CSIRO

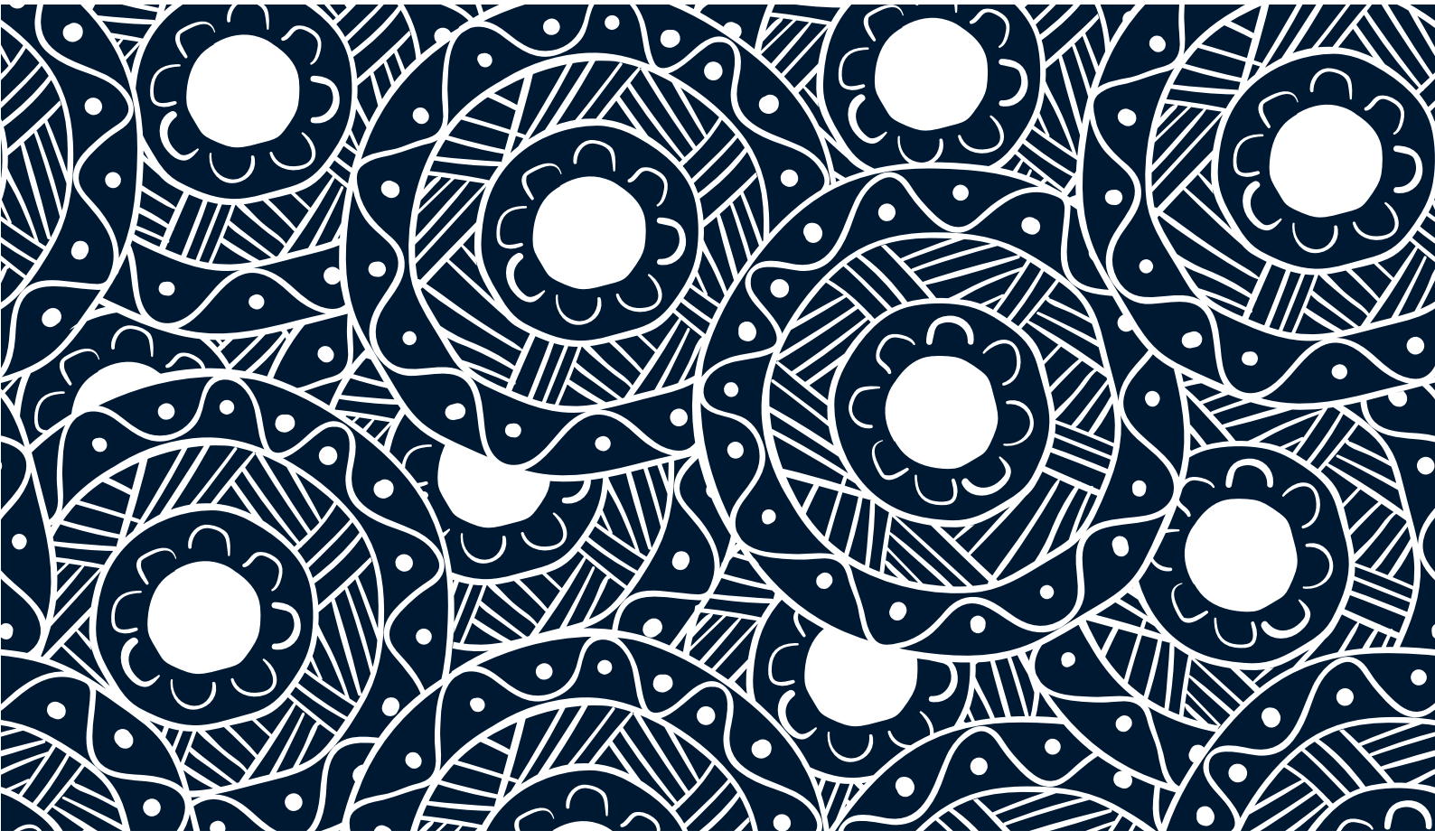
Australia's National Science Agency

Indigenous STEM Education Project

Inquiry for Indigenous Science Students (I^2S^2)

Case study evaluation report

June 2021



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Acknowledgements

Acknowledgement of Country

Aboriginal and/or Torres Strait Islander peoples have longstanding scientific knowledge traditions. These traditions have developed knowledge about the world through observation, using all the senses; through prediction and hypothesis; through testing (trial and error); and through 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 and complementary to western scientific knowledge.

