



Submission TAFE Directors Australia
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OPTUS

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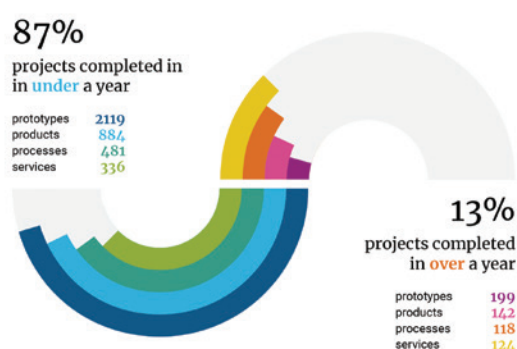
SUMMARY AND RECOMMENDATION

Summary

- As Australia seeks to return to pre-COVID economic activity, small and medium enterprises (SMEs) will need targeted and sustained support. Businesses emerging from COVID-19 are likely to pursue transformation, however, they face significant challenges in accessing services and the support needed to adapt.
- SMEs can be assisted during the extended economic recovery phase from COVID-19 through an applied research and practice-based innovation strategy in partnership with Technical and Further Education (TAFE) institutes.
- TAFEs are the natural partners to help SMEs with applied research. Funding from the Australian Government will allow for pilot projects in partnership with SMEs and family businesses.
- Lessons learned from 15 years of applied research in Canadian colleges inform this submission.
- For example, in 2017-2018, research activity in Canadian colleges and institutes led to more than 4,400 new processes, products, prototypes and services. Approximately 87 per cent of these results were achieved in less than a year.

Innovation with tangible results

In 2017-2018, research activity at colleges and institutes led to more than **4,400** new processes, products, prototypes and services. Approximately **87% of these results** were achieved in less than one year.



Recommendation

Cisco, Optus and TAFE Directors Australia recommends the Australian Government invest \$5 million for a 12 month period to pilot an applied research model where TAFEs will assist small and medium enterprises to develop or enhance products and improve services and processes.

Drawing on a very successful approach by Canadian community colleges and funded by the Canadian Government, the pilot program would fund practice-based innovation projects using the deep technical capabilities within TAFEs and leveraging their strong working relationships with enterprises. With SMEs critical to the success of the program, projects will need a focus on the digital economy in areas like digital readiness, cyber security and Internet of Things. TAFE students would also be exposed to the experiences of innovation and change and enhancing the skills and knowledge they will take forward into future employment.

Lessons learned from the pilot will provide a platform to expand applied research to assist with innovation within firms as part of the economic recovery from the recession resulting from the response to the coronavirus. The CSIRO has indicated its intention to be involved in implementing the program in an advisory capacity given its experience in applied research and strong linkages to SMEs.

NOW IS THE TIME – A RESPONSE TO COVID-19

Small and medium enterprises (SMEs) can be assisted during the extended economic recovery phase from COVID-19 through an applied research strategy conducted in partnership with Technical and Further Education (TAFE) institutes.

SMEs continue to face challenges to make their businesses COVID-19 safe for workers and customers, and in adapting their business models to respond to government strategies to manage the risks of the pandemic.¹ This includes innovation to move to online or e-commerce platforms and adapting individual product attributes and product mixes to meet the new demand from customers.²

A pilot between SMEs and TAFEs on practice-based innovation and applied research can demonstrate its leverage in growing SME effectiveness and ultimately contribute to Australia's economic recovery.

Applied research is a targeted intervention to bring technology and know-how to solve real-world production and service issues within SMEs.³

Such an approach reaps broader returns. Students engaged in this innovation and research approach learn from the experience of the innovation journey and with this understanding are ready to bring these skills and a practice-based understanding into workplaces.

This proposal arises from exploratory research in early 2020 with Canadian community colleges and polytechnics, the equivalent of TAFEs. The Canadian Government has a fund available for colleges and polytechnics to provide practical, applied research support services to SMEs in Canada.

A small-scale pilot in Australia based on the Canadian approach would uncover the critical success factors in an Australian setting and demonstrate the economic benefits to business and government of leveraging the pilot.

Throughout COVID-19, TAFE institutes across the country have continued to clearly demonstrate their ability to adapt to new circumstances. The majority of programs have been delivered through a connected learning experience, to maintain educational continuity. TAFEs are now supporting the upskilling, reskilling and cross-skilling of citizens to meet key new employment demands. Online and remote delivery of TAFE has been taken up in high numbers.⁴

TAFEs already act as innovation agents. Many TAFEs have major projects with partner companies such as with defence industries, infrastructure and health. Hundreds more innovation projects exist between TAFEs and SMEs: they are largely unrecognised and stretched by lack of funding. As many SMEs do not have the capacity or resources available to explore new approaches, this proposed applied research model will assist firms and industries to adopt new technologies, improve products, processes and business models and, importantly, solve real world challenges.

TAFEs are the logical partner for the pilot program as the lessons and approaches from the pilot would be captured within the public sphere. Results can then be disseminated through the national TAFE network and beyond as a new model of support to businesses, reflecting the industry-ready relevance of the vocational education approach.

Applied research as a pathway for SME recovery

Small and medium enterprises and family businesses are the backbone of the Australian economy, creating around 7 million jobs, contributing 57 per cent of Australia's gross domestic product and cementing our reputation as a nation of entrepreneurs.⁵ In terms of employment they account for over 99.5 per cent of all employing Australian businesses.⁶

At June 30 2019 there were nearly 2.4 million active businesses in the Australian economy. Ninety three per cent had a turnover of less than \$2 million. Now, forced lockdowns and social distancing measures imposed to deal with COVID-19 have severely curtailed activity of many businesses, especially those in services such as tourism and hospitality.

As Australia seeks to return to pre-COVID economic activity, SMEs will need targeted and sustained support.

The hasty adaptation of business processes, such as working from home, and the application of technology to deliver goods and services in new ways is likely to have awoken business owners and managers to the power of innovation. Businesses emerging from COVID-19 are likely to pursue transformation, however, they face significant challenges in accessing services and the support needed to adapt.

This submission has been developed from collaborative research with several community colleges in Canada and from meetings with Canadian officials to investigate the policy rationale, outcomes and approaches to applied research facilitated through their public community college system.

It tackles practical problems faced by firms and industries in areas such as product enhancement, business models and processes, and distribution. Practice-based innovation and applied research provide a pathway to prosper through the application of the latest technology and knowledge to improve current products and practices, or by expanding employee skills to create new products and processes.

The capability to undertake practical research and apply it into the firm or industry is the key to success – for the firm, employees and ultimately the economy.

