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Indigenous STEM Education Project

Bachelor of Science (Extended)

Evaluation Case Study Outcomes Report

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Acknowledgements

Acknowledgement of Country

Aboriginal and Torres Strait Islander peoples have longstanding scientific-knowledge traditions. These traditions have developed knowledge about the world through:

- observation, using all the senses;
- prediction and hypothesis;
- testing (trial and error); and
- making generalisations within specific contexts.

These scientific methods have been practised and transmitted from one generation to the next and contribute to particular ways of knowing the world that are unique as well as complementary to Western scientific knowledge.

A deep respect for these Aboriginal and Torres Strait Islander cultural practices and knowledge underpin the philosophy and practice of the Indigenous STEM Education Project. Recognition of traditional contexts for technologies and concepts and their application in the past, present, and future—including supporting modern STEM career pathways for Aboriginal and Torres Strait Islander students—reaffirm the ingenuity and creativity of Aboriginal and Torres Strait Islander peoples' knowledge systems.

The Indigenous STEM Education Project acknowledges the Traditional Owners of the lands with whom this Project is collaborating and their vibrant living cultures and knowledge systems. We pay our respects to Elders past and present; and we thank all community members who are providing the leadership to ensure meaningful and effective engagement with Aboriginal and Torres Strait Islander communities for the six distinct but complementary STEM education programs that make up this Project.

CSIRO acknowledges that Aboriginal and Torres Strait Islander peoples make extraordinary contributions to Australia in cultural, economic and scientific domains; for example, incorporating Indigenous knowledge of ecological and social systems is vital to the achievement of sustainable development.

Other acknowledgements

CSIRO wishes to acknowledge the invaluable contribution of Aboriginal and Torres Strait Islander scientists, educators and program leaders—without their knowledge and leadership the development and implementation of the Indigenous STEM Education Project would not have been possible. In addition, CSIRO acknowledges the advice and guidance of Murrup Barak staff and the reference group for this research. Their wisdom in relation to respectfully engaging Aboriginal and Torres Strait Islander students in the research was enormously helpful and is appreciated.

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Glossary

Classroom dynamics refers to the nature of interaction between students and teachers in a classroom community. Positive dynamics is where students feel comfortable learning and communicating with other students and with the teacher.

Culturally responsive, in an education context, refers to approaches to teaching and support that value diversity, include cultural knowledge and awareness, and are adapted to cultural needs.[1]

Cultural safety, refers to an environment that is spiritually, socially, emotionally and physically safe; and which empowers individuals and enables them to contribute to the achievement of positive outcomes.[2]

Family (in the context of this report) refers to parents, caregivers, families and extended families, Elders, and community members involved in the education of their children.

I2S2 is the Inquiry for Indigenous Science Students program and is one of six program elements of CSIRO's Indigenous STEM Education project. I2S2 uses hands-on inquiry-based projects in Indigenous contexts to increase student engagement and achievement in science.

ITAS (Indigenous Tutorial Assistance Scheme) is a specialised tutorial program which provides funding to Murrup Barak to employ qualified tutors to provide free assistance to students.

Murrup Barak is the University of Melbourne Institute for Indigenous Development and has the primary role of supporting the Aboriginal and Torres Strait Islander student community to succeed in their studies.

Place-based learning/education is an approach that enables students to interact with facets of local heritage, cultures, landscapes, opportunities and experiences, and which uses these experiences as a foundation for students studying language, arts, mathematics, social studies, science and other subjects across the curriculum.

Scaffolding in education refers to a variety of instructional techniques used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process.

1 See Perso (2012) for a more detailed definition.

2 See Bin-Sallik (2003) for a discussion.

Staff. *Teaching staff* refers to the lecturers in the Bachelor of Science (Extended) program. *Support staff* refers to the staff from Murrup Barak, residential colleges, student support services, and ITAS tutors.

STEM is an acronym that refers to science, technology, engineering, and mathematics. A **STEM pipeline** is the educational pathway for students into STEM, including into a STEM career.

Supported pathway/program is a defined pathway/program for prospective and current university students that offers a range of focused support to assist students achieve educational goals and qualifications. In contrast, most **mainstream** programs offer only general support to students.

Two-way science is an approach where learning is based on the traditional ecological knowledge held by Aboriginal and Torres Strait Islander people. The approach privileges local Indigenous languages and is linked to Western science, the Australian Curriculum, on Country activities of local Indigenous groups, and the ecology-based scientific research taking place in different areas.

1 INTRODUCTION

This Evaluation Case Study Outcomes Report for the Bachelor of Science (Extended) program involves reporting against the program's Impact Pathway (Attachment A) jointly developed by CSIRO and the University of Melbourne. The overall goal of the program is to provide a supported pathway for Aboriginal and Torres Strait Islander students to complete a Bachelor of Science degree and to embark on careers that build on a strong science background. The Bachelor of Science (Extended) Program is one of six programs that comprise the Indigenous STEM Education Project, which is funded by BHP Foundation and delivered by CSIRO. The overarching goal of the Indigenous STEM Education Project is to provide supported pathways that improve the participation and achievement of Aboriginal and Torres Strait Islander students in STEM (science, technology, engineering and mathematics) subjects. There are six program elements to the project, which cater to the diversity of Aboriginal and Torres Strait Islander students as they progress through primary, secondary and tertiary education, and into employment.

The University of Melbourne was subcontracted by CSIRO to develop the course content of the Bachelor of Science (Extended) Program for Aboriginal and Torres Strait Islander students. The contract arrangements are from 1 September 2014 to 31 August 2019. This report evaluates progress in the program up to December 2017. Subsequent progress will be reported in the Indigenous STEM Education Project Third Evaluation Report and Final Evaluation Report.

Section 1 of this report briefly outlines the Indigenous STEM Education Project and Bachelor of Science (Extended) program, the purpose of the evaluation, evaluation scope and limitations, outcomes targeted for evaluation, and the case study approach. Section 2 outlines the key findings from the case study, in relation to the evaluation framework and intended outcomes for this element of the program. Section 3 presents a discussion of the findings, and Section 4 concludes the report with recommendations for program improvement in the future.

1.1 About the Bachelor of Science (Extended) Program

The Bachelor of Science (Extended) is a four-year degree at the University of Melbourne that provides a supported pathway for Aboriginal and Torres Strait Islander students (The University of Melbourne, 2018a). The program was made possible through $145,000 of seed funding provided to the university to develop the program curriculum. The model is based on the University's Bachelor of Arts (Extended) program, which has been operating since 2009. The Bachelor of Science (Extended) program is designed for Aboriginal and Torres Strait Islander students who show potential in science but who might otherwise not have access to such an opportunity. This is a situation many Aboriginal and Torres Strait Islander students find themselves in due to the barriers experienced in accessing education (O'Bryan & Rose, 2015; Pechenkina, 2015a; Pechenkina, 2015b; Pechenkina, Kowal, & Paradies, 2011). Other key aspects of the program include a scaffolding approach to learning; and aspects of place-based learning, including leveraging local assets and people.

The program includes an additional year of study comprising study units spread across the first and second years of the degree. The first year is taken full time and is a foundation year, which includes integrated science subjects (as well as integrated mathematics and communication subjects) and the opportunity to complete one mainstream science, mathematics or technology subject each semester. The integrated subjects are aimed at cultivating and refining the students' academic skills. These first three semesters of the degree focus on practical workshops and tailored academic support and is aimed at providing a strong foundation for the rest of their study. Incorporation of Indigenous perspectives in the science curriculum in terms of content and approach is integral to the program. It is expected that this incorporation will increase as the curriculum develops over the years.[3]

3 The University of Melbourne also has strategies, plans, policies and positions across the university that support the inclusion of Indigenous knowledge in curricula and promote cultural competency. These include an Indigenous Education Strategy, Teaching and Learning Indigenous Knowledges Community of Practice, and the appointment of a Pro Vice-Chancellor (Indigenous) (The University of Melbourne, 2019).

After the first year, students move to a more standard Bachelor of Science course structure. Combined with the foundation year, this makes the degree a four-year program (the mainstream Bachelor of Science is three years full time), which sets it apart from other supported programs (see Appendix A) in that the University commits to students for four years, in contrast to many one-year-supported programs that students complete and then have to apply to enter the degree in question. While there is no evidence that specifies the effectiveness of a four-year-support period, the extended commitment may be significant in light of evidence indicating that students commencing STEM-related studies at university generally have a longer road ahead of them compared with their colleagues in other fields of study, taking them an average of six years to complete a four-year degree (National Academies of Sciences, Engineering, and Medicine, 2016).

Additional support is also provided—for example, through providing accommodation at the university's residential colleges—to help students transition to university life. In terms of costs for students, if students are Abstudy-eligible, accommodation costs are provided by Centrelink. If students are not eligible for Abstudy, then Murrup Barak, the residential colleges and the student contribute to accommodation costs. Accommodation costs outside of the residential colleges are not subsidised by the University. Students' tuition costs are partly covered by Commonwealth supported places (CSPs), but students still make payments through the Higher Education Contribution Scheme (HECS) for their degree tuition costs. Accommodation includes meals. The success of this type of support aligns with research evidence — for example, Brady (2012) found that rates of retention and completion among students residing at tertiary institutions were significantly higher than among those who do not.

Residential support is part of a wider support structure that the University of Melbourne has in place for Aboriginal and Torres Strait Islander students in the program. Students commencing the program are also able to participate in an orientation week during which they get to know the support staff at Murrup Barak and the physical layout of the university, as well as receive an overall idea of the courses offered and the University's expectations. Once started, students in the program have access to a full range of opportunities, including study abroad and exchange; scholarships, awards and prizes; volunteering and leadership opportunities; and career opportunities, such as internships.

As at late 2017 (the end of the timeframe covered by this report), three cohorts of students had entered the program since it began accepting students in 2015. Over this period, the program has demonstrated significant progress in a number of key areas. By June 2016, it had developed and delivered a science and mathematics curriculum to students that integrated Indigenous knowledge. Over the same period, the intake of students gradually increased and challenges for students, particularly in mathematics, were being addressed by individualised support provided by teaching and support staff.

The three cohorts admitted to the program since 2015 have comprised students from a wide range of backgrounds, including those from rural and urban backgrounds, as well as low- and high-socioeconomic backgrounds. The 2015 cohort comprised students from Queensland (including Thursday Island), New South Wales, South Australia, Victoria (one regional and three metropolitan), Tasmania, and Western Australia (Perth). In 2016, students were recruited from Queensland, New South Wales, Western Australia, and the Northern Territory. In 2017, a higher proportion of the commencing cohort had completed study in Victoria immediately prior to entry (6 out of 8). However, some students had also come originally from other states, including Western Australia, Queensland, Australian Capital Territory and the Northern Territory, as well as Victoria (urban and rural). Edwards and McMillan (2015) note that there are compounding effects on successful outcomes for university students who belong to multiple cohorts, such as Aboriginal and Torres Strait Islander students from both non-metropolitan and low-socioeconomic areas.

The Bachelor of Science (Extended) is among a range of supported pathways for Aboriginal and Torres Strait Islander students to succeed at universities in Australia. However, programs providing support specifically in STEM pathways are few. Most programs provide general support and typically fall in one of two categories: pre-admission programs and post-admission programs. To place the Bachelor of Science (Extended) program into a broader context, a short overview of representative programs across Australia is provided in Appendix B.

1.2 Purpose of the evaluation

The purpose of this report is to present the findings from the case study of the Bachelor of Science (Extended) program, including analysis of progress toward meeting the program's goals and the challenges. The key inquiry question guiding the case study research was: *How has the Bachelor of Science (Extended) program progressed to achieve its goal (in part) of providing Aboriginal and Torres Strait Islander students with a supported pathway to complete a mainstream Bachelor of Science at the University of Melbourne?* This report covers the period from the commencement of the program in 2014[4] up to December 2017, representing an early assessment of progress toward outcomes. Future evaluation research will need to be conducted to ascertain ongoing and longer-term effects.

