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STEM-TRAINED AND JOB-READY

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Australia is looking to universities to re-imagine what science education should be, and re-engineer for a future in which science is central. Industry experience equips graduates with job-ready skills whilst building bridges between business and universities. A national approach can embed valuable industry placements and projects into Australian STEM education.

Universities have two obligations to their students and the community which shares the costs of education: to equip graduates with deep knowledge of their discipline; and to prepare them for employment.

Work-integrated learning (WIL) is widely understood to be a valuable tool in bridging the gap from study to work. WIL embeds meaningful and authentic industry placements and/or projects into an academic programme. Students who undertake it have consistently been shown to achieve better employment outcomes, in Australia and other nations.[1,2]

WIL is associated with skills of application of theory, teamwork, communication, self-management and critical thinking. It also encourages students to reflect on their learning, broaden their career horizons and connect with mentors in their chosen profession.[2]

Engineering faculties require all students to complete industry placements in order to graduate. In other science, technology, engineering and mathematics (STEM) disciplines (Figure 1), industry placements have been offered in an ad hoc manner or on a small scale.

Students, employers and governments are now calling for new approaches that can scale up the success of industry partnerships seen in Australia (BOX 1).

The impetus is particularly clear across the STEM disciplines, which provide vital skills required to drive a competitive knowledge-led economy; and are strongly associated with innovation in business.[3]

In Australia, the Chief Scientist has called for every Australian STEM degree course to maximise the opportunities for industry placements or projects for academic credit.[4]

At a glance

- All STEM students should have the opportunity to gain meaningful experience in industry, integrated into their courses, for credit.
- Many employers prefer and students benefit from placements of at least three months.[5,6]
- Only 3 in 100 undergraduate science students currently participate in a long term placement.
- Barriers to be addressed include a lack of incentives in universities, a lack of capacity in businesses, and a lack of communication between the two.
- Drawing on the experience of successful programmes can ensure more and better WIL opportunities for students.

Box 1: Work-integrated learning practice in Australian universities

Queensland University of Technology has a university-wide target of a WIL experience for 60% of the 2016 graduating cohort. Associated key performance indicators are designed to recognise staff incorporating WIL for credit.

Swinburne University of Technology has developed a doctoral program tailored for the medical devices industry. Participants from diverse STEM disciplines in the three year PhD program will spend at least one third of their time within industry environments.

The **University of Technology, Sydney** offers a combined degree in engineering and a diploma of professional practice. The program includes two internships of at least 22 weeks each, for more than 350 placements at any one time.

To explore the extent of WIL, and the effort required to reach the universal target, the Office of the Chief Scientist commissioned two reports in 2014. One investigation, conducted by the Australian Council for Educational Research (ACER), interviewed 120 staff from STEM faculties representing every public university in Australia. A second investigation conducted by the National Centre for Vocational Education Research (NCVER) interviewed 99 employers across industry sectors.

This paper combines the findings of these investigations with a global perspective on best practice programmes. It calls for a national commitment to job-ready STEM graduates to meet the national interest in innovation-led growth.

> *"It is relatively well accepted that teaching is seen as the poor cousin to research among academics... Well, I often feel that WIL teaching is the poor cousin of teaching."*
>
> - A senior academic involved in the project

THE 'POOR COUSIN' IN HIGHER EDUCATION

ACER's survey confirmed that industry placements have played a marginal role in science and IT education in Australian universities.

In the natural and physical sciences, just 1 in 7 undergraduate students participate in an industry project, and only 3 in 100 in a long term (at least 12 weeks) placement (Figure 1).

73 per cent of students in IT faculties participate in industry projects, but only a minority have access to longer term workplace experiences (Figure 1).

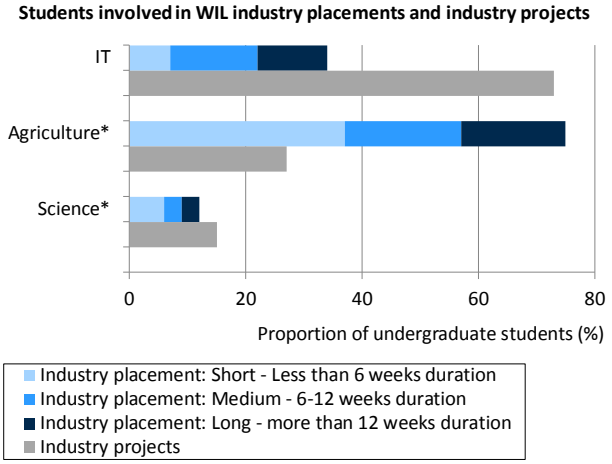

Figure 1: Proportion of undergraduate students involved in WIL, by broad discipline (%)

**Science is Natural and Physical Sciences; Agriculture is Agriculture, Environmental and Related Studies.*

Consultations pointed to continuing and emerging systemic and cultural barriers to establishing WIL programmes at scale, and embedding them into the academic curriculum.

Faculty leaders and teaching staff saw few incentives to make the significant investment of effort and time required. Generally:

- Faculty staff were not rewarded or acknowledged for facilitating industry placements, or integrating industry projects into classroom teaching.
- Courses were not designed to engage with industry. Integrating industry perspectives required extensive consultation and new materials.
- Work placements 'bolted on' to the end of a degree (Box 2) were less useful to students; and more easily stripped from the course when the initial momentum passed or an individual convenor moved on.
- Staff were limited by inadequate resources, including a lack of dedicated outreach officers and up-to-date business contact databases.