This respect encompasses the recognition of Aboriginal and Torres Strait Islander contexts for technologies and concepts; their application in the past, present and future, including supporting Science, Technology, Engineering and Mathematics (STEM) career pathways for Aboriginal and/or Torres Strait Islander students; and reaffirming the ingenuity and creativity of Aboriginal and/or Torres Strait Islander peoples' knowledge systems. A deep respect for these Aboriginal and/or Torres Strait Islander cultural practices and knowledge underpins the philosophy and practice of the Indigenous STEM Education Project.

The Indigenous STEM Education Project team 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 thank all community members who provide 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. We specifically acknowledge the Traditional Owners of the lands on which the case study research was conducted:

- Darumbal people
- Gunggandji people
- Nukunu people
- Wonnarua people
- Yidinjdji people
- Yuggera people

The Commonwealth Scientific and Industrial Research Organisation (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 significant knowledge and leadership of Aboriginal and/or Torres Strait Islander scientists, educators, and program leaders that have made the development and implementation of the Indigenous STEM Education Project possible.

The authors would like to thank the external peer reviewer, Dr Jessa Rogers from Macquarie University, whose insightful feedback improved the report significantly. We also thank the I^2S^2 program team for their constructive feedback.

CSIRO acknowledges the contributions of former and current members of the program teams and evaluation team who led or supported the program monitoring and evaluation methodologies, data collection, and analysis. The evaluation team members include Dr Michael Tynan, Dr Kirsten Sadler, and Karlie Noon. A special thanks goes to Mhairi King, who assisted with setting up some of the data analyses.

Throughout this report, the 'Inquiry for Indigenous Science Students or I^2S^2 program' is used as a short-hand primarily for the people that developed and implemented the program and the activities they undertook, including teacher professional learning, supporting schools to implement inquiries, and developing resources. It is through the passions, capacities, knowledge and skills of the I^2S^2 team that the 'program' had an impact. The I^2S^2 program has comprised many Aboriginal and/or Torres Strait Islander and non-Indigenous Coordinators, managers, and leaders, including Ashleigh Boyle, Susan Burchill, Ziggi Busch, Dr Renee Chapman, Linda Cooper, Cassandra Diamond, Dean Duncan, Kim Dyball, Amy Gulbinas, Alex Ibarra, Nerissa Jones, Alisha King, Jesse King, Mhairi King, Liz Kupsch, Megan Ladbrook, Max Lenoy, Alex Lewis, Sarah McDonnell, Nathan Meredith, Dr Celia McNeilly, Trish Morton, Mary Mulcahy, Therese Postma, Carlie Ring, Joe Sambono, India Shackleford, Kate Shackleford, Jess Stimson, and Torres Webb. The 'program' is chiefly referring to these people.

CSIRO gratefully acknowledges the two state education departments that provided academic and STEM subject selection data for analysis in this report.

Finally, and most importantly, the students, teachers, teacher assistants, principals, Aboriginal and/or Torres Strait Islander education workers, parents/ carers, heads of department, and heads of curriculum that helped organise and took part in the research are gratefully acknowledged. The time that was given to the evaluation team, and the knowledge that was shared, made the evaluation possible.