1.3 Evaluation scope and limitations

This report includes findings arising from a one-off case study, as well as ongoing program-monitoring data provided by the University of Melbourne. Program-monitoring data focus on monitoring student enrolments, student retention, and course completions. Given the small cohort, the case study aimed to capture details of two key aspects of the program: first, a sense of the students' diversity and their university experience, including their pathways to university, their decision to enrol in the extended program, their experience of the program, their connection with the teaching staff, the role of Murrup Barak and other support structures, and interactions with the wider Bachelor of Science cohort of students; and second, an exploration and analysis of the creation and operation of the program. The case study explored specifically the processes of individualised academic, personal and cultural support, the role of peer networks, and Indigenous contextualised curriculum (if relevant).

Seven intended outcomes have been identified for the Bachelor of Science (Extended) program. These outcomes—and how they are related to inputs, activities, outputs, and the intended impact of the program—are contained in an Impact Pathway (Appendix A) developed for the Bachelor of Science (Extended) program to focus the evaluation and the case study design and implementation. The case study was designed to provide evidence for five of the seven outcome areas outlined in the Impact Pathway. These five areas are:

OUTCOME 1: Strong student engagement, retention and results

OUTCOME 2: Seamless transition into Bachelor of Science with comparable outcomes in retention and results with other students

OUTCOME 3: Areas of curriculum refinement identified to integrate Indigenous scientific knowledge

OUTCOME 4: University building stronger relationships/partnerships re Indigenous scientific knowledge with Indigenous organisations

OUTCOME 5: Student aspirations, experience of university, and support factors including cultural responsiveness.

A further two outcomes are identified in the Impact Pathway. These are: *Best practice in science extended courses identified and adopted by other universities*; and *Strong engagement with development opportunities (study abroad, exchange, scholarships, awards, prizes, volunteering, and leadership opportunities)*. These two longer-term outcomes will be explored in further detail in the future by utilising additional evaluation methods. Findings for each of the five areas are discussed in Section 2 of this report.

4 Students were accepted into the program commencing in 2015.

1.4 Methodology

While program-monitoring processes have been established across all the programs of the Indigenous STEM Education Project to measure high-level student outcomes, the case study methodology was designed to enable a greater understanding of the pathways and processes of the program, and the extent to which program goals have been achieved. This includes understanding both the barriers that prevent, and the enablers that lead to, engagement, aspiration-building, and improved results. The value of case studies is that they allow in-depth exploration of the 'how' and 'why' of interventions (Hudson, 2017; Kelaher et al., 2018; Muir & Dean, 2017) and that they enable participants to tell their stories and describe their views of reality (Johnston, 2013). The core of the case study framework for the programs comprising the Indigenous STEM Education Project is the triangulation of data from the perspectives of key stakeholders in the relevant program element: students, teaching staff, and program/support staff.

The case study was guided by a local reference group, which provided advice on the design and conduct of the case study. Each of the relevant stakeholder groups in the program was represented on the local reference group, which consisted of one student, one lecturer, one program staff member, and one Murrup Barak staff member. Membership on this reference group included Aboriginal and Torres Strait Islander and non-Indigenous university academic staff.

The local reference group discussed aspects of the case study approach, including when and where to conduct interviews, participant recruitment, and the tailoring of interview questions and information/consent sheets. Three meetings were conducted in the lead up to data collection to inform the case study approach and ensure its appropriateness for the local context. Further clarification was sought from relevant members to address ad-hoc questions as these arose.

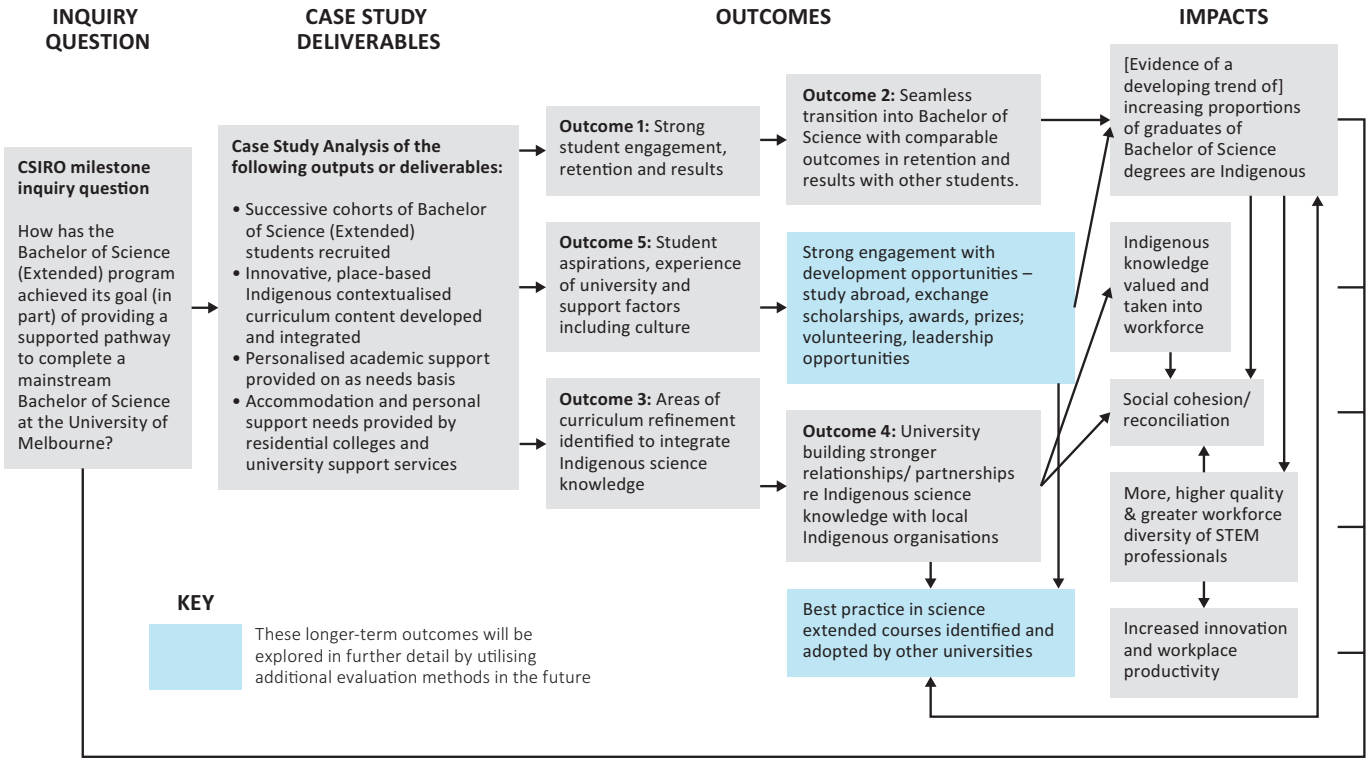
The case study methodology consisted of qualitative data collection and analysis. A total of 24 people participated in interviews: 18 individual interviews and three group interviews (each with two participants) were conducted in total (see Table 1). Semi-structured questions were asked of each of these stakeholder groups. The interview questions are attached in Appendix C. All students who were currently enrolled or had withdrawn from the course were invited to take part in the research. Six currently enrolled students participated out of a total of 24 students who were invited. These six students provided a rich source of information; however, because of the relatively small sample, some care should be applied in generalising the findings to all participants. Five out of the six students moved from interstate to attend the University of Melbourne, and the majority were school-leavers.

In terms of potential limitations, there may be some concerns with the representativeness of the students who were interviewed. Four out of the six student case study participants were male (66 per cent), which contrasted with the overall cohort, of which 11 out of 24 were male (46 per cent). In addition, five of the six students were currently enrolled students at the time of the study in 2017, with one student having departed the program. Therefore, information to help understand why students decide to leave the program was somewhat limited. Although the precise reasons why a smaller proportion of students participated in the case study compared to the teaching and support staff are not known, teaching staff did note that it was common for students not to respond to emails and texts from the University in a timely manner.

Table 1. Case study participants and total program participants, by stakeholder group

PARTICIPANT GROUP	NUMBER PARTICIPATED IN THE CASE STUDY	TOTAL NUMBER IDENTIFIED AND INVITED TO TAKE PART IN THE CASE STUDY	PER CENT PARTICIPATION
Students	6	24	25
Teaching staff	7	8	88
Support staff, including Murrup Barak, ITAS tutors, Residential Colleges, student support services	11	17	65
Total	**24**	**49**	**49**

The figure below provides an overall conceptual map of the inquiry process and illustrates how—within the framework of the Bachelor of Science (Extended) program; Impact Pathway—the five outcomes identified for evaluation in the case study relate to the main inquiry question, the key deliverables of the case study, the potential influence on the two outcomes not evaluated in the case study, and the intended impacts (benefits, economic, environmental, and social) of the program.



Conceptual map of the inquiry process

2 FINDINGS

In this section, interviews with students and teaching and support staff are presented. The findings are structured under two major themes: student experiences, and the curriculum.

2.1 Student experiences

2.1.1 EASE OF TRANSITION

Transitioning to university, particularly for school-leavers, comes with challenges. Some students spoke about the loneliness of being far away from home and sometimes feeling disconnected from the rest of the student population. This is not surprising given most of the students who participated in the case study were from interstate and were also school-leavers. One student said, "It gets kind of lonely and overwhelming if you move somewhere you've never been"; while another said, "...you're alone...you just kind of go to your class, leave, go to your tutorial, leave ...". Hence, students were appreciative of the multi-layered academic and pastoral support structure in place for them when participating in the program. They felt they were able to develop personal connections with lecturers and support staff, which enabled them to reach out to them when required:

> *"In that first year they were very supportive, and I think they couldn't have really improved any more on that kind of support. They did a great job ... they helped out so much." (Student)*

> *"The support that they offered and the sense of community that they were fostering here, I thought it was a fantastic opportunity to get back in touch with my Indigenous heritage because it wasn't something that I was offered at school." (Student)*

> *"...in Extended the teachers would, like, always help me catch up if my stuff was late." (Student)*

Murrup Barak has two Student Support Officers providing support to around 370 Aboriginal and Torres Strait Islander students at the University. Although these support officers do not monitor the progress of individual students, if a student is deemed at risk, they will contact the student and offer consultation and support. While such support is quite common among universities in Australia, having a separate Indigenous student support unit in the form of Murrup Barak—with a relatively low student-to-staff ratio (compared to support provided to the non-Indigenous student population)—was greatly valued by students and teaching staff alike.

Students indicated that they valued their relationships with student peers in the program. Outside their families, their student peers provided support during times of difficulty or loneliness.

> *"I think us transitioning ... to a new university; there was a good bond there as well. You keep in contact with them all [the other students], and you send them a message, or a text ... and see how they're doing. It's a good friendship and relationship you have ... I definitely think it's important, especially because a lot of us are away from our families, and that was nice having each other there." (Student)*

Students described their relationships with peers as more than just friendship but 'community', which was significant in light of students saying many of them originated from small country towns.

> *"I lived at the college ... They were all very welcoming, and a lot of us were from similar kinds of backgrounds, we weren't all city people; we were from smaller towns and got along quite well. And it's a smaller college as well, so that helped in the transition period." (Student)*

However, there was negligible evidence of students having such close bonds or extensive associations with non-Indigenous students, which may have been the students' own choice, an indicator that students did not feel culturally safe, or simply due to the small size and close proximity of the program participants.[5]

According to the students, the multi-layered support that they appreciated was also culturally responsive. They appreciated that, although teaching staff were non-Indigenous, they were eager to be more culturally aware and competent. This contributed to a non-judgmental, two-way learning environment, which was ideal for new ideas to be explored.

5 It is beyond the scope of this research to broadly assess cultural safety, but it has been established that the inclusion of Aboriginal and Torres Strait Islander students in the academic environment within a university requires the whole institution to be culturally inclusive (Andersen, Edwards, & Wolfe, 2016).

