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CSIRO Submission 19/700

Education in Remote and Complex Environments

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Introduction

CSIRO Education and Outreach welcomes the opportunity to provide input to the inquiry into Education in Remote and Complex Environments.

CSIRO is Australia's national science organisation and one of the largest and most diverse scientific research organisations in the world. Our purpose is to solve Australia's greatest challenges through innovative science and technology. An important part of our work is our significant investment, through our CSIRO Education and Outreach team, to provide high-quality science, technology, engineering and mathematics (STEM) programs for teachers, students and community.

CSIRO Education and Outreach is focused on delivering engaging STEM learning experiences that help to build and equip Australia's future STEM-skilled workforce. Through our programs, we promote the importance and application of CSIRO research to the community and to increase Australia's STEM literacy to capitalise on the industries of the future. This includes significant programs in remote communities across Australia.

Our submission provides case studies, evidence and research from several of our programs in response to areas of the Terms of Reference in which we have relevant insights. In particular, our Indigenous STEM Education Project provides significant evidence of effective approaches to STEM education programs in remote and complex environments across Australia.

CSIRO response to the Terms of Reference (ToR)

Key barriers to the education journey, including the effects of environmental factors such as drought on families and communities

Since 2014, CSIRO's Indigenous STEM Education Project has offered six program elements across Australia, including in remote WA and NT, to increase participation and achievement of Aboriginal and Torres Strait Islander students in STEM education and careers. In delivering these program elements, including the Aboriginal Summer School for Excellence in Technology and Science (ASSETS) program, Science Pathways for Indigenous Communities and Inquiry for Indigenous Science Students (I2S2), the team has identified key barriers impacting the education journey of students, as well as effective activities to address some of these challenges. In addition, CSIRO's recent Virtual Work Experience pilot highlights the barriers remote students face to accessing meaningful work experience and the innovative solutions that can be employed to engage these students.

Teacher retention

One of the keys challenges identified by research into teaching and learning in remote areas of Australia is the difficulty in recruiting and retaining teachers (Halsey, 2018). The Science Pathways for Indigenous Communities program uses on-Country projects as the context for learning science linked to Indigenous ecological knowledge. The program targets primary and middle school students in remote Indigenous communities. In delivering the program, teacher and principal turnover as well as a lack of opportunity to promote the program and collaborate more widely have been identified as barriers to sustainability. Emerging findings from recent qualitative evaluation research with remote school communities that participate in the program has highlighted these barriers. (These findings are to be published in a forthcoming program evaluation report of the program.)

Students from equity groups

Research has also highlighted that students in schools in rural Australia are less-advantaged than their urban counterparts and are less likely to finish secondary school or attend university (Fraser, Beswick & Crowley, 2019). These challenges are further compounded if the student is from an equity group, such as Aboriginal and Torres Strait Islander students. Students from these equity groups can face challenges in secondary school and university, including access to resources and support, being the first in family with aspirations of further education, and a perceived lack of benefit for some students (Day & Nolde, 2009; Gore, 2017).

Further to this, students in rural and remote locations are less likely to see people in a wide range of occupations and are less likely to have student peers aiming for university and professional careers compared to students in urban areas; this can limit their education and occupational aspirations (Parker, Jerrim, Anders, & Astell-Burt, 2016; Wilson, 2013).

To address some of these challenges, the ASSETS program offers a summer school for high-achieving Indigenous students which increases students' exposure to STEM careers and professionals and facilitates the creation of peer networks (Banks, Mudhan & Fidler, 2019). This is coupled with an ongoing leadership and support program to nurture students through years 11 and 12. Approximately 20 per cent of students who were offered places in the 2018/19 program were from remote areas (as defined by the Accessibility/ Remoteness Index of Australia data, ABS).