THE PLACE OF INNOVATION FOR A COVID RECOVERY

Innovation is vital for Australia's future.

As the world becomes more interconnected and complex, innovation is becoming more critical to national economic performance, job creation and standards of living.

As the historical drivers of Australia's productivity growth wane, a stronger capacity to generate value from the ideas and inventiveness within firms is needed.

Australian governments should be applauded for their commitment to help SMEs and family businesses in a post COVID-19 economy. Smaller businesses, unfortunately, do not have the capacity or capability to independently do the applied research that may lead to innovative improvement. TAFE engagement with businesses based on an applied research model is one tangible and practical solution to rebuilding resilience in SMEs.

The OECD has highlighted that SMEs will bear the brunt of this global economic disruption.

“SMEs are at the centre of the economic crisis brought on by the COVID-19 pandemic and containment measures, more so than during the 2008 financial crisis. The current crisis has affected SMEs disproportionately, and has revealed their vulnerability to the supply and demand shock (in particular with regard to their liquidity) with a serious risk that over 50% of SMEs will not survive the next few months. A widespread collapse of SMEs (60-70% of OECD employment) could have a strong impact on national economies and global growth prospects, on perceptions and expectations, and even on the financial sector, which may already be under strain by non-performing portfolios. In some countries, a deterioration of the financial situation of SMEs could have systemic effects on the banking sector as a whole.”⁷

Government responses to the coronavirus crisis have acknowledged the impact on SMEs and family businesses, however till now policies have been focussed on compensating for loss of revenue. Turning the focus to enhancing the innovation and entrepreneurial potential of SMEs and family businesses is an important element in economic recovery. It would kickstart those enterprises looking to the future but still seeing an uncertain environment.

The crisis has in many instances demonstrated the value of innovation as many business owners fight their way out of the crisis. Examples include:

- developing new products, or adapting existing products, and changing the product mix;
- creating new forms of production (processes and supply chains) and sales (platforms such as digital) and leveraging digitisation both for business inputs and product outputs; and
- finding solutions to the crisis – such as producing protective equipment or contributing to containment measures.

Innovation is far more than the linear journey starting with science. Helinä Melkas and Vesa Harnaakorpi in *Practice-Based Innovation: Insights, Applications and Policy Implications*⁸ offer other forms of economic order and origins of innovation. They work from a practice-based approach operating between the two sub-systems of innovation – acquisition and assimilation of knowledge, and transformation and exploitation of knowledge.

This is an extension of the logic of the OECD’s OSLO manual for measuring innovation. The metrics of the OECD show that innovation is often incremental and comes from within the firm (Table 1).

Table 1 Comparing types of innovation (based on Table 3.2, OECD OSLO Manual 2018)⁹

Innovation types	Sub-components
Product	<ul style="list-style-type: none">• Goods• Services• Knowledge capturing goods and services
Process	<ul style="list-style-type: none">• Production• Distribution• ICT
Organisational	<ul style="list-style-type: none">• Administration• Management
Marketing	<ul style="list-style-type: none">• Marketing• Sales• Support

Some national governments, including many trade competitors, have put structural policies in place to support innovative practices that capture entrepreneurialism of SMEs and make them more resilient. Such policies are critical to enhancing the potential of firms to grow post the COVID-19 crisis.

Canada is one of these countries. It has in place structural policies to assist SMEs in responding to the coronavirus crisis through their *College and Community Innovation Program – Applied Research Rapid Response to COVID-19*. Building on the successful College and Community Innovation (CCI) Program, Canadian colleges and polytechnics are playing a vital role in addressing some of the challenges of COVID-19 by accelerating the transfer and application of applied research and expertise to local organisations from the public, private and not-for-profit sectors.

There is a clear opportunity for Australia to respond in a similar way.

The Australian Government already has a policy framework for innovation that could easily support and adapt the concept of applied research connecting businesses and vocational education through TAFE providers.

The Australia 2030: Prosperity through Innovation from Innovation and Science Australia outlines a strategy to generate and capture more of the benefits of innovation, making 30 recommendations framed under five strategic imperatives – education, industry, government, research and development, and culture and ambition.¹⁰

This submission seeks to draw together strategic opportunities identified in the 2030 Plan:

- Education – Australia's vocational education and training system can be made more responsive to the new priorities presented by innovation;
- Industry – Reverse the current decline in business expenditure on research and development by improved targeting of government support; and
- Research and development – Making the most of available research talent would be facilitated by promoting greater diversity in the research and innovation workforce.

THE CASE FOR INVESTING IN TAFE INSTITUTE PRACTICE-BASED INNOVATION AND APPLIED RESEARCH

The core business of TAFEs is to deliver a comprehensive range of education programs, from VET for school students and foundation programs; technical and vocational education, including apprenticeships and other training delivered in the workplace; and higher education programs as the natural extension of their vocational education programs for industries. The comprehensive nature of the technical and higher education and support services at each TAFE creates a platform for students and businesses to engage with TAFE to address their needs. TAFEs develop deep and broad relationships with SMEs: TAFEs informally become the learning and development partners, the innovation partners for these businesses.

TAFEs are the natural partners of SMEs. TAFE institutes work with SMEs in their communities every day in a myriad of ways and believe there is an opportunity to do more.

The network of TAFEs is unique in Australia. It has expansive geographic coverage with over 600 delivery points across central business districts, suburban, regional, rural and remote locations in Australia.

As the only truly industry facing education sector, vocational education and training is the obvious vehicle to engage SMEs and family businesses. The long history of the working relationship between TAFEs and SMEs sets a strong foundation for practice-based innovation and applied research. The public foundation of TAFEs provides a high-integrity, deliberate platform for the progression of government policy priorities.

A new approach for vocational education targeted to productivity, technology adoption and applied research can be a new form of stimulus for enhancing economic growth. Expanding transfer research and development capacity in TAFEs to solve the everyday – and COVID-normal – challenges faced by SMEs can create and diffuse an innovation culture across more areas of the Australian economy.

Benefits of applied research

As highlighted in the Productivity Commission's report, *Shifting the Dial* (2017), innovation policy “seeks to foster, nurture and develop knowledge, and to have these ideas put into practice by business in new and better products, processes and ways of doing business”.¹¹

Governments assist by providing incentives to invest in generating new knowledge, supporting basic and applied research, while at the same time strengthening workforce skills and providing a well-functioning regulatory environment.