Students also mentioned the inclusive relational capabilities of teaching staff, which is a form of cultural capability.[6] For example, one student said, "... my ... teacher ... would organise times for me to meet them and we'd go through everything ... and what I need to work on, and I think that's something that really helped". Another student mentioned how helpful the tutoring and residential college were: "[The college] was a great help ... you'd see the wardens there at dinner, and they'd ask, 'How are you doing?' ... but mainly the tutoring helped quite a lot". While another student confirmed it was "... a very supportive kind of environment ... [with] one-on-one consults about how our results were going, but also just how we're feeling about the course, and how we're feeling about where we're living, and people we're meeting".

One student talked about how the University held activities that helped create inclusiveness, such as the Indigenous University Games and luncheons that "really build a sense of community". In line with this, Barney (2016) highlights the importance of university events across campus for networking and peer support among Aboriginal and Torres Strait Islander students. Students did not mention, and were not directly asked about, some other aspects of cultural capability and responsiveness, such as the University developing and exercising good judgment when faced with contested values.

Some students were concerned that there was stigma surrounding the program, because a few students not in the Bachelor of Science (Extended) program had mentioned that it was an 'easier' alternative pathway to a university degree. The University's public position that the program was embedded in its policy of delivering high-quality education helped to counteract this concern. In its public position, the university has also made it clear that while it has high expectations of students that enrol in the program, that there would be relevant support structures in place for students to succeed (The University of Melbourne, 2018b).

The University's policy on the program influenced personal interactions between students and teaching and support staff, and between students and their peers. Teaching staff spoke of commitment to the success of the program and students spoke of the benefits of having teaching staff that really cared. At each level, there were strong relationship threads driven by a mutual desire to see the program succeed:

> *"... they're all realists and intelligent people [science faculty] who want the program to succeed, they understand that if they're taking people in who haven't yet shown that they can do it, that they're going to have to work hard on getting them there." (Support staff)*

> *"The lecturers were great ... [they're] so friendly ... [they] remember you and it's good to know that they actually care for you." (Student)*

2.1.2 STUDENT ENGAGEMENT AND ATTENDANCE

At times, both students and teaching staff were concerned about the low and inconsistent attendance rates due to illness, participation in extra-curricular activities, and attending cultural events. One teaching staff member said: "... across all those subjects attendance is a real problem". Another reason for inconsistent attendance was the adjustment students had to make between the more regulated environment of school and the less regulated environment of university. Norton (2010) noted that students are often excited to be at university because they are not subjected to the regulatory constraints that exist in schools, but at the same time they are anxious about not having such regulations to guide them.

Teaching staff believed that there was a correlation between student attendance and achievement in the program. Students and teaching and support staff discussed the importance of attendance in contributing positively to the quality of classroom discussion and learning, and the negative impact of non-attendance on students who were attending regularly:

> *"It is fair to say, I think, that class attendance is, for most students, crucial to success." (Teaching Staff)*

> *"... attendance ... is to enable them to make the most of the learning opportunities with which they've been provided." (Teaching Staff)*

6 In an education context, types of cultural capability and responsiveness comprise personal, relational, professional, organisational and intercultural capabilities (Durey et al., 2016).

In terms of engagement in specific course content, there was mixed feedback. Some students struggled to stay engaged in content that they felt was 'boring' and 'not really what I expected'. One student felt that some of the subjects were 'so broad' that they couldn't really engage with them because they offered no specifics to ignite their interest. One of the teaching staff acknowledged that "we try and make it engaging and we give them interesting experiences from our perspective, but I feel like we haven't quite got that magic happening in the classroom".

However, many of the students described the content as "interesting for sure" and that the inclusion of Indigenous knowledge in particular "was a really good motivation, it made the class more interesting". The pedagogical approaches also engaged students:

> *"I think it was a mixture of different ways of teaching during the lesson. So, sometimes for half the lesson they would be explaining something but then they'd actually give you a worksheet to answer questions too and that kept it a bit more engaging, rather than just working out all of this information." (Student)*

Teaching staff concurred with this view.

> *"I think the students do find the content engaging. They have different disciplinary interests, so they'll find different bits more interesting than others, and they'll find different parts of it more challenging than others too." (Teaching Staff)*

One teaching staff member noted the variation in engagement levels among students: "Some were super engaged; others, I think, were having a lot of stuff going on in their lives". Ensuring that the difficulty levels were appropriate was important as well, as some students found, "It was not challenging, it didn't really engage me much, a lot of the content we learnt in Year 11".

Teaching and support staff noted that small class sizes also had some downsides, such as unpredictable attendance patterns making it difficult to plan effectively. According to staff, the most effective classroom strategies hinged on student interaction with each other. When all students where present, classroom discussions were robust, creating energy and motivating students to participate. Low student attendance on the other hand had the opposite effect, leaving teaching staff to 'anguish' over lost opportunities for students:

> *"... you need a weight of numbers to get stuff going; if you've seven students and three of them aren't there, it's pretty obvious you can't have much of a class discussion." (Teaching Staff)*

> *"If it's too small there can be periods of stagnation when you have a class discussion and things like that, but when there's more you can get more of a lively discussion, you can hit more people and you can get different views." (Teaching Staff)*

One benefit of the small cohort in the program was the ability to collaboratively monitor attendance and identify issues students were experiencing. The teaching staff were "... talking to each other about who was in class and who wasn't ... [which] became really important to supporting the students".

Disruption to the small cohort was not only attributed to low attendance. It was not uncommon for Indigenous Tutorial Assistance Scheme (ITAS) tutor arrangements to not begin till four or five weeks into the semester. Given how dependent the personalised teaching approach was on diagnostic data of students' ability levels, teaching staff pointed out that it meant lost support opportunities for students, and that a more proactive approach to delivering tutoring support was advisable.

Students and teaching staff identified a number of examples that improved attendance and engagement. For example, one student's engagement in a course increased markedly after they began to see an ITAS tutor with whom they had connected particularly well. A teaching staff member thought that changing "... the topics quite regularly" had enabled them to keep students from diverse backgrounds interested.

Staff talked about the challenge of finding a balance between being culturally responsive and administering consequences for non-attendance. The hands-on assistance and the flexibility of the program, according to members of staff, could be counterproductive to students transitioning to the broader university context where the high levels of individualised support provided in this program would not continue to be available:

> *"... I think [their] class attendance was sort of middle of the road in the Bachelor of Science Extended ... because the [mainstream] Chemistry is a lot more demanding and a lot more content heavy than what we do, I think that regular attendance is much harder, and the [mainstream] Chemistry, the attendance requirement is very minimal. So, I think students might see a low-attendance record and they think, 'Well, that's all I have to do.'" (Teaching Staff)*

Students acknowledged the personal commitment of staff to the program and valued their individualised support, especially how they diligently monitored student progress and adjusted their approaches to changing variables. Students noticed the benefits of the scaffolding approach, particularly the conceptual understanding of complex subjects. One student, in comparing Year 11/12 and university subjects, said:

> *"It's more conceptual learning as opposed to just rote learning. So Year 12 Biology was like 'OK, learn photosynthesis, learn it', whereas here it's like 'Here's photosynthesis, understand it'. In that way you learn better because you don't need to focus on learning individual details because when you learn the concept it just sort of makes sense as to what follows through next." (Student)*

Students also appeared to understand the longer-term benefits of the scaffolding approach in the way it allows them to find their way in terms of grasping an idea of the options that lay before them:

> *"... with this [the course] it ... shows you what you need to do – it's like a pathway. It gives you an opportunity to see everything rather than focus on one specific thing." (Student)*

Staff discussed the extra hours they put into their planning, collaboration with colleagues, and seeking ways to be proactive in their quest to keep students fully engaged. They also discussed the challenge of balancing their responsiveness to individual student learning needs with the need to cover the required curriculum. They found it was beneficial to focus on developing students' ways of learning rather than the content. In this way, students were more capable of learning the subject matter required. Staff assisted students with their writing style and helped them to conceptualise complex learning content:

> *"... I'm teaching what I think is important and that means I'm passionate about what I'm teaching, and I'll go the extra mile." (Teaching Staff)*

The incorporation of Indigenous science content into the curriculum necessitated staff devoting considerable time to learning how to do it appropriately and effectively. Their efforts were rewarded in the form of increased motivation by students, especially when they felt challenged. One student captured this point with this statement:

> *"It definitely made it a lot easier to learn because, it [Indigenous knowledge] was really quite fascinating. In school we didn't get taught about Indigenous practices, I only learnt that from my Aunty. So it was really nice to have those things taught in class, it was a really good way to stay motivated. Particularly towards the end of semester ... it's like the pressure for the exams hasn't quite hit yet, you just hit quite a slump." (Student)*

2.1.3 STUDENT RETENTION[7]

Student retention has been relatively high with 19 out of the total of 25 students enrolled still engaged in the program in 2018. This equates to an overall retention rate of 76 per cent. Yearly and cohort retention rates are shown in Table 2. Yearly retention rates range from 75 per cent (in 2016 for the 2015 cohort) to 100 per cent (multiple years and cohorts). Three of the five students who did not complete the Bachelor of Science (Extended) in the 2015 cohort enrolled in other courses that were STEM-related, which should not be viewed as a negative outcome for the program. Other remaining students in the 2015 cohort had taken a leave of absence in 2017, often due to illness or health-related reasons.

Although based on a small sample of students, and at a relatively early point in its implementation, the efficacy of the Bachelor of Science (Extended) can be broadly compared to general data on retention rates, as shown in Table 3. These rates are not specific to Bachelor of Science (Extended) degrees for Aboriginal and Torres Strait Islander students but do provide a context for understanding the findings.

7 The retention rate is a measure of the proportion of students who continue on to complete a course. That is: 'Retention rate for year (x) is the number of students who commenced a bachelor course in year (x) and did not complete in year (x), and continued in year (x+1) (retained students), as a proportion of all students who commenced a bachelor course in year (x) and did not complete in year (x)' (Australian Government, 2017b, p. 18). The opposite of retention is the attrition rate, which is defined as: 'Attrition rate for year (x) is the proportion of students who commenced a course in year (x) who neither complete nor return to study in year (x + 1)' (Australian Government, 2017b, p. 5).

Table 2. Bachelor of Science (Extended) retention rates

	2016 (9 STILL ENROLLED)	2017 (12 STILL ENROLLED)	2018 (19 STILL ENROLLED)	OVERALL (19 STILL ENROLLED)
2015 cohort (12 enrolled)	75 % (9 out of 12)	78 % (7 out of 9)	100 % (7 out of 7)	58 % (7 out of 12)
2016 cohort (5 enrolled)	n/a	100 % (5 out of 5)	100 % (5 out of 5)	100 % (5 out of 5)
2017 cohort (8 enrolled)	n/a	n/a	88 % (7 out of 8)	88 % (7 out of 8)
All cohorts (12, 17 and 25 enrolled)	75 % (9 out of 12)	86 % (12 out of 14)	95 % (19 out of 20)	76 % (19 out of 25)

Note: Yearly retention rates are based on retention of students from previous year. Overall retention rates are based on retention of students from the original cohort commencement year.

Table 3. Data on university retention rates

RETENTION RATE	COHORT	YEAR(S)	SOURCE
71.2	All Aboriginal and Torres Strait Islander university bachelor students in Australia	2014	Universities Australia (2017)
95.6	Retention rate for domestic commencing bachelor students at the University of Melbourne	2016	Australian Government (2018a)
81.6	Retention rate for all students studying Natural and Physical Sciences	2013	Australian Government (2014)[8]
78.2	Retention rate for all students studying Information Technology	2013	
85.7	Retention rate for all students studying Engineering and Related Technologies	2013	

8 Reported as attrition rates in original data. Retention rate has been estimated by the formula: 100 minus the attrition rate.

