>
Engineering	<input type="checkbox"/>	<input type="checkbox"/>
Mathematics	<input type="checkbox"/>	<input type="checkbox"/>
<b>OR</b>		
Combined STEM Projects	<input type="checkbox"/>	<input type="checkbox"/>

**Question 6**

Do you provide support or resources for teachers?

- Yes - (If YES – please answer question 6.1)
- No

**Q 6.1** If you provide support or resources for teachers are they: *(please select all that apply)*

	YES	NO
<b>HARD COPY RESOURCES:</b>		
Brochures	<input type="checkbox"/>	<input type="checkbox"/>
Links to Curriculum	<input type="checkbox"/>	<input type="checkbox"/>
Samples	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>
<b>PERSONAL RESOURCES:</b>		
Training	<input type="checkbox"/>	<input type="checkbox"/>
Mentoring	<input type="checkbox"/>	<input type="checkbox"/>
Scholarships	<input type="checkbox"/>	<input type="checkbox"/>
Work placements	<input type="checkbox"/>	<input type="checkbox"/>
Other <i>(please describe)</i> :		

**Question 7**

Why have you agreed to be involved in this pilot project?

	Select all that apply:
I am concerned about the declining STEM skills in the workforce	<input type="checkbox"/>
I am struggling to recruit the skills I need in my business	<input type="checkbox"/>
I might find opportunities for future recruitment	<input type="checkbox"/>
I want to engage with my local school	<input type="checkbox"/>
I like the idea of real world projects for students to do	<input type="checkbox"/>
My firm has a corporate responsibility objective focused on education	<input type="checkbox"/>
My firm's corporate head office wants us to engage with community	<input type="checkbox"/>
I think a school project is more practical than sponsorship	<input type="checkbox"/>
I want to support teachers to know more about the world of industry	<input type="checkbox"/>
I want teachers to know more about what we need for future workforce	<input type="checkbox"/>
Doesn't seem too onerous in terms of my firm's time and resources	<input type="checkbox"/>
Other <i>(please describe)</i> :	

**Question 8**

Are there any other comments you would like to make (*Optional*):

**Thank you!**