Contents

Acronyms

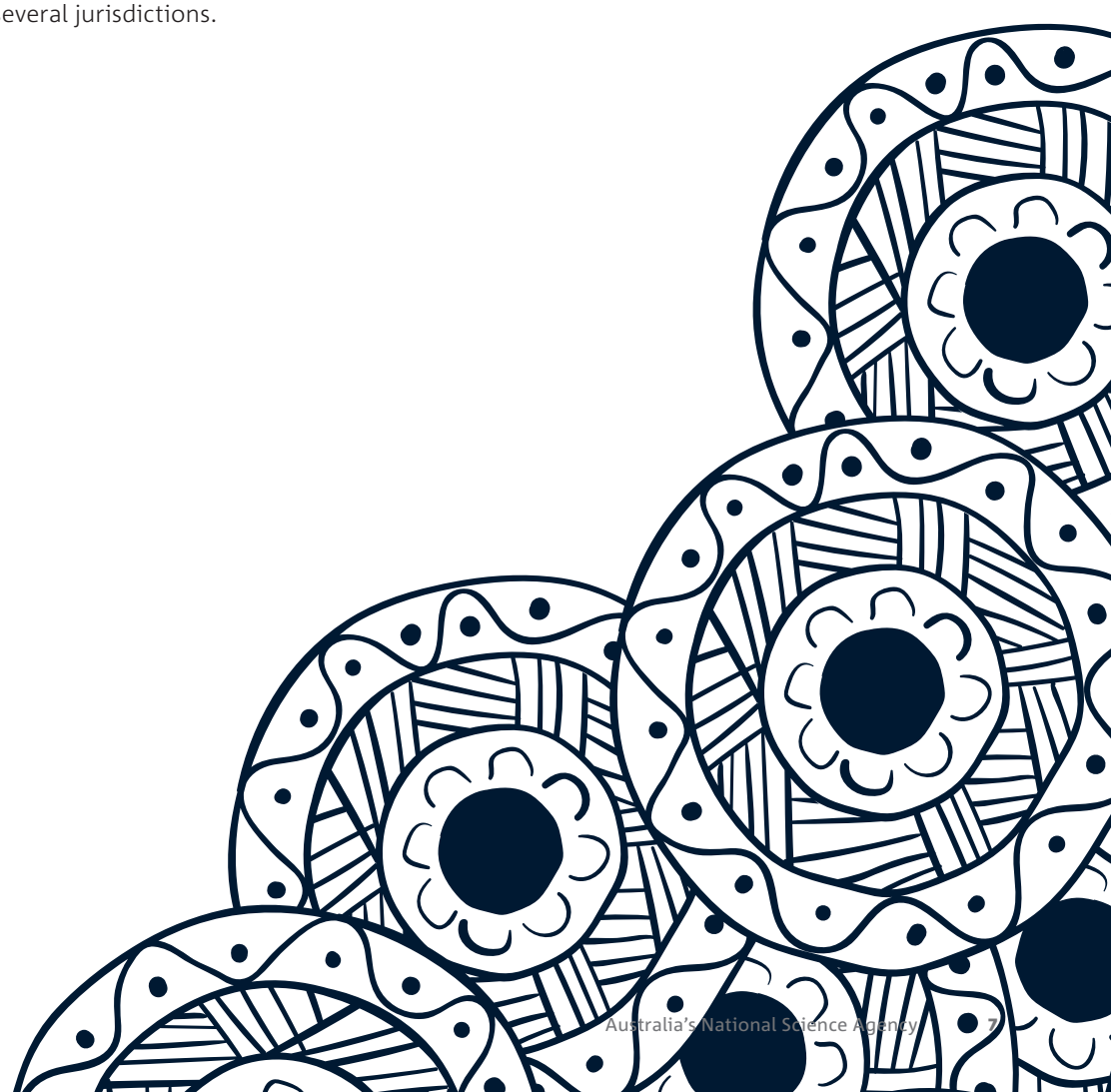
ASSETS	Aboriginal Summer School for Excellence in Technology and Science
CREST	Creativity in Research, Engineering, Science and Technology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
I²S²	Inquiry for Indigenous Science Students
ICSEA	Index of Community Socio-Educational Advantage
PRIME Futures	Purposeful, Rich Indigenous Mathematics Education (PRIME) Futures
STEM	Science, Technology, Engineering and Mathematics