The overall 76 per cent retention rate and the yearly retention rates for each cohort (2015 cohort: 75, 78 and 100; 2016 cohort: 100 and 100; 2017 cohort: 88) of students in the program are higher than the 71.2 retention rate of all Aboriginal and Torres Strait Islander university bachelor students (Universities Australia, 2017). In 2018, the overall retention rate for the program was 95 per cent, which is in line with the University of Melbourne average. Overall, yearly retention rates for the Bachelor of Science (Extended) program also compare relatively favourably to Australian students studying STEM fields (ranging from 78.2 per cent for Information Technology to 85.7 per cent for Engineering). Unfortunately, retention data were not available for Aboriginal and Torres Strait Islander students studying at the University of Melbourne or in STEM fields in Australia. As there has not been sufficient time for Bachelor of Science (Extended) students to have completed their degree, it is not possible to report on completion rates at the time of this report.[9]

2.1.4 STUDENT ASPIRATIONS

The Bachelor of Science (Extended) appeared to support and reinforce students' existing ambitions, rather than developing new ones. For one student, the supportive nature of the program "motivate[ed] me to pick up my study ... it's a pathway ... it gets you into where you want to go". One student felt that being accepted into the program itself was a motivation to succeed. Exposure to a number of different subject areas in the program appeared to confirm for students their existing plans for qualifications and careers. As one student expressed it: "... it's kind of like a pathway. It gives you an opportunity to see everything rather than focus on one specific thing". Another student articulated that the Bachelor of Science degree would provide a pathway to "... most places [career options] that have a need for it".

Aspirations for STEM careers often originated with good educators prior to entry into the program:

> *"I had a really good teacher in Year 10, who, when I was doing Science made everything really fun and I got really engaged with it, so I just thought 'Hey, why not do Science?'" (Student)*

> *"How did you become interested in Geology? Just doing it in high school, it was just interesting. My high school teacher was very interesting ... he encouraged me to do it, I guess. He just made it very fun." (Student)*

Students spoke of having really effective teachers in high school that had consistently encouraged them to one day follow a career in science. Students indicated that their teachers were quite explicit about requirements they had to meet. A high level of awareness of this was evident in many of them being able to specify whether they would seek careers, for example in physiotherapy, geology, or marine biology. The place-based nature of their prior and current learning experiences provided some students with inclinations to follow science careers that would contribute to the welfare of their own local communities rather than elsewhere:

> *"I've always been interested in Science. I come from a quite a poor family, so I've always just wanted to be able to give back to the community." (Student)*

9 Completion rates are a measure of the proportion of students who have completed a subject, course or degree, as compared to the number who commenced a subject, course or degree.

2.2 The curriculum

2.2.1 CURRICULUM STRUCTURE

In general, students showed enhanced understanding and appreciation of the course structure as the course progressed. This was evident from all three groups initially indicating that at some point they had regarded an aspect of the science content to be too simple for university, or a repeat of what had already been learned. While there remained a cohort of students who felt that the pace of progress was too slow, most students later realised that the simplicity of the concepts taught, and the thoroughness of delivery, were prerequisites for future understanding:

> *"The lecturers they will take it really slowly to make sure everyone understands it … we don't move on until everyone understands it and if we struggled with some of the questions we'd get tutoring for it from the lecturers and then extra tutoring." (Student)*

> *"Personally, I found the learning a little bit slow this year but in hindsight that's because not everyone can be up to the same speed and that's okay." (Student)*

Students indicated that more consideration should be given to the structure of the course in relation to its placement within the larger context of the University. The practical workshops and tailored academic support portion of the Bachelor of Science (Extended) is concentrated over the first three semesters including the first semester of the following year. Students indicated that they missed out on subjects being offered in the first semester of the Bachelor of Science degree in the year following commencement of the program. This meant that, if students wished to enrol for a two-part subject with understanding of concepts in the second part of the subject dependent on an understanding of concepts in the first part, they were at a disadvantage. Students' views on this matter are captured in this statement:

> *"Because the Extended goes over three semesters, it's kind of annoying … I needed to do Chemistry 1 and Chemistry 2 second semester, but I wasn't able to do that, so it kind of pushes everyone back a semester." (Student)*

Staff noted that this situation could be addressed on a case-by-case basis. For example, students can begin their mainstream Bachelor of Science subjects (not requiring a Year 12 background) after two semesters in the Extended degree, depending on the strength of their preparation after their first year in the program. In addition, similar to the mainstream Bachelor of Science, students can use the summer semester to resolve this situation.

2.2.2 CURRICULUM CONTENT

The wide range of topics covered in the subject content in science generated mixed responses from students. The mixed responses tie in with the gradual appreciation of the course that emerged with the passage of time. Students initially felt that the topics covered were too wide-ranging and there were therefore not many opportunities to focus on, or specialise in, understanding a few concepts. Over time, though, after appreciating how the concepts contributed to scaffolded understanding of more complex processes later on in the program, they began to appreciate the variety. Students also acknowledged that they were residents at the University and had originated from a number of unique environments of their own, and therefore the wide variety of concepts included in the curriculum presented everyone with the opportunity to engage with content familiar to them.

> *"… it was definitely something that I hadn't considered before. How Indigenous knowledge can help the world. You don't see many references to Indigenous knowledge, so it's really nice to know that Indigenous practices can benefit the world, we're not just some fringe population. [And it was taught] in a really useful and respectful way." (Student)*

While students were generally interested to learn the stories passed down to them by Elders represented scientific knowledge, they raised an issue about the relevance of Indigenous knowledge to Indigenous people. Some students were of the view that a specific piece of Indigenous knowledge may only be relevant to a specific Indigenous group and not to Indigenous people in general. According to these students, therefore, this meant that knowledge may not be regarded as broadly 'Indigenous' but rather specific to a particular group—for example, the Wurundjeri (the Indigenous people of the Birrarung [Yarra River] Valley). One student went as far as stating that this point was so important that it may be more appropriate for the University to use 'non-Indigenous knowledge' in subject content for the sake of inclusivity of all students rather than offending students of a particular Indigenous group.

Responses by staff also indicate that subject content played an important role in the scope of opportunities available to implement Indigenous scientific-knowledge perspectives. They stated that some curriculum areas (e.g. Biology) offered more opportunities to integrate topics than did others (e.g. Chemistry, Physics). Staff were encouraged that some members of staff were a little more confident (and/or creative) in exploring ideas or providing leadership than others in the effort to integrate Indigenous science perspectives in learning. Importantly, students indicated that they were aware that integration could not be achieved at the same level across all curriculum areas. Therefore, there appeared to not be any pressure on staff by students to demonstrate integration consistently across curriculum areas. Teaching staff with lower levels of confidence in integrating Indigenous science perspectives will need to be supported to do so if the program is to reach its goals.

Students indicated that the Bachelor of Science (Extended) program and its curriculum was culturally responsive. One student noted that the teaching staff adapted the curriculum content to suit individual students: "... one of the teachers knew I was into [a particular subject], so I did that while the other students worked on something else, so that was really good, and still connected [with] ... what they had to teach". Students stated that Indigenous knowledge was integrated effectively into the curriculum. For example, one student said that "[i]t didn't seem forced, it was streamlined". According to some teaching staff, students' feedback assisted them to develop culturally appropriate ways of incorporating Indigenous knowledge into the curriculum as staff reflected on their methods and subject content:

> *"... we introduced a lot of the stuff by doing an excursion to the botanical gardens and looking at the Indigenous walk there ... and students came forward with stories of their own history, aunts and uncles and stories that have been told ... it certainly gave us a different way of thinking about or engag[ing] ... with the students." (Teaching Staff)*

There was some evidence that teaching staff had existing culturally appropriate pedagogies. For example, one teaching staff member was well versed in Indigenous education theory and the problems with binaries (ancient versus modern) set up in colonial societies, while another had "done a huge amount of research and thinking to make sure that [the curriculum was] culturally safe". However, there was an acknowledgement from teaching and support staff that achieving culturally responsive curriculum and pedagogy was a work in progress. One teacher said that "... some sessions have worked better than others and I'm getting better at it as I get my head around [it]".

2.2.3 CURRICULUM METHODOLOGY

Students revealed that Indigenous scientific knowledge being taught in the classroom with links to what they had learned earlier, either in formal or informal contexts, was more interesting and easier to understand. This was particularly true when students were able to see, through discovery, how previously acquired Indigenous scientific knowledge aligned or complemented global scientific knowledge. Students seemed to discover that some of the 'stories' they had been told by immediate and extended family were actually factual, even though the way the stories had been told to them earlier in their lives had led them to believe that they were philosophical or mythological. The realisation that the Indigenous scientific knowledge they had been taught earlier in the community outside the classroom aligned and complemented global scientific knowledge was highly motivating to students:

> *"I thought it was really important that those Indigenous sort of sources and readings and lectures were acknowledged ... with the inclusion of fire into Indigenous knowledge and practices ... that was quite fantastic." (Student)*

While staff had made considerable progress in incorporating Indigenous-led scientific knowledge into their programs, they remained cautious in terms of whether implementation of such knowledge could be expanded enough to keep pace with the program, given that implementation should be preceded by appropriate consultation with Elders or experts in the field. Their caution was also related to the fact that success so far involved a combination of appropriate content and effective methodology. They acknowledged that the rate of implementation rested on forging close working relationships with Indigenous organisations. They added that in order for this to happen, previous ways of interacting with such organisations needed to be re-evaluated and a new paradigm of dialogue and engagement be implemented where local Indigenous knowledge led by an Indigenous Elder was central to any partnership:

> *"... you need to embed Indigenous knowledge perspectives in your curriculum, and so it's a very complicated thing and in some ways we're still right at the start of that ... we're all together starting to think through how and in what ways can you engage with Indigenous knowledge." (Teaching Staff)*

> *"[A] very non-trivial difficulty [is] trying to engage with Indigenous knowledge without taking it out of its context and embedding it in a picking and choosing [manner]." (Teaching Staff)*

Staff also highlighted the role that students played in establishing and maintaining relationships between the Indigenous community/organisations and the university. Students facilitated a cyclic relationship in which they provided the University with a family link to the community through Indigenous Elders, and then benefited from Elders' input into the University's program. Other students provided them with a higher sense of awareness of how that knowledge could be integrated into the curriculum. The university may consider how to recognise students who contribute to improving the program in this way:

> *"... one thing that we did have was small-group discussions with Elders about their experiences with health care ... and they were there and willing and happy to talk to us and to share their experiences." (Support Staff)*

> *"... [an Elder] comes into the Science Extended and talks about how their [community's] aquaculture system works, and it becomes a point of reference for science teaching ... So, it's not us going and reading a book and grabbing it and presenting it. It's [an Elder] coming and presenting it, and I think that's useful ... [that] partnership-based engagement with knowledge." (Teaching Staff)*

Students and teaching staff alike commented on the value of learning about localised Indigenous culture and technologies, a key feature of place-based learning. Excursions to specific locales and discussions of specific practices in a 'place' allowed students' attention to be directed to the technologies and approaches used by specific Indigenous groups. Several students talked about visiting a local centre and learning about the Wurundjeri people and their fishing practices which achieved balance in the natural environment. Students were able to make links from this local example to the biology of ecosystems and the chemical processes underlying salt and fresh water.

3 DISCUSSION

The Bachelor of Science (Extended) program comprises a number of elements that, in combination, set it apart from many other transitional programs. This evaluation case study has confirmed these features are working effectively to support students, including the University of Melbourne's four-year commitment to entrants (inclusive of the initial BHP Foundation/CSIRO-funded component); high levels of individualised and culturally responsive support; a scaffolding skill base rather than a content-based approach to learning; a high student-retention rate; and the use of Indigenous contextualised learning content. A number of other broader policy features at the university level likely bolstered these features,[10] including an Indigenous Education Strategy (The University of Melbourne, 2019).