Access to STEM-based work experience

Work experience can be a key step on students' education journey, assisting with the transition from school to work. Each year, however, organisations such as CSIRO receive significantly more applications for work experience than there are places available and many of these places are available only to students in metropolitan area. For example, in 2019, CSIRO received 834 applications for 102 placement opportunities. Of those 102 placements in 2019, only seven were for students from regional or remote locations.

To help address these challenges facing regional and remote students, CSIRO worked with the Commonwealth Department of Education and Training to trial the Virtual Work Experience Program in Semester 1, 2019. The program provided an opportunity for students to undertake collaborative, group STEM projects, including projects linked to real-world CSIRO research and industry challenges. Students participated in these work experience projects using online collaboration tools while in their schools or homes. Experienced CSIRO and industry STEM professionals—who were remote from the students—were engaged as work experience supervisors.

 A total of 57 students participated in the pilot, with 60 per cent of these students living in regional areas and 24 per cent of these students living in remote areas of Australia. The program evaluation revealed that, had they not participated in the virtual program, 29 per cent of participating students would have done no work experience at all and a further 29 per cent of students would not have been able to do STEM-related work experience. For students in regional and remote areas, only 37 per cent reported that they could have found alternative STEM-related work experiences if the virtual program was not available.

The role of culture and country in a child's learning

Within CSIRO's Indigenous STEM Education Project, Aboriginal and Torres Strait Islander cultures, languages and Country play a central role. Evidence from program evaluation demonstrates the significant benefits of sharing and integrating Aboriginal and/or Torres Strait Islander knowledges and contexts into the education curriculum for all students. In particular, the following programs exemplify this:

Inquiry for Indigenous Science Students (I2S2)

Within the I2S2 program, students build skills and capability through hands-on, inquiry-based projects in an Indigenous context. The program is designed to show teachers and students how Aboriginal and Torres Strait Islander peoples have created, developed and used high-level science inquiry skills for 65,000+ years. Inquiries are delivered as part of schools' regular science curriculum and use multimodal delivery techniques. The inquiries also allow all students to demonstrate their cognitive science skills through assessments that are not dependent on written English literacy skills (such as verbal assessments or graphics-based assessments on tablet computers). The I2S2 team also trains and supports science teachers in the delivery of the inquiries and broader Aboriginal and Torres Strait Islander cultural awareness, relevant to their implementation.

The benefits of this culturally responsive approach are demonstrated in research literature (for example, Lewthwaite, Osborne, Lloyd, Boon, & Llewellyn, 2015) and by CSIRO's forthcoming I2S2 program evaluation report (currently in draft). Emerging findings identify that in 2016, 66 per cent of Aboriginal and Torres Strait Islander students achieved an A, B or C grade after participating in the program (up from 49 per cent). Students reported that they found it encouraging that Indigenous knowledge was included in the curriculum, and teachers reported a high level of interest and engagement demonstrated by Aboriginal and Torres Strait Islander students. For example, several students shared their own knowledge and experiences in the class and helped peers where needed.

Science Pathways for Indigenous Communities

Science Pathways for Indigenous Communities works with remote schools and communities to develop integrated two-way Science learning programs that connect Indigenous ecological knowledge with Western science and the Australian Curriculum. The program supports schools in WA and NT to develop curriculum and education plans that are built around on-Country projects developed through strong community partnerships with Elders and, where they exist, Indigenous ranger groups, scientists and land management organisations. The program recently released the *Two-Way Science* book (Deslandes et al., 2019) containing curriculum-linked education activities for primary and middle school students, and background knowledge for teachers, based on the desert regions of Australia.

In CSIRO's forthcoming program evaluation report (currently in draft)**,** Elders, local educators and other cultural leaders in each participating community highlighted the value of the program in strengthening young peoples' connections with first languages. Community evaluation visits highlighted the role of first languages in education, including the importance of language during classroom learning, to reduce the pressure on students to constantly code-switch between home and school, and as a central element of transferring cultural knowledge. This is in line with research that demonstrates that language reconnection has the potential to improve wellbeing, through belonging and empowerment (Doyle & Hill, 2008; Marmion, Obata & Troy, 2014; Sivak et al., 2019).