Executive summary

Background and methodology

Inquiry for Indigenous Science Students (I^2S^2) is part of the Indigenous Science, Technology, Engineering and Mathematics (STEM) Education Project, delivered by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and funded by the BHP Foundation. It is aimed at Aboriginal and/or Torres Strait Islander students in Years 5 to 9, but is delivered to all students in those year levels. The program provides teacher professional learning, resources, and support to embed Aboriginal and Torres Strait Islander scientific knowledges through hands-on inquiry-based projects to increase student engagement and achievement in science.

The key evaluation question guiding the evaluation was: To what extent has the I^2S^2 program achieved its intended outcomes? A multi-method approach was employed, including interviews and focus groups with students, teachers, and school leaders in eight schools across three jurisdictions. The voices of program participants have been privileged in this report through the inclusion of numerous quotes. An analysis of the quantitative data was also undertaken, including pre- and post-inquiry academic and engagement results provided by teachers, and academic and subject selection data from several jurisdictions.



Findings

The findings were organised around eight intended outcomes that were identified in the program's Impact Pathway; assessments against a strengths-based scale (emerging, effective, and transformative) were made for each outcome (see Figure 1). Key findings comprised:

The program led to increases in engagement and academic achievement among many students, particularly low achieving students.

The hands-on, inquiry-based activities incorporating Aboriginal and Torres Strait Islander knowledges were engaging for the vast majority of students.

Beyond school-based outcomes, the program also led many Aboriginal and/or Torres Strait Islander students to feel more pride, sense of value, and belonging.

Based on eight schools involved in the case study, there was widespread enthusiasm for greater parent/carer and community involvement in the school and I^2S^2.

At the time of the case study, this involvement was primarily in the early stages of development, although there were a few instances of increasing engagement or newly established partnerships with parents/carers and community as a direct result of I^2S^2.

There was evidence of interest in STEM subjects and careers among I^2S^2 students (and some evidence of better than average uptake of STEM subjects in I^2S^2 schools), although there was insufficient evidence to attribute this directly to I^2S^2.

I^2S^2 has achieved recognition as a program of excellence and has seen a steady increase in uptake across Australia.

The schools involved in the case study were all involved in multiple STEM programs, although this involvement was likely a result of an overall commitment to STEM learning. In all eight case study schools, I^2S^2 was the only STEM program to feature Aboriginal and Torres Strait Islander knowledges.

Students, teachers, and parents/carers reported that their school had a culture of high expectations of students, focused primarily on effort. There was anecdotal evidence that I^2S^2 contributed indirectly to this culture.