The University's formal commitment to the program and the program's multi-layered support structure, coordinated at student level by Murrup Barak, appear to be assisting students through the transition into the program effectively. The program has enabled students to manage some of the common anxieties associated with transitioning from the familiarity of a school to a university environment (Headspace, 2017; Norton, 2010). Nevertheless, it will be important for the University to ensure these support systems are core business rather than an 'add on' feature; and that there is a commitment to ongoing refinements and operation of the support structures (Rossingh & Dunbar, 2012).

Importantly, the program has been acknowledged by the students as being culturally responsive. Cultural responsiveness is characterised 'by respect for culture, ongoing self-reflection, expansion of knowledge and commitment to improving practices and relationships' (Department of Education Western Australia, 2015, p. 16). Many students who appreciated the cultural responsiveness of the support unit and the Bachelor of Science (Extended) program had also had such experiences in school before entering the program. The evidence suggests that a seamless continuation of culturally responsive support for Aboriginal and Torres Strait Islander students from school to university was important in maintaining students' trust; and this reinforces the work being done through programs such as the Inquiry for Indigenous Science Students (I2S2) and Science Pathways for Indigenous Communities, both delivered by CSIRO. These programs engage Aboriginal and Torres Strait Islander students in inquiry-based learning in schools with the aim of establishing pathways to university.

After feeling initially frustrated, most students recognised the graduated flexible approach, deliberate pace, and use of a variety of instructional techniques in the scaffolding approach as greatly beneficial to their transition from school to university. Brinkworth, McCann, Matthews, and Nordstrom (2008, p. 14) found that 'flexible teaching and learning strategies are vital in promoting a climate of inclusiveness'. While it is important to consider the needs of those students who thought the pace of progress too slow, most students acknowledged that the approach helped make them more independent as learners. The scaffolding approach can move students 'progressively toward stronger understanding and, ultimately, greater independence in the learning process' (The Glossary of Education Reform, 2018; Parviz & Sepideh, 2014)—a key objective of the program.

The current retention rate is relatively high but needs to be viewed against the backdrop of current trends. In 2017, a 71.2 per cent retention rate of all Aboriginal and Torres Strait Islander university bachelor students (Universities Australia, 2017) translated into a completion rate of 40.5 per cent of all Aboriginal and Torres Strait Islander students completing their university undergraduate degrees in Australia (Australian Government, 2017a). This implies that the current high-retention rate does not necessarily mean that the program will see high completion rates of students—a common trend in Aboriginal and Torres Strait Islander student retention and completion (Oliver, Grote, Rochecouste, & Dann, 2015). The program intends to meet this challenge by continuing to provide and improve multi-layered and tailored support and by early identification of risk of non-completion, including emotional, motivational, health, familial, financial, and study needs (Hall, 2015).

10 Kinnane et al. (2014) outlined 14 elements of leading practice that can be utilised to achieve successful transition to higher education for Aboriginal and Torres Strait Islander students.

The indication that the place-based nature of students' prior and current learning experiences influenced students' aspirations of careers in their home communities is supported by some research (Getting Smart, 2018). According to Bowers (2006), engagement in place-based learning experiences can enable participants to revitalise, and reinvest in, their communities. A youth survey conducted by Mission Australia in 2013 found that more Aboriginal and Torres Strait Islander students were motivated to attend and finish their university studies when they had aspirations to follow local employment than those that did not have such local aspirations.

Admittedly, place-based education is not a catch-all solution or easy to implement; and few programs can guarantee that the creation of local jobs will materialise at the rate at which students graduate. Nevertheless, if some students continued to be motivated to follow locally-based careers outside the scientific pathway beyond the program, the Bachelor of Science (Extended) program would have achieved a goal sought by many university support programs, namely 'to meet the needs of first year students, help inform them of the realities of university life and hence facilitate the transition from secondary to tertiary education' (Brinkworth et al., 2008, pp. 14–15).

The progress of the place-based approach in having such a far-reaching effect on important issues influencing Indigenous education, such as completion of tertiary education and rural/remote places retaining their young graduates, supports the case for diverting more attention to programs that will build teacher confidence in implementing inquiry- and place-based learning in classrooms. Combined with a culture of high aspirations, as embodied by the University, such programs are likely to build students' confidence and support aspirations and skill sets that will help them succeed in their studies.

Students' responses indicated that they understood concepts better when there were links between new concepts and those that they had learned earlier in their lives. Inquiry-based learning relates to the popular constructivist approach to learning, which maintains that prior knowledge can affect the learning process (Bada, 2015).

Students' responses indicated that they understood concepts better when there were links between new concepts and those that they had learned earlier in their lives.

In addition to benefitting from new learning being grounded on prior learning, when students discovered that the stories passed down to them by Elders were scientific knowledge that was part of a global system of knowledge, they were excited to know that Indigenous culture was directly relevant to Western scientific knowledge and education. Nakata (2002) refers to students being at the 'cultural interface' where interaction of Western and Indigenous knowledge systems happen. He goes on to state that students 'learning about both knowledge approaches through the appropriate methods will find their own thoughtful connections if they can come to a conscious awareness of the meanings and conditions of both' (p. 56). Pechenkina (2014) found that when Aboriginal and Torres Strait Islander students are able to reassert their indigeneity in this way, they are likely to become successful academically.

There were concerns raised by some students about the appropriateness of Indigenous knowledge being shared with all Aboriginal and Torres Strait Islander students. These concerns are valid; however, there is an alternative view that provides a counterpoint. It is generally accepted that knowledge pertaining to a particular Indigenous Country is sacred to the group originating from that Country (National Museum of Australia, 2018) and that it belongs to present and past generations of that particular group (Liddle, 2015), it is possible for Indigenous knowledge to be generalised and taught widely across groups. For example, in the I2S2 program, inquiries are based on non-secret, non-sacred knowledge, processes and technologies of Aboriginal and Torres Strait Islander peoples across Australia. These inquiries use activities such as fire-lighting, cooking, land management, and music as the basis for scientific exploration. The I2S2 program team hold the position that the key to developing and working with curriculum topics that relate to Aboriginal and Torres Strait Islander peoples is to remember that not everything is historic, exotic, or taboo.

The program demonstrates that all Aboriginal and Torres Strait Islander peoples had to eat, sleep, shelter, learn and live in a community—most of these activities do not have secret or taboo aspects. Bachelor of Science (Extended) staff could therefore be guided by this approach to generalising Indigenous knowledge in a science context, which has the potential to increase confidence in delivering culturally responsive content. This generalist framework also provides the opportunity for students to learn about other specific Indigenous groups' technologies and methods, and to think about the intersections between them (for example, between remote islands and central desert areas). In questioning the wider applicability of different groups' knowledge, students may have been indirectly expressing concerns about a lack of Indigenous overview or authority of the curriculum, the lack of Indigenous teaching staff, and/or gaps in the cultural responsiveness of the degree. Teaching staff should further explore these concerns with students.

Looking ahead, staff have a firm idea of what is required to expand on the incorporation of Indigenous knowledge in their programs. The view by teaching staff that forging close working relationships with Indigenous organisations, possibly through students, to expand the Indigenous scientific knowledge base at the university is supported both by research and government policy (Australian Human Rights Commission, 2008; Inspiring Australia, 2013). Indigenous knowledge accessed from traditional owners of that knowledge is authentic and less likely to be contentious if implemented in partnerships (Australian Government, 2018c). In having most students originating from outside the University's locality, the university could still establish strong links to local traditional knowledge by establishing an advisory group comprising students and Elders to help identify appropriate links and deliver mutually reciprocal outcomes.

The view by teaching staff that forging close working relationships with Indigenous organisations, possibly through students, to expand the Indigenous scientific knowledge base at the university is supported both by research and government policy

There are emerging challenges to the success of the program as well. One such challenge is that, though the culturally-safe support environment of Murrup Barak encourages students to form close internal bonds within the program cohort, there is less evidence of the establishment of wider networks of non-Indigenous peers beyond the support unit. These wider links are in no way necessary or an indicator of the success of the program (and are not surprising given the specialised nature of the program), but this realisation may reveal the possibility that students are not having similar experiences to students outside the program or benefiting from wider networks. Conversations with people from other backgrounds (as well as more formal interactions) have educational benefits: 'Diversity experiences are known to positively impact cognitive development, and interactions with culturally diverse peers are among the most salient of those experiences' (Asmar, Page, & Radloff, 2011, p. 7). As students transition through the program and take more subjects with mainstream Bachelor of Science (Extended) students, this may change. The University is encouraged to discuss with Bachelor of Science (Extended) students all the opportunities available, including wider networks, and also the benefits of the strong support network students have established with their program peers.

The University of Melbourne has in place numerous strategies to ensure a culturally-safe environment. To further enhance these strategies, the University could encourage further uptake of the multitude of existing subjects containing Indigenous content, which is an action in the University's Indigenous Education Strategy. For example, the subject *Aboriginalities (MULT10001)* introduces students to the complexity, challenges, and richness of Australian Indigenous life and cultures. The subject draws on a wide range of diverse and dynamic guest lecturers. Students have the opportunity to encounter Australian Indigenous knowledge, histories, and experiences through interdisciplinary perspectives (The University of Melbourne, 2018c). The subject provides a platform for increasing the cultural capacity of non-Indigenous students studying in a range of disciplines across the University, such as engineering and health.

Regular attendance was another challenge. The 'anguish' that staff felt when attendance was low demonstrated the close relationships that staff had forged with students in the small cohort despite the variable turnout. Hagenauer and Volet (2014) found that such close relationships at universities are more likely in smaller supportive learning groups than in general lectures. The high expectations that staff had of students formed part of this relationship—staff would show genuine interest in students' progress and, in return, students would make the required effort to meet the high standards expected. The Stronger Smarter Institute argues that there is a crucial difference between 'high-expectation rhetoric' and 'high-expectation relationship', with the latter developing relationships that connect teachers and students through their shared humanity (Stronger Smarter Institute Limited, 2014).

The 'anguish' that staff felt when attendance was low demonstrated the close relationships that staff had forged with students in the small cohort despite the variable turnout.

While there is acknowledgement that university students should be allowed some degree of freedom in management of their time, there is also evidence of a correlation between student attendance at classes and their academic achievement (Alexander & Hicks, 2016; Massingham & Herrington, 2006).[11] Unpredictable attendance patterns had implications for the wider groups as many of the learning strategies implemented involved peer discourse. It may be possible that, in its efforts to be culturally responsive to students, the University found it difficult to impose consequences for non-attendance at classes. Rather than imposing consequences, a more effective strategy may be further unpacking why students are not attending classes and addressing the issues that are within the university's control, acknowledging that some issues are not (e.g. family illnesses).

Some students' low attendance could also be an indication that the program should further build on current initiatives (where appropriate) to establish student-led connections with their own Indigenous community regarding the broader contexts of students' lives. This connection can raise students' levels of motivation and aspiration (Gore et al., 2017). The benefit is likely to be felt more prominently by students from remote communities. The counterpoint to these views is that some students may have entered higher education in part to escape the pressures of family and community. Connections with Aboriginal or Torres Strait Islander non-family members from the university and local community, including University academics, Elders, and Indigenous staff, would be more appropriate in this situation to raise students' accountability and engagement with the degree program. The University will need to understand more deeply the factors associated with high student attendance and engagement (within institutional control), such as the classroom experience and continuously improving the quality of instruction, in order to make advances (Shah & Widin, 2010).

11 In contrast, an informal study at Australian National University found that, although attendance levels dropped significantly over a semester, enrolments and pass rates did not decrease (Jeffery, 2015).