The *Innovation and Creativity Inquiry* undertaken by the House of Representatives Standing Committee on Employment, Education and Training in 2017 identified opportunities for “collaboration between small and medium enterprises (SMEs) and the VET sector in Australia are significant. SMEs dominate the Australian economy and the majority of STEM skills are developed in the VET sector.”¹²

Major global skills shortages are projected in many high-technology disciplines, including cyber security and data analytics. Many of the new roles being created won't require a university degree, because the jobs require a unique mix of skills and knowledge and because industry needs graduates on a quicker timescale. Cisco and Optus have coined the term ‘blue tech’ sector, meaning transitioning from blue collar¹³. TAFE institutes have a critical role to play in the emerging ‘blue tech’ sector. This sector can be the engine room of the Australian economy in the coming decade as traditional blue-collar roles become more technologically advanced.

University vice chancellors and their peak representative bodies publicly acknowledge it is a challenge for universities to partner with business given Australia “...has mostly small to medium-sized enterprises, and a few big industries such as the pharmaceutical giants that fund research in Europe and the United States.”¹⁴

This is not the case with TAFEs, which have decades-long experience in working closely with SMEs, derived from the training relationship. More could be achieved if the relationship could be expanded in a deliberate way to formalise, acknowledge and support TAFE applied research with and for businesses. The blend within TAFEs of higher-level vocational education and higher education gives them the capacity to offer this service. Unfortunately, public funding is directed to training outputs. Expanding funding to TAFEs to offer applied research in a more systemic and sustainable way has the capacity to create added value to the Australian economy.

This is a direct way to address the shortfalls in collaboration between the tertiary sector and industry. ISA 2030 acknowledges Australia has low rates of industry research collaboration by international standards. Only 5.1 per cent of the expenditure on research and development by the higher education sector is financed by industry, placing Australia eighth among 11 peers.¹⁵

SMEs generally do not have the capacity to invest in innovation or research and development.

Any solution aiming to bring industry and research together to improve productivity must include easy access to a research and development ecosystem for SMEs, an environment that de-risks innovation, and workforces capable of adapting to the changes.

As in the now-successful Canadian case, the challenge for the Australian VET sector is to be seen as a credible and effective avenue for applied research. Many providers do not have the capacity nor would want to take on that role, but this is not the case for the public provider. This is a natural extension for TAFEs, in their services on behalf of their government to industry, community and students. Applied research can be the avenue to bring new capabilities to firms and build a stronger adaptive workforce to stimulate this way of operating across the economy.

Applied research processes provide hands-on opportunities for learners to work alongside employers to solve real-world challenges. It extends current endeavours in work-experience, practical placements and apprenticeship and traineeship activities. Embedding students in applied research projects offers the real-world experience – the highs and lows of change management and innovation – that employers seek.

Graduates with applied research experience will enter the labour market with strong problem-solving skills, an understanding of the ebbs and flows of practical innovation plus employer connections.

Most importantly, it would expose students to the SME sector and vice versa, creating direct employment opportunities. Ultimately, the critical talent pipeline will be enhanced to deal with skills shortages and an ageing workforce.

Lessons learned in applied research will be folded back into the program offerings of TAFE institutes creating a virtual innovation ecosystem that would get stronger with each project. Such experiences and lessons learnt will then be more widely distributed across the VET sector.

TAFE applied research experience and capability

Applied research has opened a new dimension for the national network of TAFEs that extends the impact of their industry contacts, knowledge and training know-how.¹⁶ Australia's TAFE institutes have been identifying and building their capability in the applied research arena since the 2016 TAFE Directors Australia visit to Canada identified an opportunity to bring institutes closer to industry through these partnerships.

In Victoria, TAFE institutes have engaged in applied research in such areas such as water recycling, winemaking, boatbuilding and textile innovation.

The Holmesglen Institute of TAFE established an applied research and innovation centre in 2016 which:

“...acts as an important driver of relationships with industry and the community in the development of an innovation driven economy. It works closely with faculties and provides a supportive environment for Holmesglen researchers: it is an important complement to our teaching and learning program”.¹⁸

Case Study 1: Applied research at Holmesglen for the water industry

In late 2015, South East Water approached Holmesglen's Plumbing Department to test a new sustainable water management system for a new housing development in south east Melbourne called 'Aquarevo'. The development is located next to a large wetland ecosystem. The applied research team investigated:

- processes to heat rainwater collected from house roofs for domestic use to reduce the use of potable (drinking quality) water;
- the potential impacts of filtered heated water on wetland environments;
- the implications of sustainable water management systems on town planning, building surveying, and building design at the site.

Holmesglen's plumbing and building teachers worked with specialists from South East Water to construct a test rig at Holmesglen and test the performance of the new water filtering system. The rig included a simulated two storey house and an assembly of water tanks, pumps, filtration systems and fixtures, valves and pump systems that were electronically monitored, recorded and tested over a period of 12 months.

The applied research resulted in the development and testing of a new heated rainwater system which is currently being implemented across the 500-home subdivision. It also resulted in an improved understanding of patterns in household water usage and how overall water footprint can be reduced in large housing developments.

Holmesglen Institute is now planning to use this research to develop training programs for apprentices and licensed tradespersons in the installation and use of these new technologies.¹⁹

TAFEs know how to work with businesses of all sizes and at all stages of their development. Applying that sound understanding to collaborative problem solving and idea development is an essential pathway for successful applied research.

TAFE Queensland developed the applied research model through *RedSpace, the Centre for Applied Research and Innovation*. It was established in 2016 as a pilot to identify, support and amplify the work of educators, experts and students as they continued to tackle complex problems, with industry and community partners, that were not on the radar of more established research bodies.

The TAFE Queensland's *Applied Research Innovation and Entrepreneurial Services Case Studies*²⁰ features 20 examples of VET educators working with employers and within communities. It marked a starting point in applied research efforts and in promoting stronger partnerships with SME employers.

Case Study 2: Applied research at SkillsTech (TAFE Queensland) for the gas industry

Trade teachers at SkillsTech (TAFE Queensland) worked with two international suppliers of high-pressure polyethylene (HDPE) gas pipelines and with international gas experts to find and fix leaking joints in a pipeline newly laid in the Western Darling Downs region (Redspace, 2016, footnote 16).

The problem, identified during the testing phase of the pipeline, had major potential implications for the coal and gas industry. The extraction of coal seam gas and conversion into liquefied natural gas is a significant economic opportunity for Queensland dependent on hundreds of kilometres of sealed pipeline infrastructure being successfully buried metres underground.

The applied research revealed the plastic welding technique used to join large diameter pipes together was causing the joints to crack and release methane gas. Further problems were caused by contamination of welded joints by the sunscreen used by welders on hot days.