Community and family structures that support a child's education and their attendance at school

Evidence from CSIRO's Indigenous STEM Education Project demonstrates the importance of community and family engagement in student education and provides evidence of effective engagement strategies for programs involving students from remote communities. Learnings from this project have been used to guide the design of CSIRO's recently established Young Indigenous Women's STEM Academy.

Science Pathways for Indigenous Communities

Research has shown that stronger student connections with their communities can result in students feeling more engaged in their learning (Zyngier, 2018), and there is some evidence that students may be more likely to be motivated to learn and achieve higher grades when their parents are actively involved in their learning (Perkins, 2014). These findings were confirmed by schools and communities that participated in the Science Pathways for Indigenous Communities program evaluation (report currently in draft). Participants agreed that the involvement of family, community members and other Aboriginal cultural knowledge holders, such as rangers, was valuable in enhancing student learning experiences. The evaluation found that embedding a two-way learning approach into the curriculum; immersive two-way teacher professional development led by local Elders; and incorporating on-country learning into curriculum to support subjects such as Science, Mathematics, English and general capabilities, are all factors that improved the involvement of community and family in student education. In the program, this approach is supported by the development of trusting and collaborative partnerships between program staff and the community, including through a community development approach that encompassed coordination, modelling and mentoring.

Aboriginal Summer School for Excellence in Technology and Science (ASSETS)

Similarly, the ASSETS program provides evidence of the value of community and parental engagement in program design. A core component of the ASSETS nine-day summer school is to engage with a range of community members, who have the opportunity to share personal and work-related knowledge as well as cultural knowledge and stories of their own journeys. Evaluation has found that ASSETS staff and students find the involvement of Elders to be a highlight and a positive influence on students' career aspirations. Some students were able to identify ways they would continue to engage at a community level after the summer school, especially with local cultural leaders, such as through volunteering, taking on a role-model mindset and sharing their culture with others.

In addition to this, program communication with students' parents is designed to establish an early expectation of engagement, particularly in the social and cultural aspects of the summer school. Importantly, the ASSETS program acknowledges the importance of recognising non-traditional family settings in the successful engagement of remote students. Through the development of relationships with the wider community that support a student, parents and care-givers are more likely to encourage participation and engagement with education programs (Banks, Mudhan & Filder, 2019).

Young Indigenous Women's STEM Academy

In 2019-2020, the Young Indigenous Women's STEM Academy began operation of its first regional cohorts in Cairns, the Torres Strait, Townsville and Palm Island. The Academy model seeks to maximise student success by engaging a broad spectrum of community and family members and providing tailored, local support, including individualised learning plans. The Academy is structured around clusters of students in regional groups, each of which is supported by a dedicated, regional Academic Coordinator. This model enables Coordinators and students to develop one-to-one relationships and local peer networks that support students through the STEM pipeline. Further to this, teacher, schools, family and community are involved in the Academy from the application stage are included in all appropriate correspondence and contribute to learning programs. This early involvement of each student's community enables CSIRO to understand the unique requirements of each student, and build a network of local supporters and culturally safe spaces with interlocking relationships to support and guide Academy students.

Innovative approaches to workforce, including recruitment, professional learning, retention and support, and lessons from communities that could be more generally applied

Several CSIRO Education and Outreach programs specifically offer teacher professional development opportunities designed to increase teachers' capacity to deliver quality science education. The Science Pathways for Indigenous Communities program, in particular, supports teachers in remote communities to build confidence and capacity to develop a more culturally responsive two-way pedagogy.