Another challenge is the duration of the extended degree subjects. The tailored academic support and practical workshop portion of the program is structured over three semesters, which means that it includes the first semester of the second year. This affects the transition of students to a more standard Bachelor of Science course structure—that is, one without that level of support. Some students felt that commencing their mainstream science degree courses in Semester 2 disadvantaged them in terms of subject selection. They reported missing out on first semester Bachelor of Science subjects, often having to begin with part two of a two-part subject. This made it difficult for them to achieve high results in that subject; and often required extra work to catch up on what they had missed in that critical first semester. However, in Semester 3, only one of the four subjects is a Bachelor of Science (Extended) subject, and students can start their mainstream study before this (or may even continue study taken in second semester of the first year). Support staff report that there is individual course discussion available for each student, but that it is possible that when the case study interviews were completed, the University had not articulated this clearly enough to students. Research also indicates that university students commencing mid-year are disadvantaged in other ways, such as feeling alienated by the fact that tutors, staff, and students are already familiar with others in the cohort; and the difficulty of joining already established learning networks (Brady & Sliuzas, 2018).

The small class sizes were an advantage in terms of personalised instruction and feedback in the classroom but also presented some special challenges. Billson (1986, p. 143) states that small groups can be complex units 'that focus on purposive and meaningful contact'. When all students attended, the 'purposeful' and 'meaningfulness' of class interactions, especially peer-to-peer discourse, were acknowledged and appreciated by both students and teaching staff. However, when attendance dropped off, classroom dynamics favouring learning were considerably compromised. It may be worthwhile for the University to explore the idea of incorporating other students into the groups. Martins and Walker (2006) found that smaller classes in universities in and of themselves do not necessarily translate into gains in student achievement.

4 CONCLUSION AND RECOMMENDATIONS

Although it is still early days, considerable progress has been made in the program towards the overall goal of providing Aboriginal and Torres Strait Islander students with a supported pathway to complete a Bachelor of Science at the University of Melbourne and to go on to participate in STEM careers. Although every cohort is and will be different, evidence in this study suggests that students have had positive experiences in the program and have felt supported in a culturally-responsive environment. However, some challenges have also been identified. Based on student and staff views, Table 4 outlines what CSIRO concludes is working well in the program in each of the outcome areas, and some challenges and ideas to consider for the future. As each cohort of students is different, strategies may need to be tailored and reviewed regularly to maximise success.

Outcome 1: Strong student engagement, retention and results

The program has led to strong student engagement, retention and high expectations from students (and there is strong commitment from the University), but there is room for improvement. Key to achieving this outcome area is the program being embedded as a strategy by the University of Melbourne in the form of a culturally responsive and multi-layered support structure. This approach enhances student engagement, retention, and results but may also be responsible for students being less inclined to engage with non-Indigenous peers beyond the supported group. Although this engagement is not necessary from an academic perspective, such relationships can support students' development and aspirations by widening their networks.

Student engagement is diminished by the non-attendance of others in the group. The low staff–student ratio in the class leaves class dynamics vulnerable to fluctuation. When attendance is low, teaching staff struggle to generate vibrant classroom peer discourse—a primary mode of learning in the first two years of the program. A proactive plan to address factors that affect attendance, and more broadly engagement, may benefit the program in terms of achieving consistent classroom dynamics.

The retention rate of students in the program is high but, as broader research evidence on Indigenous university students suggests, this may not translate to a high completion rate. Here, too, the program could benefit from a proactive/early-intervention plan that gives greater consideration to students' personal and academic circumstances. Closer relationships with individuals that can provide support (including, but not limited to, families), could be an effective way to make a positive contribution to those circumstances. It should be noted that the fact some students leave the program to enter a different field of study is not necessarily a negative outcome; it can be viewed as a positive outcome in so far as it meets student aspirations.

The University has committed in principle to continue with the program, however the challenge will be to sustain the support structure indefinitely. The model of support is staff and capital intensive and may require a wider scope of program partners to ensure sustainability. Accordingly, a broader scope of program partners should be sought for added stability of the current program and beyond.

Outcome 2: Seamless transition into Bachelor of Science with comparable outcomes in retention and results with other students

There is evidence that the program is on course to provide students with a seamless transition to obtaining a Bachelor of Science degree. The embedded, multi-layer support structure provides students with the assurance that the University is committed to seeing them through the transition. If students do get to integrate more with their wider cohort outside the program, as suggested under Outcome 1, they are likely to be better orientated towards merging with, and completing, the Bachelor of Science degree. Closer student-led relationships with individuals that can support students, either locally or in students' home communities, could also play an important role in the retention of students as the demands of the degree course become greater in subsequent years. Elders, University teaching staff, other students, and families can all play a complementary supporting role to that provided by support staff to encourage completion.

The place-based elements of the curriculum have contributed to learning science concepts and are likely to contribute to the seamless transition of students into the more mainstream Bachelor of Science course structure. The curriculum appears to have supported some students' aspirations to consider science careers that enable them to contribute to their own communities. Research has shown that when students are orientated towards employment in their home community, they are more likely to complete their studies. However, this orientation presents a challenge to both the university and students' communities—if students are to remain motivated, there would need to be evidence that that their career pathways were going to lead to employment. The University may therefore need to take the lead on dialogue with employers in students' communities to facilitate work experience placements that lead to employment, acknowledging at the same time that not all students want to return to their home community to work, and some may feel pressured from family members to gain employment in their home community (Fredericks, Mann, Skinner, CroftWarcon & McFarlane, 2015).

Table 4. Summary of targeted outcomes, what worked well, challenges, and ideas to consider in the future

TARGETED OUTCOMES	WHAT WORKS WELL	CHALLENGES	IDEAS TO CONSIDER (RECOMMENDATIONS)
1, 2	Multi-layered academic and pastoral support structure and overarching commitment by the University of Melbourne.	This support structure and overarching commitment is foundational to success and will need to be sustained. Student aspirations in science are often positively influenced by high school and other educators; maintaining a pipeline of teacher support throughout the education system will factor into students' success at university.	Broader scope of program partners that would add to the stability of support to the current and future programs. Further efforts in relation to students' previous educators, including retaining relationships (if possible), exploration of their influence on student aspirations and interest in science, creating links with teachers involved in other STEM programs (such as I2S2), and highlighting the importance of the STEM pipeline. Undertake data collection from exit interviews in order to comprehensively understand student success factors.
1, 2, 5	Culturally responsive support environment.	Students are focusing relationships and networks within the Bachelor of Science (Extended) and Bachelor of Arts (Extended) cohorts and may be missing some opportunities.	Build on current strategies and programs to support Bachelor of Science (Extended) students to access the full range of experiences and opportunities available across the University, and to continue to build the cultural competency of the University.
		Low attendance and engagement affects students' progress and class dynamics.	Proactive/early-intervention plans and strategies to address factors affecting attendance and engagement and that may affect completion, including improving the classroom experience and closer student-led relationships with individuals that can support students.
1, 2	Retention in program and subject completion.	High retention rate may not translate to high subject and degree completion rate.	
2, 3, 5	Place-based education attracts students to employment in their own communities (if they choose). Motivates students to complete their studies. Skills reinvested in local communities.	Limited availability of suitable jobs in their own communities. Place-based education approach requires changes to curriculum and building relationships with local agencies and organisations is resource-intensive.	Coordination between the University, students' communities and potential employers to assess employability skills required for community employment (if students choose).
3	Scaffolding approach is inclusive of all student levels and leads students to be independent learners.	Pace of progress could be too slow for some students, leading to disengagement.	More consideration for those students who are able to progress faster in specific subjects; for example, through the creation of different 'levels' of subject content. Although this is currently done informally, consideration should be given to formalising this process.
1, 2	Duration of program allows for consolidation of support.	Delays in appointing ITAS tutors results in lost support opportunities for students. With course structured over three semesters, students are disadvantaged in subject selection in the second year.	Consideration be given to timeliness of appointment of ITAS tutors, and the options students have when they commence with the mainstream degree-course structure (course planning).
3, 4, 5	New learning is more effective when related to students' informal learning.	Knowledge from specific Indigenous groups may not be applicable to other groups. Uncertainty on the part of teaching and support staff may lead to them being less innovative.	Effective working partnerships with other Indigenous STEM-program element staff, such as I2S2, and use of general Indigenous knowledge frameworks. Establishing additional or stronger partnerships with Indigenous organisations and role models for advice on the incorporation of Indigenous knowledge in the curriculum.
3, 4, 5	Connections, through students, with Indigenous organisations yield valuable Indigenous knowledge.	Most students originate from localities far away from the University's immediate community.	

More consideration could be given to how students' courses are structured in relation to the wider University's course structure. Currently, some students find themselves at a disadvantage in terms of what courses they could enrol in, particularly in the second year of the degree. Students could therefore benefit from a wider range of information and options. Teaching staff may need more course-planning training and a more proactive approach to course planning. The first three semesters undertaken in the program may be causing problems with students and with the timely delivery of the ITAS tutoring.

Outcome 3: Areas of curriculum refinement identified to integrate Indigenous scientific knowledge

The scaffolding approach to developing students' understanding of science concepts works well in that it is inclusive of students of various ability levels. Students are supported according to their needs and benefit from the variety of teaching strategies used. There was some indication that this approach could be improved by giving more consideration to students who are able to cope with a quicker pace.

Considerable insight has been gained as to what topics and content motivate students to be fully engaged. Topics that explored how stories passed down to students fit within the sphere of global scientific knowledge motivated some students to take a keener interest in learning more. These earlier stories appeared to form conceptual foundations for the further understanding required in class. The challenge to teaching staff, however, is that introducing or incorporating Indigenous knowledge in class is fraught with potential obstacles. One of the obstacles is that such knowledge may not be applicable to, or accepted by, students belonging to specific Indigenous groups. The uncertainty this causes for teaching staff may lead them to be less innovative, as they may find it safer to steer clear of topics that are potentially contentious. Effective working partnerships with program staff in other CSIRO Indigenous Education Program elements such as I2S2 could be helpful. Staff in the I2S2 program have had success in facilitating inquiries based on a framework of non-secret, non-sacred knowledge, processes and technologies of Aboriginal and Torres Strait Islander peoples across Australia in the curriculum areas of chemical, physical, biological, and earth and space sciences. University teaching staff could also form additional alliances with Indigenous organisations, through reference groups with students included in such groups, for advice on the incorporation of Indigenous knowledge in the curriculum.

Outcome 4: University building stronger relationships/partnerships re Indigenous scientific knowledge with Indigenous organisations

Evidence of how the program has met this outcome related strongly with evidence informing how the program has met *Outcome 3: Areas of curriculum refinement identified to integrate Indigenous scientific knowledge*. One of the potential areas for curriculum refinement discussed under Outcome 3 was the pedagogic benefits of relating new knowledge to that which was introduced to students earlier in their lives by family (where this occurred). There is potential for new knowledge to be contentious; however, guidance provided by Indigenous organisations could help avoid or minimise this.

The University has made progress in building relationships with Aboriginal and Torres Strait Islander peoples and groups external to the university. Students spoke of the excitement of someone known to them presenting learning content, and teaching staff spoke of their realisation of how achievable it was to establish links between their programs and external individuals. Staff could perhaps take a step further and establish more formal relationships/partnerships with Indigenous organisations. A closer association with Indigenous organisations would enable the University to deliver a science curriculum that is authentic, help to negotiate potential contentious areas, and expand the curriculum knowledge resource base. Another option is to recruit and nurture more Indigenous early career researchers and staff to increase the expertise and knowledge available from within the University, which is vital to improve student access and success (Barney, 2016).

One of the challenges for the university is to keep students at the centre of any relationships with Indigenous organisations. Most of the students originate from localities far away from the University. This could be overcome by the university establishing an advisory group comprising students and Elders to help identify appropriate links. More student involvement in the University's Traditional Owners and Elders Group is another possibility.

Outcome 5: Supporting student aspirations, positive experience of university and contributing to support factors including cultural responsiveness

The program appeared to have supported students' existing aspirations. The latest *Longitudinal Surveys of Australian Youth* indicate that non-metropolitan areas lose about a quarter of their young people indefinitely after they complete school each year (Hillman, 2018). Some students in the program, however, indicated that they wished to return to their communities to make a contribution. Many of them had developed firm ideas of what careers they would like to follow. The challenge posed by these trends, though, is the limited jobs available in non-metropolitan areas, especially for science graduates. There would therefore have to be greater coordination between the University, students' communities, and potential employers in order to avoid students aspiring to careers in their communities that do not materialise.