The research team identified new work procedures and skills for HDPE welders, which led to a new industry training centre at SkillsTech. The team also provided technical advice for the development of a Code of Practice for the coal and gas industry by the Australian Pipeline and Gas Association.

A pilot program is justified

A pilot program will lay the foundation for a more systemic and sustainable national approach to applied research.

The previous examples of applied research from TAFEs have been funded from their existing resources. The immediate need in the COVID context - to direct resources to skilling and upskilling to help Australians transition into new work opportunities - puts further projects of this type in jeopardy. The risk of crowding out applied research from TAFEs misses a vital ingredient Australia needs to rebound in economic activity.

TAFEs are more than just training providers: as well-established, resilient, public institutions, TAFEs are committed to delivering on their public mission to develop Australia's workforce capability.

TAFEs are the natural partners to help SMEs with applied research. Funding from the Australian Government will allow for pilot projects to be established in partnership with SMEs and family businesses. As is the case in the Canadian model, businesses engaged in the pilot would be asked to make a contribution to the project as an indication of their commitment to the project.

The pilot projects would uncover the elements that make applied research work in a more systemic way between TAFEs, other providers, and SMEs and family businesses. Practical issues such as connections to faculty, embedding projects within vocational education programs, and the metrics of success in innovation will be able to be worked through. These lessons can be taken to expand the program.

The VET sector itself is exploring new ways of bringing industry into the workforce development process. The Australian Government's Skills Organisation Pilots bring a new model of industry engagement. The intersection of work design and workforce arrangements with technology and skills is a challenge for most economies. This pilot will allow for local, practically-based solutions to be put in place to meet these challenges. Project outcomes can be used to inform new approaches to workforce development which are relevant to skills organisations and other parts of the sector and drive new areas of economic activity and growth.

PRACTICAL INSIGHTS FROM CANADIAN COLLEGES

Australia can apply lessons from the Canadian experience. A pilot program offers Australian governments the opportunity to assess the role of practice-based innovation and applied research in building firm productivity and affirm how TAFEs and the vocational education sector can play a facilitator role.

Given the similarities in the economic make-up of Australia and Canada, especially business mix, population and geographic dispersion, TDA and its industry partners Cisco and Optus initiated and self-funded a study visit in early 2020 to learn from Canadian colleges about their approach to applied research. In depth engagement took place with three Canadian colleges in Toronto and Ottawa, and with senior staff in the Canadian Government, peak bodies and advocacy organisations.

An analysis of the journey the Canadian Government has taken in building the capacity of Canadian colleges demonstrates the benefit of investing in applied research capacity in the non-university sector here in Australia. Refer to Attachments 1 and 2 for details about the evolution of the College and Community Innovation Program (CCIP) and the return on investment from private sector funding, applied research outputs (product prototypes, new products, processes, services) and student and staff participation.

This was a unique opportunity to understand the successes and challenges faced by the colleges since offering applied research services. Colleges opened their doors and gave access to their SME industry partners, faculty, researchers and students to offer a broad reflection on the applied research model.

Importantly, the in-depth engagement allowed for better understanding of the successes and challenges of the Canadian experience and the application in the Australian context.

SME industry partners talked openly of business challenges faced in their operations and the prohibitive cost they face investing in research and development. They had difficulty acquiring or accessing the skills to develop ideas, adopt technology, produce prototypes, remodel business process and overhaul business models, or create new product offerings. Access to specific skills, equipment and research capability has created opportunities for these businesses that weren't available before the CCI Program. Importantly, colleges are accessible because they are part of the local community.

"In the first instance I had approached a university who wanted more than \$100,000 to begin a research project. Once I learned of the George Brown College Applied Research offering, in my first meeting with their food scientists they were able to shape my idea into something realistic and I left committed to working with them. They had the expertise and access to specialised equipment. It was a great experience and great money spent. I wouldn't have a successful business with four flavours of ice-cream if it wasn't for this applied research program."

Jason Cherun, Founder Hero Ice Cream.

Students who participated in the research projects were enthusiastic about opportunities provided for extending their depth of industry knowledge and broadening and deepening their skills. Working closely with employers complemented their learning and they gained a greater understanding of their chosen industry and could see employment opportunities.

“This kind of research opens up different opportunities. As a research student I got closer to employers and the broader industry. I experienced new technologies and equipment and it opened my mind to different potential career paths in my industry and the chance to get known and begin to build a portfolio and reputation. It has certainly enhanced my employability”.

International Student Fashion – Apparel Technician Design.

The funding bodies, the Natural Sciences and Engineering Research Council of Canada (NSERC), talked openly about the clear outcomes of the CCI Programs and how it is now working to shape, develop and grow the research capacity of the Canadian college system to continue to support the development of local businesses across Canada. There are now 113 colleges across the country with applied research capacity supporting significant outcomes for SMEs, students and for the Canadian economy.

College faculty and researchers talked of enhanced student experience and education outcomes beyond that from the curriculum. Applied research gave extended exposure to industry.

The reputation and credibility of the college also improved as a result of the closer ongoing relationship with businesses as they gained insight into the capacity and capability of the college itself.

A selection of case studies that give a greater understanding of the types of projects and outcomes produced through applied research in the Canadian context is at Attachment 3.

The critical elements for success for Canadian colleges may be readily transposed to the Australian context:

- Focus on solving the practical problems of local SME industry partners in areas of strength for the college
- Clearly demonstrate to SMEs that they underutilise capacity of the community colleges that is available to them
- Ensure any intellectual property developed is held by the industry partner and can be leveraged in the future
- Recognise that this is not just student research but is applied industry research guided by skilled vocational education professionals and industry SME partners from which students augment and enhance their skills and add to industry workforce future capability.

Conversely, some of the challenges needed to be overcome include:

- Ensuring SMEs are aware of the capability and capacity of the community colleges, which requires promotion, engagement and out-reach on the part of the colleges;
- Ensuring government grants are leveraged through industry cash or in-kind contributions;
- Setting clear expectations and agreements between colleges and their SME industry partners on project outcomes and tightly managing projects so agreed outcomes are delivered; and
- Demonstrating applied research capability with SME industry partners so they and the wider industry have confidence in self-funding projects.

The CCI Program in Canada generated a collective compounding effect by making the college system of vocational education and training more attractive as a first choice for students, and as an integrated part of the SME community across Canada.

Lessons learned

Innovation is not a straight-line process, nor is it the domain of certain sectors of the economy. As the OECD has found, innovation is incremental changes in products and services and takes place as small steps in management and marketing change. Many agents act on the innovation journey.