Science Pathways for Indigenous Communities

Research shows that teachers who genuinely collaborate, respond to the cultural context and develop culturally responsive pedagogies aligned with the experiences of their students are more likely to be effective teachers, engaging their students to achieve learning outcomes (Harrison & Greenfield, 2011; Sullivan, Jorgensen, Boaler, & Lerman, 2013; Boon & Lewthwaite, 2016; Moriarty & Bennet, 2016). In line with this research, the Science Pathways for Indigenous Communities program offers professional learning that builds teacher confidence and capacity to develop a more culturally responsive two-way pedagogy. Underpinning this is the program's place-based, immersive approach to teacher education and an emphasis on local Aboriginal leadership, knowledge and influence. These program elements are critical to supporting teachers to shift their approach to teaching to better support students in their community. Emerging evaluation findings of the Science Pathways for Indigenous Communities program highlight that when teachers are supported by program staff and principals to work cross-culturally through reciprocal learning relationships with students and community members, teacher capacity to connect more positively with their communities was improved (findings to be published in the forthcoming program evaluation, currently in draft).

Access and support to deliver the Australian Curriculum (including STEM) in a flexible way to meet local learning needs and interests of remote students, including examples of innovative ways in which the curriculum is being delivered in remote schools

All CSIRO Education and Outreach programs and resources are linked to the Australian Curriculum and use best practice STEM teaching methods. In particular, the Science Pathways for Indigenous Communities, STEM Professionals in Schools and Bebras programs demonstrate effective ways in which the Australian Science Curriculum can be delivered flexibly to meet local needs in remote communities.

Science Pathways for Indigenous Communities

The Science Pathways for Indigenous Communities program supports Aboriginal communities and schools to work together to develop an integrated two-way Science learning program that connects Indigenous ecological knowledge with Western science and the Australian Curriculum. The foundation of two-way Science is Learning on Country, involving Aboriginal experts, such as Rangers and Elders, teaching cultural knowledge of Country to students outside the classroom. Aboriginal people decide what to teach, how to teach and where to teach students from their communities. Two-way Science provides a context for delivering the Australian Science Curriculum, with opportunities to integrate other curriculum areas, such as Mathematics and English.

The program's innovative approach to including Aboriginal scientific knowledge as a focus within the science curriculum was recognised by the Australian Curriculum, Assessment and Reporting Authority (ACARA) in its illustrations of practice. For example, at Wiluna Remote Community School students go on Country with Martu Elders and undertake hands-on cultural and science activities. The program is connected to learning before and afterwards in the classroom. This method of on-Country, inquiry-based learning has seen increased student attendance and engagement, as well as stronger relationships between the community and the school, which is crucial to the success of students. Using the traditional knowledge model provided by the Science Pathways for Indigenous Communities program, the school repurposed the former TAFE site as a Training Centre in 2017. This facility allows upper secondary students to work with Martu Rangers to facilitate intergenerational transfer of knowledge through Certificate I and II that correspond to on-Country oriented employment.

STEM Professionals in Schools

STEM Professionals in Schools is a national volunteer program that facilitates partnerships between schools and industry to bring STEM into the classroom. Evidence from the program highlights the importance of tailored partnerships between teachers and industry to enrich the Australian Curriculum and showcase how STEM applies to everyday life and the workforce. Since beginning in 2007, the program has supported more than 6000 partnerships, which include teacher professional learning, mentoring and one-on-one tutoring, site visits and field trips, career talks and presentations, hands-on demonstrations, and online engagement e.g. videoconferencing. As of February 2020, more than two per cent of program partnerships are in remote and very remote schools and 25 per cent of program partnerships are in outer and inner regional schools. The program provides additional support for these regional and remote partnerships by conducting Regional Tours involving school visits and networking sessions and developing online resources to encourage and support regional, remote and long-distance partnerships.

Bebras

The Bebras Challenge is an international computational thinking challenge run in 60 countries via an online platform and completed by students individually or in teams. As part of the program, online teacher professional learning is offered to demonstrate how the Challenge aligns with the Australian Curriculum. In addition to the Challenge, CSIRO offers Bebras 365—an online tool providing teachers and students access to previous challenge questions for practise or classroom diagnostic purposes.