The way the program has been implemented has contributed to a positive experience for students. Students speak of supportive teaching and support staff and close bonds with their peers. The experience of living on campus and having access to meals is greatly appreciated by students, as many of them have to move away from their families and communities to gain an education, and it reflects well on the university's commitment to set students up for success. While the culturally responsive support unit (Murrup Barak) plays an important role in students' success and growing confidence in planning their future, there appears to be a lack of meaningful interaction between some students in the program and their wider cohort outside the unit. This may be an indication that there is a lack of cultural safety in the wider University cohort or simply that it is the students' preference. Although Murrup Barak already provides some programs, additional support for students' engagement with the wider University in terms of internships, studying abroad, cadetships, and academic skills would be worth exploring further.

Recommendations based on the findings may be summarised as follows:

Recommendation 1: Build on current strategies and programs to support Bachelor of Science (Extended) students to access the full range of experiences and opportunities available across the University, and to continue to build the cultural competency of the University.

Recommendation 2: Proactive and earlier intervention strategies be developed to address the range of issues that are likely to affect student attendance, engagement, and completion.

Recommendation 3: Monitor employment goals of students and coordination with regional authorities and potential employers of those students inclined to seek employment in their own communities and those that prefer work placements elsewhere, including in Melbourne. Potential avenues for establishing links are the Australian Reconciliation Network, and national non-profit organisation CareerTrackers, which creates internship opportunities for Indigenous university students.

Recommendation 4: Consideration be given to the pace of progress towards new curriculum content to cater for individual learning needs, for example by formalising 'levels' of subject content.

Recommendation 5: Enhance course-planning support for students to ensure seamless progression through the degree program and ensure the timeliness of ITAS tutoring support.

Recommendation 6: Facilitate regular workshops between lecturers and/or pedagogical innovators and/or Indigenous community organisations/Elders to explore ways to authentically integrate in the course curriculum those Indigenous perspectives and knowledge that are personally relevant to students.

Recommendation 7: Expansion or broadening of the scope of program partners to help ensure the sustainability of the support structure.

Recommendation 8: Undertake further efforts in relation to students' previous educators, including retaining relationships, exploring their influence on students, creating links with teachers involved in other STEM programs, and highlighting the importance of the STEM pipeline.

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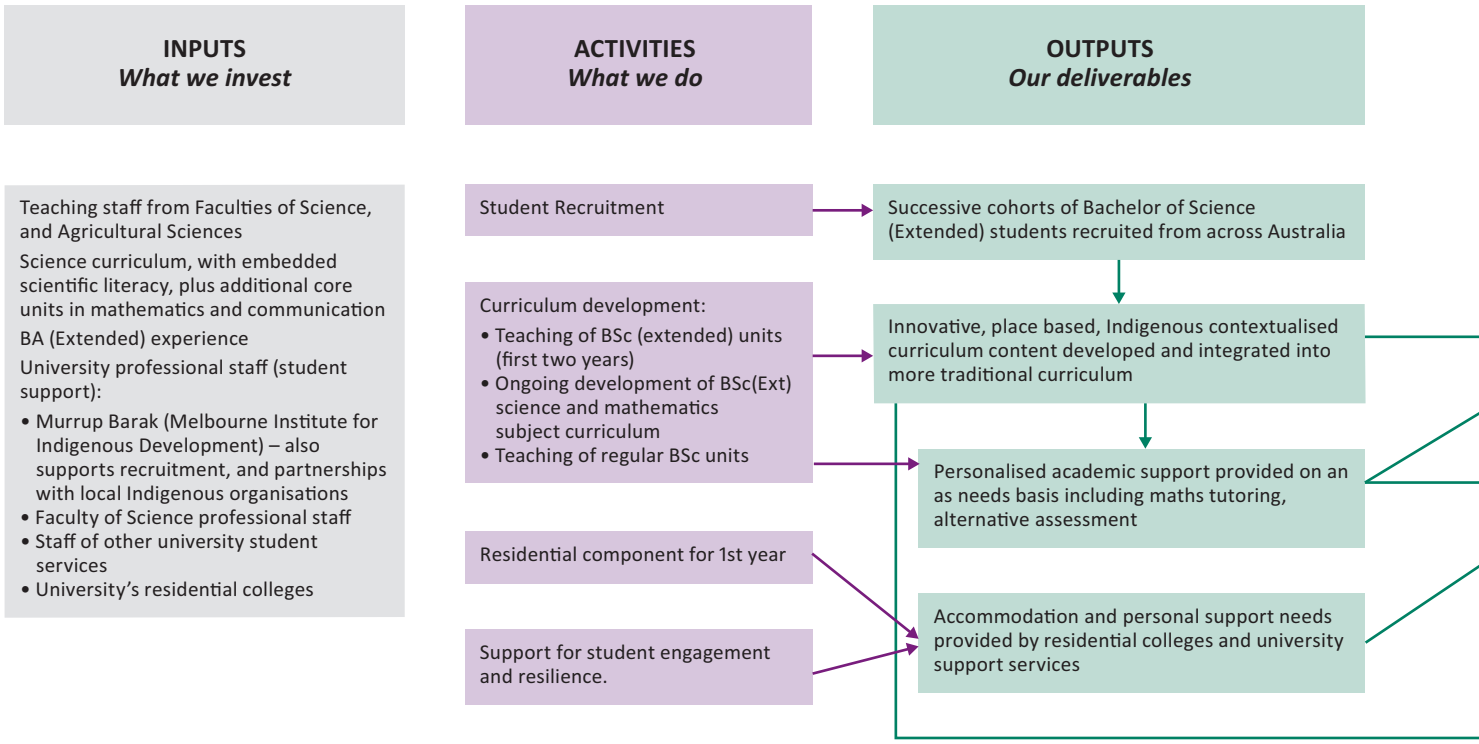
Appendix A – Bachelor of Science (Extended) Impact Pathway

Impact Pathway for Bachelor of Science (Extended)

Participation

Murrup Barak, Residential colleges
BSc (Ext) team, support services, students
Universities, students
University of Melbourne
Staff, support services
Elders, Indigenous organisations, community
CSIRO, jurisdictions



Assumptions

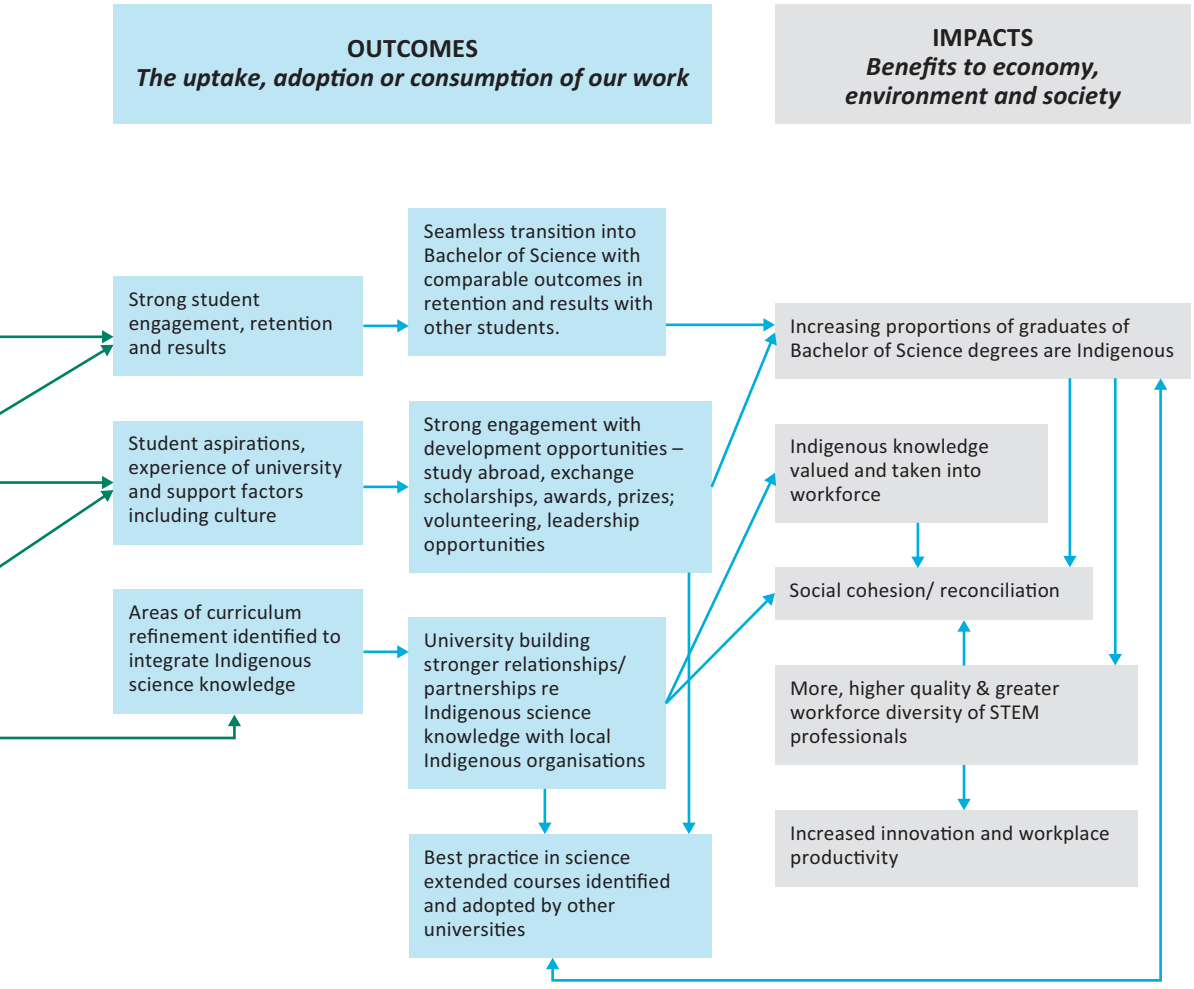
The additional year of the BSc (extended) emphasises practical workshops and tailored academic support to provide a strong science foundation within a number of science, mathematics and communication subjects unique to the extended programs.

Cultural identity is supported through Murrup Barak, living in residence and through an increasing identification of relevant local Indigenous science knowledge experiences being incorporated into the curriculum.

External factors

The BSc (Extended) caters for Indigenous students who do not meet current entry requirements for the standard, three-year Bachelor of Science program. Their interest in science or technology may have emerged later in their schooling, or their educational opportunities may have limited their capacity to be well-prepared to enter the BSc.

The BA Arts extended has demonstrated significant variation in cohort size from year to year making enrolment targets unpredictable.


OUTCOMES
The uptake, adoption or consumption of our work
IMPACTS
Benefits to economy, environment and society
Strong student engagement, retention and results
Seamless transition into Bachelor of Science with comparable outcomes in retention and results with other students.
Increasing proportions of graduates of Bachelor of Science degrees are Indigenous
Student aspirations, experience of university and support factors including culture
Strong engagement with development opportunities – study abroad, exchange scholarships, awards, prizes; volunteering, leadership opportunities
Indigenous knowledge valued and taken into workforce
Social cohesion/ reconciliation
Areas of curriculum refinement identified to integrate Indigenous science knowledge
University building stronger relationships/ partnerships re Indigenous science knowledge with local Indigenous organisations
More, higher quality & greater workforce diversity of STEM professionals
Increased innovation and workplace productivity
Best practice in science extended courses identified and adopted by other universities

Appendix B – Review of representative university and pre-university programs for Aboriginal and Torres Strait Islander students

This brief review of university and pre-university programs is meant to cover a representative sample of programs rather than be a comprehensive overview.[12]

Pre-admission programs (Aboriginal and Torres Strait Islander students)

Examples of general alternative pathway and bridging programs

At Monash University in Melbourne, Aboriginal and Torres Strait Islander students are able to enrol in the *Monash Indigenous Access Program* or the *Indigenous Non-Award Pathway* to assist them in making a successful transition to university study (Monash University, 2018). Toowoomba's University of Southern Queensland offers the *Indigenous Higher Education Pathways Program* to give Aboriginal and Torres Strait Islander students the academic skills needed for university study (University of Southern Queensland, 2018). These programs are primarily designed to develop skills that will enable students to succeed at university; they do not involve additional years of study.