Applied research is a key input to innovation and diffuses capability across the economy.

Table 2 sets out from the experience of Canadian colleges the benefits to sectors of the economy.

Table 2: Benefits for stakeholders of applied research undertaken in Canadian colleges

Benefits for students	Benefits for industry
<ul style="list-style-type: none"> Accelerated practical experience to solve technical, scientific, and economic problems Connections to future employers and jobs Enhanced program curricula Strong experiential learning outcomes 	<ul style="list-style-type: none"> Quick turnaround of practical applied research applications – new or improved products, business processes and models Access to research and development resources, expertise and equipment that may not be otherwise affordable Increased sales, new customers, skills development for employees, and access to students with strong experiential learning outcomes as potential employees
Benefits to the Canadian economy	Benefits to colleges
<ul style="list-style-type: none"> Increased value of companies and improved productivity Pathway to a post-COVID economy Resilience in SMEs through sustained innovation and engagement with applied research; better able to adapt to disruption 	<ul style="list-style-type: none"> Stronger linkages with industry Experiential learning and jobs for students Economic development in the community Enhanced reputation and understanding in the community of their capability State-of-the-art equipment and facilities

The 2018 NSERC evaluation of the CCI Program concluded²¹:

“Over the past decade, the importance of innovation has become increasingly apparent for Canada’s economy, competitiveness and the well-being of its citizens. Canadian colleges are becoming increasingly engaged in applied R&D activities and, with their knowledge of industry and community needs, are in a strong position to partner with Canadian organisations in an effort to increase their innovative, and thus, their competitive abilities.”

The evaluation shows the enhanced capacity of Canadian colleges to conduct research and development which is being recognised by SMEs through their work with the colleges.

The evaluation also provides strong evidence that Canadian colleges' increased participation in research and development is enriching college curriculum and students' learning experiences.

Staff can participate in research and development projects and then share their increased knowledge and experience with their colleagues and, often through improving course content, with their students. In addition to improved curricula, students benefit by being directly involved in funded projects, giving the opportunity to apply their classroom learning in the 'real-world'. With an increased knowledge and skills base students improve their potential for employment.

On economic grounds the capacity embedded in colleges in the form of capital, equipment and expertise can be leveraged to the benefit of SMEs which are not able to retain these capabilities. The Canadian funding body NSERC summarises this complementarity in Table 3.

Table 3: Natural Sciences and Engineering Council summary of colleges enabled SME innovation

SMEs	Colleges
<ul style="list-style-type: none"> • Lack of in-house expertise • Lack of time • Lack of technology/ equipment • Lack of research and development funding/capital • Excessive regulation and reporting requirements • Insufficient market incentives • Insufficient government incentives 	<ul style="list-style-type: none"> • Industry-relevant expertise • Strong industry connections • Facilities and equipment • Funding application and reporting expertise/assistance • Preference for intellectual property to be held by SME industry partners to encourage commercialisation

Colleges, as public entities, can direct this capacity to supporting their local industry to stimulate local economic development.

Building capability

A resource kit has been developed to support approaches to applied research by TAFEs. The kit is based on materials and models generously provided by the colleges in Canada.

The kit will help TAFEs establish or refine their applied research models. The resource kit includes:

- Industry and SME engagement strategies, outreach activities and business development approaches that reflect successes and lessons learned from the Canadian experience
- A toolkit providing examples and advice on:
 - partner application processes
 - project selection criteria
 - collaboration and contribution agreements and non-disclosure agreements
 - tracking and reporting
 - project budget guidelines
 - project sign-off agreements

- Recommendations on how to structure research teams from inception through to growth and the necessary skill sets to manage research projects successfully, including:
 - required project management capability
 - required business development capability
 - required research capability and approach to scaling up
 - how-to engage faculty and students in the program.

The Canadian colleges and the Canadian Government have also offered ongoing support and have expressed an interest in working with Australia on issues such as building the potential for international applied research projects, and faculty and student exchanges.

CONCLUSION

The potential for applied research to drive local innovation has been identified for some time. The Inquiry into Innovation and Creativity by the Standing Committee on Employment, Education and Training recommended in their report of 19 June 2017²²:

“...the Australian Government consider the merit of adopting elements of Canada’s Applied Research and Innovation Services model with a view to strengthening connections between vocational education and training providers and small- and medium-sized enterprises via a \$50 million fund over four years which is specifically targeted at funding collaborations between the VET sector and business”.

The *Vocational Education and Training Reform Roadmap: Consultation Draft*²³ released under authority of Australian skills ministers recognises the opportunity for applied research as a support to industry.

We strongly urge consideration of a pilot program to explore the potential of a sustained innovation and engagement model to strengthen economic growth in SMEs through partnering with TAFE institutes.

It is proposed the pilot would be supported by a working group of industry, TAFE and government stakeholders to guide the program and to measure its impact.

A CASE STUDY: THE CANADIAN COLLEGES AND COMMUNITY INNOVATION PROGRAM

The Canadian experience

In 2002 the Canadian research funding body, the Natural Sciences and Engineering Research Council - of Canada (NSERC), wanted to learn more about the form, nature and scope of applied research carried out in Canadian colleges and to understand the role colleges played across the innovation spectrum.

NSERC found that a range of research and innovation activity was already contributing to the needs and opportunities of local industry. Even though the activities were not typical of the 'research' supported by NSERC in universities, nonetheless it included problem solving, prototype building, product development, product testing and market studies. Colleges, NSERC concluded, played a significant role in building the innovative capacity of communities by helping firms commercialise new discoveries and adopt new technologies. The College and Community Innovation Pilot (CCIP) Program was established as a result.²⁴

The objective of the pilot was to increase the capacity of colleges to support innovation at the community and regional level. Program design and funding were to stimulate new partnerships and increase entrepreneurship by assisting colleges in taking risks in developing new ways of working with local businesses to spur innovation. Six grants were awarded on a competitive basis. These comprised base grants for three years, with grant amounts increasing over that time, with industry cash and/or auditable in-kind contributions leveraged toward the projects.

The grants were flexible and accommodated a wide variety of activities that initiated or increased innovation in an area where the college had recognised expertise and was already working with the local community and businesses.

The pilot program had three overriding objectives:

- increasing and encouraging partnerships and interactions between colleges and local industries and businesses;
- training people to have the skills required to work in local industries and business that are introducing and adapting technologies; and
- building the capacity of community colleges to enhance innovation in the local community.

Attachment 2 shows the logic model outlining the outputs and outcomes envisaged from the pilot.