THE 'TOO HARD BASKET' IN BUSINESS

Employers responding to the NCVER survey emphasised that universities needed to make it easy to engage and that student placements and industry projects needed to align with commercial realities.

In the agricultural science sector, for example, flexibility in the timing of a placement was identified

as particularly important to align with peak times in the agricultural cycle.

Most employers preferred relationships with universities that were not overly prescriptive or associated with a heavy administrative burden. Larger firms were typically able to take on more students and were better resourced to address the barriers to collaboration.

Barriers identified by employers included:

- The costs of supervision and administration.
- A perception that the business could not offer suitable projects or activities.
- Limited knowledge or concerns about legal responsibilities, including occupational health and safety and fair work laws.[i]

Box 2: STEM curriculum models practised in Australia

The 'trust transfer will happen' model

Students learn the theory and practical skills associated with a discipline but are expected to work out for themselves how the skills might be applied in a work situation.

The 'bolt it on' model

Course designers include industry examples, case studies, guest lectures or field trips, where opportunities arise.

The 'build it in' model

WIL is embedded throughout the degree, with industry involvement or perspectives introduced from the beginning and developed as a core component of teaching and learning.

A NATIONAL COMMITMENT TO CHANGE

Whilst highlighting the barriers, both ACER and NCVER's investigations revealed a high degree of commitment amongst university leaders and the companies consulted to improve the pipeline of graduates with job-ready skills.

Universities were conscious of the advantages of lifting employment outcomes for graduates, both through time spent in a workplace, and by redeveloping courses to reflect the world of work more directly.

(i) The Fair Work Ombudsman recommends that placements must be completed as a course requirement to be exempt from Fair Work Act 2009 requirements. See http://www.fairwork.gov.au/pay/unpaid-work/student-placements

Businesses were alert to the advantages of recruiting high-performing graduates, and demonstrating their commitment to the next generation. Those interested in innovation also saw benefit in engaging with the latest cutting-edge science.

Both sectors recognised that a cultural shift on the scale required could not come about without commitment, planning and action, with the means intersecting to achieve the ends (Figure 2).[7]

Figure 2. Fields of action for Australian WIL

Universities

Universities and their STEM departments need to demonstrate their commitment to staff and students. Figure 3 puts forward a framework that institutions can use to set high expectations, and build up the supporting structures and incentives as a priority.

The framework is a self-assessment tool that universities can road-test, with a view to including a corresponding indicator in the datasets published by the Quality Indicators for Learning and Teaching (QILT). This would enable students, employers and funding bodies to gauge a university's commitment to graduate employment outcomes.

Industry capacity

Industry peak bodies can support their members, and harness their resources, by developing information packages, along with a communication and action plan. They can also play a helpful intermediary role for smaller businesses uncertain of the best way to approach a university or support good outcomes for a student.

	Administrative infrastructure	Incentives	Curriculum	Student participation in WIL for credit
GOLD	University-wide coordination, marketing, & support of WIL activities. "Industry breaking the doors down to get in."	Staff competing to excel in WIL.	WIL embedded in curriculum at all year levels.	Evidence of widespread practice (100% of students).
SILVER	WIL supported at faculty level. "Seamless industry engagement."	Staff formally rewarded for participating in WIL.	WIL present in one year of undergraduate degree.	Evidence of significant WIL participation (50% of students).
BRONZE	Developing processes to support WIL. Strategy to engage industry.	WIL incorporated into the KPIs of staff.	Curriculum design that incorporates WIL.	Evidence of some WIL participation (30% of students).

Figure 3: A possible framework to assess progress in the implementation of WIL in universities.

National support structures

Two mechanisms could help to facilitate coordination across sectors:

An up-to-date, national-scale web portal to share information, establish partnerships and draw on successful models.

A review of the role of third parties or intermediaries. Agencies currently in place, such as the Computer Foundation, EA Connect (managed by Engineers Australia) and the Australian Mathematical Sciences Institute provide possible models for investigation and expansion. The Canadian not-for-profit intermediary MITACS has supported more than 10,000 research internships over 15 years.

Government policy settings

Consistent with the national focus on collaboration between business and universities, the primary contribution government can make is to provide an environment which encourages successful partnerships and accommodates innovation.

For example, in Finland, core public funding is allocated to universities based on a formula that includes student employment outcomes and student feedback. In the UK, efforts are underway to incorporate graduate employability outcomes in a Teaching Excellence Framework.

A NEW COMMITMENT TO STUDENTS

In a changing economy and higher education landscape, the demand for industry experience is already intense. It will continue to grow, and it will advantage those institutions, industries and nations which are the best prepared to respond.

Australia has the opportunity to take its existing examples of success, scale up pilot programmes into core business, and employ the kind of teaching and learning needed for the decades ahead.

Every student has the right to expect their education will provide them with a wide range of employment skills related to their studies. Every university should recognise and act on that obligation.

FURTHER INFORMATION

The full reports from ACER, *Work Integrated Learning in STEM in Australian Universities*; and NCVER, *Work Integrated learning in STEM disciplines*: *employer perspectives* are available at www.chiefscientist.gov.au.

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About this series

These occasional papers from the Office of the Chief Scientist aim to bring to the public's attention scientific issues of importance to Australian society. Each issue has been prepared by a multi-disciplinary team and has been through an external review process. We would like to thank Professor Robin King and Alan Groth for reviewing this paper.

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