The Australian National University (ANU) in Canberra offers early offers of entry to domestic school-leavers currently completing an Australian Year 12 or International Baccalaureate qualification in Australia through the *Schools Recommendation Scheme*. The scheme, also offered at other universities, offers early offers of undergraduate admission to students, based on the recommendation of their school and provided the applicant gains minimum Australian Tertiary Admission Rank or equivalent (Australian National University, 2018). This program focuses on admission to university rather than supporting students in their studies.

ANU also makes adjustments to students' selection rank in line with the National Access Scheme to give students a better chance of university entry. Students with good academic potential, who have experienced serious long-term disadvantages in their educational preparation for tertiary entrance, may be eligible for an equity-based Selection Rank adjustment. Disadvantages may include geographical isolation, serious medical problems, disability, and family relationship problems. Qualifying applicants will have a rank adjustment added to their Selection Rank for their preferred eligible ANU programs. Once students have met entrance requirements, the university also offers a number of scholarships for Aboriginal and Torres Strait Islander students and assistance with obtaining accommodation.

The University of Queensland in Brisbane has an admission pathway designed to support Aboriginal and/or Torres Strait Islander applicants who are interested in studying at the university. If students do not meet the entry requirements of their preferred field of study, the admission pathway process can improve their chances of admission. The process considers students' previous formal education and a range of factors such as their employment history, academic abilities, personal interests, and references. Once admitted, students may qualify for scholarships and financial support as well as accommodation (The University of Queensland, 2018).

The University of New South Wales (UNSW) in Sydney has the *Indigenous Admission Scheme* that provides an alternative pathway for Australian Aboriginal and Torres Strait Islander people into UNSW undergraduate-degree programs (University of New South Wales, 2018b). The program is open to students studying Business, Law, Education, Medicine or Social Work. Assessment for entry is coordinated by Nura Gili in conjunction with Faculties and Schools across UNSW. Staff at Nura Gili are available to assist students with academic and administrative issues, housing and scholarships, and pastoral support. The unit also manages the *Indigenous Tuition Program (ITP)* and facilitates programs to recruit and support Aboriginal and Torres Strait Islander students at UNSW at all levels of study.

12 Important disclaimer. CSIRO advises that the information contained in this section comprises general statements based on publicly available information. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this information (in part or in whole).

James Cook University (JCU) in Townsville has the *Tertiary Access Course (TAC),* which gives students the foundation skills and confidence to prepare them for further university study (James Cook University, 2018b). TAC has no subject fees (Student Services and Amenities Fees are applicable), and if taken full-time, can be completed in six months. Students are able to apply for TAC if they did not meet the criteria for open admission or may be eligible for recognition of prior experience. In addition, the university offers the *Indigenous Health Careers Access Program (IHCAP),* a free one-month orientation course held in January each year. IHCAP is for Aboriginal or Torres Strait Islander students enrolled in a health degree. The course provides students with the practical skills and knowledge to better cope with the demands of university study. Finally, JCU recently introduced the *JCU Summer Pre-Program for Australian Aboriginal and Torres Strait Islander Students* (James Cook University, 2018a). This three-week intensive pre-program is for prospective students who have completed Year 12 requirements for university entry. The pre-programs are intensive preparation programs related to students' preferred courses of study, and also serve as an alternative selection process for students who may not achieve required OP (overall position) or HSC (higher school certificate) scores for their preferred course of study.

Perth's University of Western Australia has a School of Indigenous Studies that provides opportunities to Indigenous applicants from a wide variety of educational backgrounds who do not meet the standard admission requirements (University of Western Australia, 2018). The *Provisional Entry Scheme* makes a number of places available to Aboriginal and Torres Strait Islander students who have completed The Western Australian Certificate of Education but have not gained a sufficiently high Australian Tertiary Admission Rank (or ATAR) to enter their preferred course or who have a strong employment history and/or a good educational background; the *Aboriginal Orientation Course* is a 12-month course that prepares students with practical skills and knowledge for entry to Arts, Science, Biomedical Science and Commerce undergraduate degrees.

Examples of STEM academic enrichment programs offered by universities for (Indigenous) high school students and university foundation programs

One of the academic enrichment programs for Aboriginal and Torres Strait Islander students specifically in STEM is *The Switched On: Indigenous STEM Program* delivered by the University of New England (in Armidale NSW) to Aboriginal and Torres Strait Islander Years 7 to 9 high school students. Students are provided with opportunities to engage positively with mathematics by using Indigenous cultural and technological traditions as a means to explore mathematical concepts (University of New England, 2018).

At Griffith University (South-East Queensland), Aboriginal and Torres Strait Islander students in Years 9 to 12 are invited to participate in a hands-on workshop during an *Indigenous STEM Experience Day*. Students are introduced to science and technology and the integrated nature of STEM disciplines (Griffith University, 2018).

The Aurora Education Foundation, a national not-for-profit organisation, runs *The Aspiration Initiative,* which is designed to enhance academic achievement for Aboriginal and Torres Strait Islander high school students, simultaneously paving the way to university. The aim of the program is for all students to complete high school with the foundational academic skills necessary for engagement and success at university and higher education. Staff work closely with high school students and their parents and/or carers for six years—from Year 8 through to the end of their first year out of high school. A significant part of the methodology is engaging, facilitating and supporting families, high schools, and the young person's community to link together, so that students can reach their full academic potential (Aurora Education Foundation, 2018).

The *Aboriginal Summer School of Excellence in Technology and Science (ASSETS)* delivered by CSIRO is aimed at Year 10 Aboriginal and Torres Strait Islander students with an interest in science. The ASSETS program comprises three key components: an intensive nine-day residential summer school, a two-year leadership and support program, and an integrated and overarching cultural program. The first and primary component of the program is the nine-day summer school, which focuses largely on personal development, including the encouragement of self-belief, a greater understanding of diversity, professional development, and the opportunity to participate in the cultural program. Upon successful completion of the summer school, a leadership and support program is offered to students (Years 11 and 12), which aims to develop leadership skills and provide an opportunity for students to access tertiary education opportunities and work placements (Tynan & Noon, 2017).

The University of Sydney's *Wingara Mura – Bunga Barrabugu* program is designed to be a multi-layered approach to support the academic and personal preparation of young Aboriginal and Torres Strait Islander peoples for higher education. This includes opportunities for students to experience university life and engage in fun, educational activities in a supportive and inclusive environment at the university, including week-long residential Summer and Winter programs (University of Sydney, 2018).

The University of New South Wales delivers three programs that target students at school: the *Indigenous Science and Engineering Program (ISEP)* is a three-day residential program for students in Years 7, 8 and 9 interested in exploring the world of Science and Engineering; the *Indigenous Winter School Program* is a one-week camp for high school students in Years 10, 11 and 12 to experience university, provided at no cost to students; and the *Aboriginal and Torres Strait Islander Info Day* invites Indigenous students to visit the university to get answers to questions they may have about university life and study (University of New South Wales, 2018a).

Post-admission programs (Aboriginal and Torres Strait Islander students)

Examples of accommodation and other practical support

Swinburne University of Technology in Melbourne does not have an alternative pathway but provides on-campus Aboriginal and Torres Strait Islander student support. Students can receive assistance with pre-enrolment, subject selection, orientation and graduation as well as plans for life after studying. The university also provides tutorial support to Aboriginal and Torres Strait Islander students enrolled in higher education studies. Tutorial support can also be arranged for students enrolled in formal vocational education and training (Swinburne University, 2018).

Similarly, the University of Sydney's Aboriginal and Torres Strait Islander Accommodation Award guarantees all commencing full-time Aboriginal school-leaver students residency in university-owned accommodation. The university will also subsidise the cost of the rent and students receive a start-up bursary of $1,000 to assist with relocation expenses (University of Sydney, 2018).

Appendix C – Interview/focus group questions for Bachelor of Science (Extended) Case Study

LECTURERS/PROGRAM STAFF

Student questions

1. Do the students find the extended structure engaging?
   a. Have you been successful in integrating Indigenous content into the curriculum? What effect has this had?
   b. Does this contrast with the regular BSc curriculum?
2. How do you measure student success?
3. What personalised student support do you provide? Do you believe it is effective?

Individual (lecturer) questions

4. How long have you taught at the University of Melbourne?
5. Has the Bachelor of Science (Extended) been similar to other curriculum initiatives you have been involved in? In what ways?
6. Are you confident in organising and delivering the extended curriculum?
7. What support have you received in developing and delivering this curriculum? (from the university?; community?)

Faculty questions

8. Has your relationship with Murrup Barak been important in the establishment of the Bachelor of Science (Extended)? How? Why?
9. Does the extended course integrate well with the BSc approach to curriculum and pedagogy? How?
10. Do your departments have a culture of high expectations?
    a. If yes, what does this consist of?
    b. Does this apply to both students and lecturers? How?
11. Do you feel you belong to a community of practice with this (or other) programs? How?

Community questions

12. Has the Bachelor of Science (Extended) program helped in building relationships with Indigenous community members and/or organisations?

STUDENTS

Student questions

1. What was your STEM pathway that led you to decide to apply for the Bachelor of Science (Extended)? What was your experience of STEM growing up?
2. What role did the Bachelor of Science (Extended) play in your transition to university life?
3. How have the staff or course helped you build academic or other skills that you need for your degree?
4. How important are the peer relationships to you within a) the Bachelor of Science (Extended) and b) the wider Bachelor of Science cohort?
5. Does the Bachelor of Science (Extended) support you to get you to where you want to be?
6. How does the Bachelor of Science (Extended) compare to studying STEM in Years 11 and 12?
7. What do you recommend for improvement in the Bachelor of Science (Extended)? Why?

Individual (lecturer) questions

8. Did you improve your skills during the BSc Extended (consider study skills, communication, maths skills, science skills, critical thinking)? What did the BSc Extended lecturers do to help you improve?
9. Did having multiple disciplines taught within a subject make the connections between them more obvious? Were these connections helpful in developing the range of skills that would support your future learning in science? (For example, quantitative skills learnt early in physics and chemistry are needed in biology in later years.)

University questions

10. Have you utilised the services of: a) Murrup Barak? b) Residential colleges c) other university support services? d) the lecturers and Bachelor of Science (Extended) Director? What has your experience of these interactions been?

MURRUP BARAK & SUPPORT STAFF

Student questions

1. What feedback do you get from students about Bachelor of Science (Extended) curriculum? Does it differ from other courses?
   a. How are they adjusting to university life compared to other first-year students? And in the subsequent years?
2. What do you see as the main type of support that you provide to the students? Is it the same as with other courses?
3. How are the students in Bachelor of Science (Extended) connected with the wider Indigenous community at the University of Melbourne?

Individual (lecturer) questions

4. Do you get feedback from students on how effectively the Bachelor of Science (Extended) lecturers deliver curriculum to Aboriginal and Torres Strait Islander students and provide personalised support? Are there cultural factors that are important to consider?
5. Is the Bachelor of Science (Extended) building Indigenous curriculum content and building relationships with relevant Indigenous organisations and individuals (e.g. Elders)?

School questions

6. Do the different faculties consistently enact a culture of high expectations? How does the Bachelor of Science (Extended) team compare?
7. Do the different faculties engage effectively with Murrup Barak to recruit and retain Aboriginal and Torres Strait Islander students? How does the Bachelor of Science (Extended) compare?
8. Do the different faculties have a good relationship with Indigenous community members and/or organisations? How does the Bachelor of Science (Extended) compare?

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