The mid-term review undertaken in 2007 reached four conclusions:

1. Colleges are well positioned to work with local industry beyond the provision of training. Those with established applied research and development capacity are well placed to help companies address problems through applied research and development projects and to assist them in adopting new technology.
2. The grants enhanced the capacity of the pilot colleges to conduct applied research and development and to work with local businesses.
3. Evidence of short-term benefits to local industry was clear and set the foundation for longer term economic benefits, even though it was too early to conclude that innovation and economic revitalisation was enhanced.
4. Stable financial support to colleges is needed to sustain applied research and development projects with local industry, along with support from the leadership of the organisation, and necessary equipment and infrastructure.

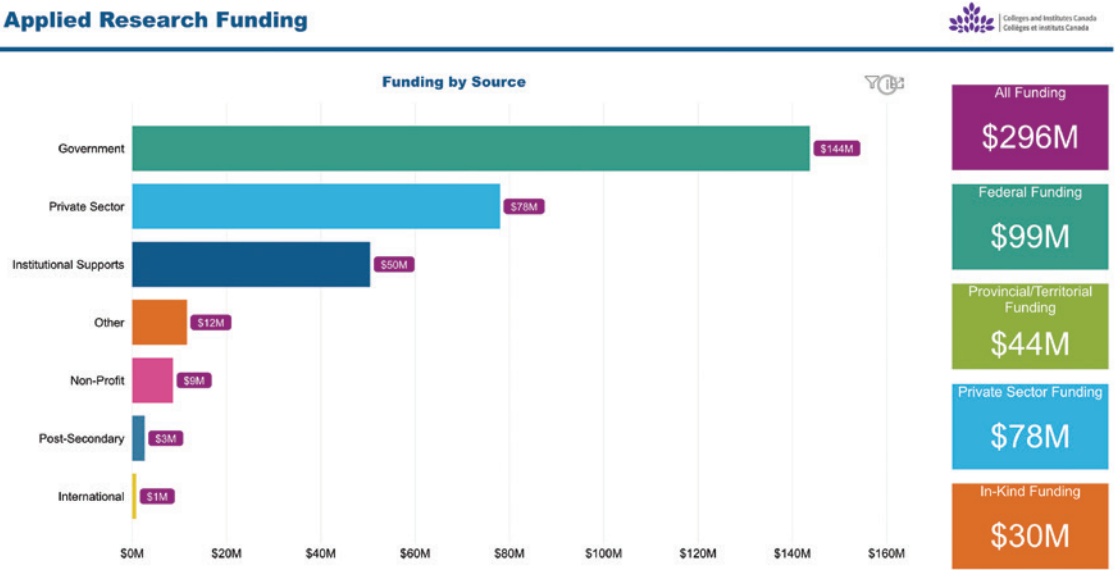
Based on the success of the CCIP Program, the permanent College and Community Innovation (CCI) Program²⁵ was officially launched in 2008-09 with \$15 million (CAD) from the Canadian *Science and Technology Strategy* announced in the Government of Canada's Budget 2007.

The CCI Program grew rapidly. It is now supported by NSERC at \$85 million (CAD) per annum. The 2017-18 Applied Research Survey by Colleges and Institutes Canada shows funding from all sources totalled \$296 million (CAD).²⁶

Research outputs

As Diagram 1 shows, private sector funding and the value of in-kind support totalling \$108 million (CAD) make up 37 per cent of total funding directed to applied research.

Diagram 1: College and Community Innovation Program funding mix



Source: Colleges and Institutes Canada 2017/2018 Applied Research Survey

Today, over 90 per cent of colleges and institutes have applied research offices ready to support their communities and local businesses with innovative solutions.

Applied research outputs include product prototypes and new products, processes or services. The translation of CCI Program sponsored research into tangible outputs is extensive. Fifty-two per cent of projects deliver prototypes, while 23 per cent deliver new products and the remainder are new processes and services (see Diagram 2).

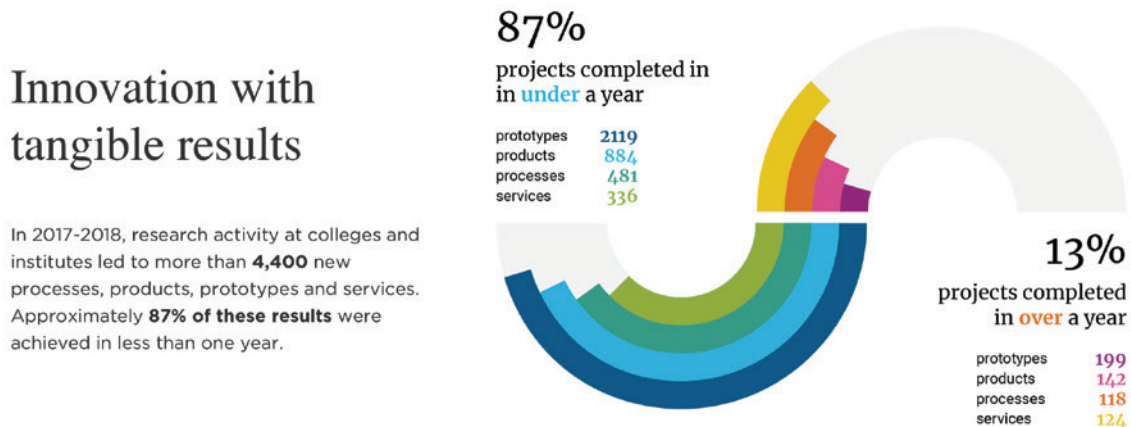
Diagram 2: College and Community Innovation Program research outputs



Source: Colleges and Institutes Canada 2017/2018 Applied Research Survey

The defining feature is rapid completion, as would be expected in an applied research context. Diagram 3 shows that 87 per cent of all projects for 2017-18 were completed in less than one year.