Evidence of the strong interest in computational thinking as a general capability, and as a skillset necessary for future employment, is seen in the increasing demand for this program. In 2019, the program engaged more than 100,000 students across Australia. In the 2019 September Challenge, 25 per cent of the 18,000 participants were from regional or remote areas. To meet demand from schools with poor internet connectivity, in 2020, CSIRO will finalise Bebras Unplugged, a set of offline computational thinking resources that can be used by schools to practice computational thinking skills in a collaborative manner.

Successful pathways to ensure students have the knowledge and skills they need to enter further education and the workforce

Recognising that preparing today's students with strong STEM skills is critical to realising the full potential of the future workforce, CSIRO Education and Outreach offers programs that seek to give students the knowledge they need to enter further education and employment. In particular, our ASSETS and Virtual Work Experience programs provide opportunities for students to better understand the skills and knowledge required for the workplace.

ASSETS

Through the ASSETS summer schools, Aboriginal and Torres Strait Islander students from across Australia, including remote communities, are provided with access to STEM professionals, universities, role models and STEM projects to boost their aspiration in STEM. Evaluation findings highlight the effectiveness of providing opportunities to high-achieving Year 10 Aboriginal and Torres Strait Islander students to explore study and career options in STEM. The impact of ASSETS on many students has been significant, particularly in supporting study and career directions, creating peer networks and increasing knowledge about preparing for STEM study at university and STEM careers (e.g. prerequisite subjects) (Banks, Mudhan & Fidler, 2019). For example, more than 80 per cent of 2016-17 participants reported their intention to pursue a STEM career following ASSETS (up 33 per cent from before participation in the summer school) and 84 per cent of 2016-17 ASSETS students reported a desire to study STEM at university. Students have also reported making the decision to relocate for tertiary study after attending a summer school hosted at a university where students were exposed to campus support services (Banks, Mudhan & Fidler, 2019).

In addition to the summer schools, the ASSETS program includes a leadership and support component that assists Aboriginal and Torres Strait Islander students to find the right pathway for them to access tertiary education and advance their career. As part of this component, students are offered advice and opportunities to participate in cadetships or work placements within STEM fields across Australia. Work placements give senior secondary students an opportunity to experience a workplace or career prior to committing to study and introduce students to mentors and new career paths (Banks, Mudhan & Fidler, 2019).

Virtual Work Experience Program

Research shows that well-designed work experience programs support students to build the knowledge and skills they need to enter further the workforce. They assist students to make informed study and employment choices, assist in developing valuable work-based skills and enhance employment prospects (Oliver, McDonald, Stewart, & Hewitt, 2016). Despite these wide-ranging benefits, many schools are limiting work experience opportunities for students due to the constraints such as risk, timetabling, child safety, lack of quality opportunity aligned to student interest and the need for travel (The Smith Family, 2014). In parallel, the skills required for work are changing rapidly with high demand for transferrable skills, like communication, teamwork, negotiation and problem solving (Education Council, 2018).

Recognising these challenges of traditional work experience and reflecting the way organisations like CSIRO work every day, the Virtual Work Experience Program sought to provide opportunities to students using internet-based technologies. Through the program students undertook collaborative, group STEM projects, aligned to student interest and industry challenges and projects. Experienced CSIRO and industry STEM professionals were engaged as work experience supervisors and used online collaborative tools to engage with the participating students.

The evaluation of the program revealed that the innovative model, involving online collaboration platforms, videoconferencing and group-based work experience projects, was effective. More than 80 per cent of students stated they would recommend the program to a fellow student, with many noting the program had inspired them to identify new career and educational paths in STEM. The evaluation also showed statistically significant growth in students' skills in negotiation and communication. This high level of satisfaction was unaffected by students' geographic location, demonstrating the potential for digital approaches to work experience to prepare students across Australia with the skills required for work.

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