Diagram 3: College and Community Innovation Program research outputs II



Source: Colleges and Institutes Canada 2017/2018 Applied Research Survey

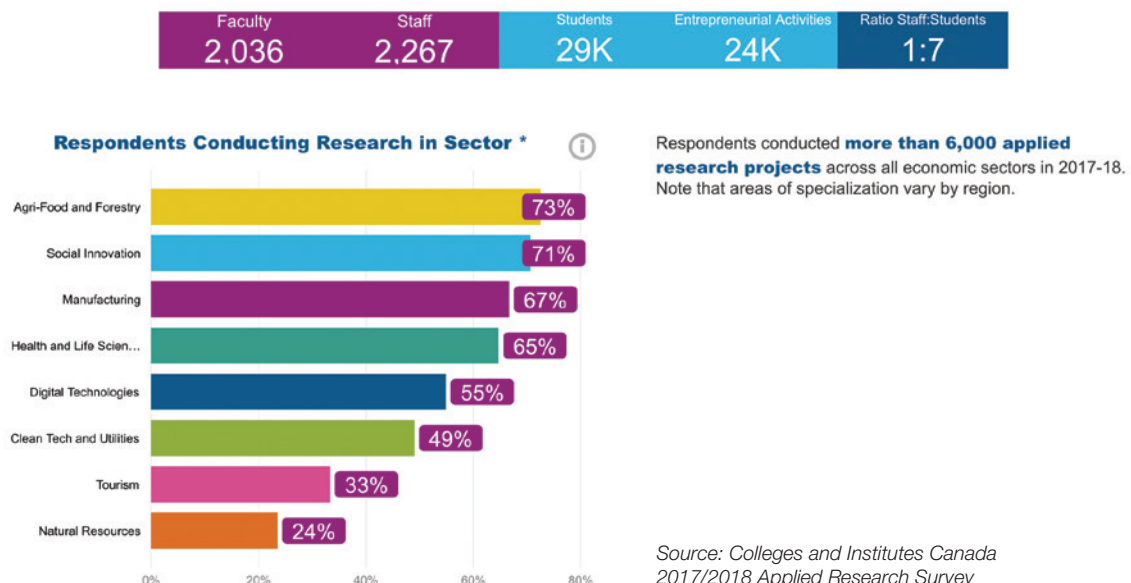
The applied research experience involved over 57,000 college staff and students in the 2017-18 year. Around 53,000 students participated in applied research or entrepreneurial activities. Students get to engage first-hand in the research and entrepreneurship journey and acquire the practical know-how in preparation for their working life. Staff keep abreast of developments in their industry and through the applied research process help drive innovation through the industry. As Diagram 4 shows, projects span a large number of Canadian industry sectors.

Diagram 4: College and Community Innovation Program student experience and industry sectors

Research Personnel



Applied Research activities bring together more than 57,000 people on college campuses across Canada. This includes more than 2,000 faculty, 2,200 administrative staff (research coordinators, administrators, deans, grant coordinators, etc.), 29,000 students involved in AR and a further 24,000 students involved in entrepreneurial activities. Despite these large numbers, the ratio of staff to students remains low, which means students can benefit from close mentorship during their work integrated learning experiences.



COLLEGE AND COMMUNITY INNOVATION PROGRAM LOGIC MODEL

ULTIMATE OUTCOMES

- FO4** - Stronger Canadian economy
- FO3** - Increase in economic development of the community
- FO2** - Increase in the number of high quality jobs based on know-how and technological innovation in the community
- FO1** - Local businesses and industries improve their market share

INTERMEDIATE OUTCOMES

- INT5** - Local industries and businesses have new and improved products and processes
- INT4** - Local industries and businesses adopt new technologies
- INT3** - The capacity of the colleges to transform new knowledge and technology into economic benefit is increased
- INT2** - Teaching activities of the college faculty are enhanced
- INT1** - Students receiving training obtain employment requiring their skills and knowledge

IMMEDIATE OUTCOMES

During Award:

- IMM8** - Colleges work with local businesses, industries and other organizations on activities to advance innovation in a particular area
- IMM7** - Local businesses, industries and institutions are aware of the benefits of working with the colleges
- IMM6** - Students receive hands-on training and financial support to work on projects advancing innovation in the local community
- IMM5** - Faculty released from teaching work on activities supporting innovation
- IMM4** - Colleges use grants according to their plan and budget, meet project milestones, respect NSERC's rules on use of funds and accountability

Pre- Award:

- IMM3** - Selection committee understands its role, recommends meritorious proposals for funding having geographic distribution, and mix of large, small, urban, rural, provide feedback to applicants and advice on program
- IMM2** - Colleges submit proposals meeting program guidelines and criteria
- IMM1** - Colleges apply for eligibility to administer NSERC grants

ACTIVITIES AND OUTPUTS

- AO6** - Assessing preliminary impacts and determining whether to seek funding to institute program on a permanent basis
- AO5** - Ongoing administration, monitoring progress and financial reviews
- AO4** - Evaluation of proposals and recommendations to funding by the Selection Committee
- AO3** - Receiving and processing applications
- AO2** - Appointment of the selection committee
- AO1** - Development of the pilot program description in consultation with the ACCC and the advisory committee

Program Rationale

- Increasing and encouraging partnerships and interactions between the colleges and local industries and businesses
- Training people to have the skills required to work in local industries and businesses that are introducing and adapting new technologies
- Building the capacity of community colleges to enhance innovation in the local community

CANADIAN APPLIED RESEARCH CASE STUDIES

Niagara College, Ontario

Advanced manufacturing - Improving highway line painting technology

Niagara College's state-of-the-art capacity in 3D design and 3D printing has offered local companies exciting new possibilities to improve their products and services.

One such company is Linetech Equipment Mfg. Ltd., one of Canada's leading manufacturers of equipment to paint lines on roads and highways. About 100 of the company's truck-mounted machines are in use across Canada, the United States, and in other parts of the world.

Several years ago, Linetech worked with the college's digital media team to update software and test a mobile monitoring device that gauges the thickness of existing road markings. After a successful research partnership with Niagara on this project, Linetech turned to the Advanced Manufacturing Innovation Centre team for help improving its equipment production.

The Centre's research team redesigned one part of Linetech's equipment to make it lighter and smaller and re-engineered the manufacturing process to involve fewer parts to allow quicker changes on the line. They were also able to create the finished part with the college's 3D printer. In the end, the team provided a more cost-effective process to Linetech, using less material for production and, in one case, creating potential for an expanded product line. The company was producing four and six-inch parts, but with the new material and process, college engineers were able to create an eight-inch part to serve the company's needs better.

Funding: Technology Access Centre (TAC) Grant NSERC
– Colleges and Community Innovation Program)

Partners: Linetech Equipment Mfg. Ltd.



Niagara College is one of Ontario's 24 colleges of applied arts and technology established under the Ministry of Training, Colleges and Universities. Since opening its doors in 1967 in Welland, Ontario and expanding across the Niagara region and internationally, Niagara College has grown to become a leader in applied education.

Advanced manufacturing - with sensations the next fashion sensation

Entering a virtual reality world may soon be as easy as slipping on a life jacket with the development of ARAIG — a wearable wireless, multi-sensory, immersive suit for gaming and simulation training. The suit is the brainchild of Michael and Brodie Stanfield, founders of Inventing Future Technologies Inc.—IFTech for short — a start-up from Oshawa, Ontario.

ARAIG, an acronym for “As real as it gets,” was developed with computer gaming in mind. It consists of an inner T-shirt-like layer and an outer exoskeleton that looks like a high-tech version of a football player’s pads. ARAIG offers wearers surround sound, vibration, pressure and resistance feedback —basically allowing users to feel what’s happening in the virtual world, where in the past they only saw graphics and heard sound tracks.



ARAIG also has possibilities beyond gaming. The Stanfields have even heard from the Canadian Armed Forces, interested in the product’s potential as a hyper-realistic way to train and simulate combat.

When they approached George Brown, the Stanfields already had a proof-of-concept model. They had worked with Durham College on the vest’s electronics and their online community advised on its look and feel. What they needed from George Brown was help with the challenge of making the ARAIG vest washable, breathable and in line with aesthetic requirements. Two fashion studies students were recruited to undertake the design.

“They were supervised by principal investigator and faculty member Zoran Dobric, who noted that “IFTECH is a great example of the next level of wearable technology. It can be implemented in both entertainment and gaming industries, as well as simulation and training.”

After many iterations and pattern prototypes, IFTech now has product specifications, and is working closely with manufacturers for commercialization. Recently, IFTech won in the Durham region of the Spark Ignite Competition, taking home a prize of \$25,000.

Funding: Applied Research and Development (ARD) Grant, NSERC, College and Community Innovation Program

Partners: Inventing Future Technologies Inc. (IFTech)



George Brown strives to build a seamless bridge between learners and employment by developing dynamic programs that are informed by industry and workplace-ready graduates who will be the candidates of choice for employers. The college offers a wide range of degree, diploma, certificate and apprenticeship programs at three campuses in downtown Toronto.

Advanced manufacturing - making power wheelchairs smarter

Many people who use power wheelchairs have poor manual dexterity because of spinal cord, stroke or head injuries, or because of degenerative diseases. Even getting in and out of an accessible vehicle can be time-consuming, and sometimes dangerous, for them. Other tasks — such as taking a shower — require an attendant to drive the wheelchair away.



SmartChair gives people who use wheelchairs more freedom and self-reliance while significantly improving their safety and mobility. SmartChair is a control system which can easily be integrated with any existing power wheelchair. The goal of the project is to give users added independence by improving their control of their power wheelchair, regardless of their level of ability.

A power wheelchair outfitted with the SmartChair control system will also offer computer-assisted autonomous movement to its user, letting him or her automate certain tasks. That might include following a pre-defined path, getting in and out of an accessible van, or navigating indoors in narrow hallways, through doorways and around tight corners. It's a technology based on lived experience: several years ago, Eightfold Inc.'s president, Ke Wang, had an accident; he has used a power wheelchair ever since, and the idea for SmartChair grew from barriers he faces every day.

The SmartChair project got a boost when it partnered with a team of four students from Algonquin College, led by researchers Dr. Theo Mirtchev and Dr. Bruno Rocha. With funding from Ontario Centres of Excellence and the Natural Sciences and Engineering Research Council, the students worked as research assistants from January 2016 to April 2017. They acquired experience in developing both hardware and software, control engineering, sensors and in testing and measuring technology.

SmartChair can change the lives of power wheelchair users every day, in a variety of ways. They include better control in narrow spaces such as doorways and ramps and the ability to “drive” the wheelchair when it's empty because the user has transferred from it to bed, the couch or the shower. Changes such as those can reduce the cost of attendants and allow for greater independence. It's also small and lightweight.

Funding: Ontario Centres of Excellence, NSERC,
College and Community Innovation Program, Engage Grant

Partners: Eightfold Technologies Inc.

Food innovation - From the Restaurant to Your Kitchen

Scaccia is a family owned Italian restaurant in downtown Toronto. Their signature dish is the “scaccia” itself – a variety of delicious, healthy vegetables, cheeses, and meats placed between two layers of dough and baked to perfection.

Looking to break into the ready-made market, Scaccia restaurant came to George Brown College’s Food Innovation and Research Studio (FIRSt) to develop a frozen microwaveable version of their scaccia sandwich. The product had to be individually portioned for the food service industry, nutritionally responsible, and as tasty as the original.

College researchers worked closely with Scaccia owners and head chef throughout the development process for four popular scaccia flavors. The FIRSt team evaluated Scaccia’s restaurant ingredients and matched them with commercially viable options able to withstand freeze/thaw cycles.

In addition to sourcing special freezing technologies, the research team also developed a unique sauce system to ensure fillings were contained within the open-sided sandwich. After 24 months, and more than 60 iterations of sauces, fillings and Italian style dough using a variety of preparation processes, Scaccia was given four formulations and product specifications to take to a co-manufacturer, complete with sensory evaluations.

Through an additional collaboration with George Brown School of Business students, the product was tested on location at Scaccia Restaurant to get customer feedback on this new sandwich. This gave the company valuable consumer insights to develop the right marketing strategy for this innovative food product.



Funding: Technology Access Centre (TAC) Grant

Partners: Scaccia Restaurants



George Brown strives to build a seamless bridge between learners and employment by developing dynamic programs that are informed by industry and workplace-ready graduates who will be the candidates of choice for employers. The college offers a wide range of degree, diploma, certificate and apprenticeship programs at three campuses in downtown Toronto.

TAFE DIRECTORS AUSTRALIA

TAFE Directors Australia (TDA) is the peak national body, which represents Australia's national network of publicly owned Technical and Further Education (TAFE) institutes and dual sector university TAFE divisions.

Each TAFE on behalf of its state or territory delivers comprehensive tertiary education, spanning senior schooling, technical and further education and higher education. In meeting the education and training needs of their students, the TAFE network serves the needs of Australian industry, enterprises, communities and economy.

Australia's network of TAFE institutes is the largest and most diverse component of our national tertiary education sector, with more than 600 delivery locations across central business districts, suburban, regional, rural and remote locations. Many institutes offer further services throughout the Asia-Pacific and other offshore regions.

TDA seeks to bring TAFEs together and link with key stakeholders in post-school education, including with other education bodies, industry and across all areas of government activity that rely on TAFEs. To support its work, TDA engages with TAFE leaders, including dual sector universities, and works in partnership with the Victorian TAFE Association that brings Victorian members together. TDA also collaborates with its corporate partners to develop initiatives and priorities for mutual benefit.

The core business of TDA is supporting our member institutes, leading the advocacy for quality skills in Australia, and managing a range of international education and training projects in co-operation with our institutes.

TAFE Directors Australia was established by TAFE directors in 1998.

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