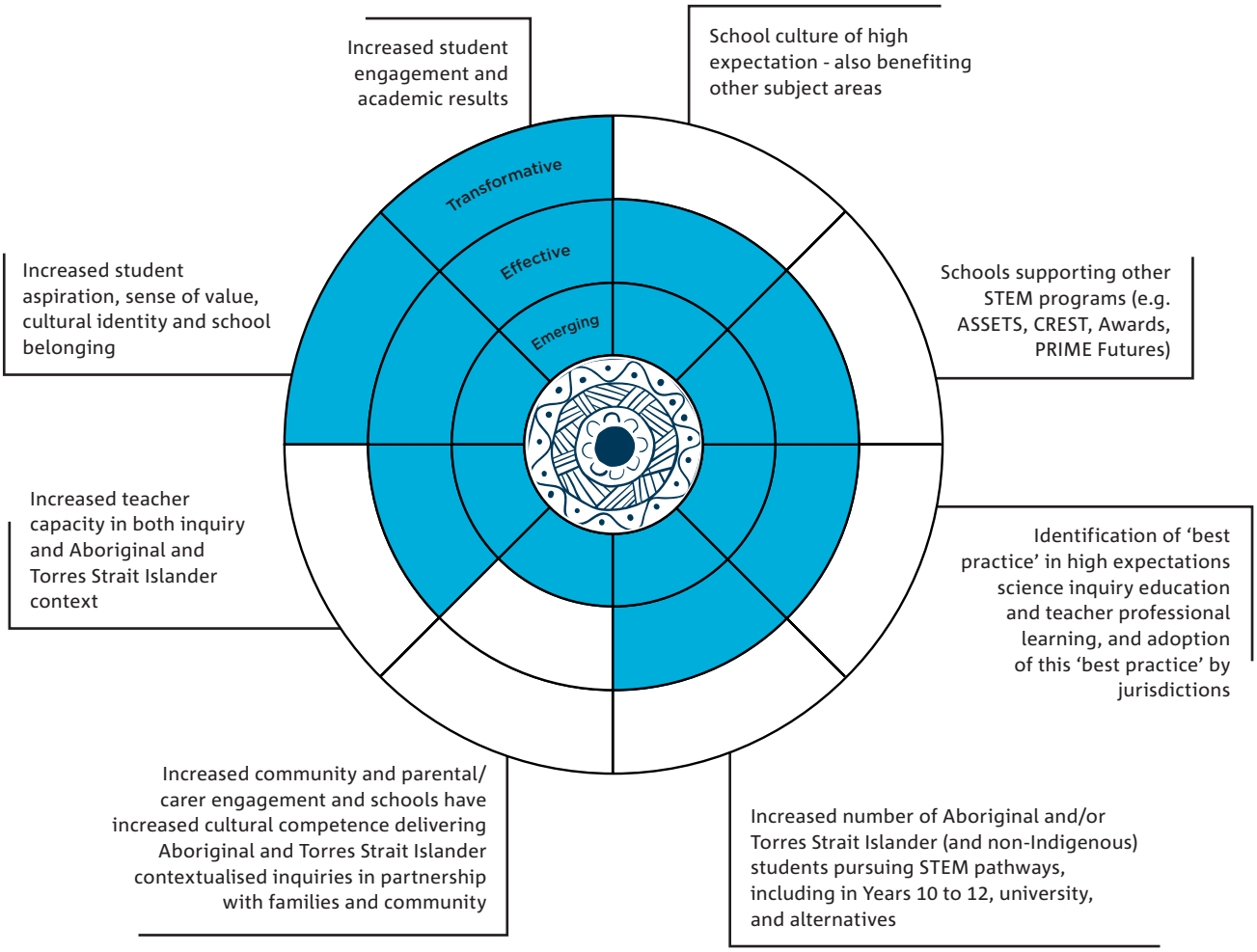


Figure 1. Summary of findings[1]

Challenges and success factors

Several challenges to the implementation and operation of I²S² were identified. These comprised issues related to logistics, the design and delivery of inquiries and units, training, and professional learning, delivering Aboriginal and Torres Strait Islander content and contexts, recruiting schools into the program, parental engagement, sustainability, and program fidelity.
A range of success factors was also identified that assisted in the achievement of the program's outcomes, including factors related to the school (such as leadership and peer support), teachers (such as confidence and capacity), community (such as authentic partnerships), and culture, program support, and curriculum (such as tailoring inquires to different student levels).

Discussion and recommendations

I²S² has been a successful program that has achieved multiple, important outcomes in the areas of academic achievement, engagement, sense of value, school belonging, teacher capacity, and other areas. Recommendations for further consideration include celebrating and sharing student success; building stronger community, school, and parental connections; bolstering professional learning and peer support; continuous improvement of lesson planning and inquiries; investigating whether more support is required in the areas of assessment and resources; ensuring consistency in I²S² Coordinators (called 'Coordinators' throughout this report), communication, and program resources; enhancing cultural competency training and communities of practice; and several suggestions for the I²S² online learning platform.

1 The wording of the outcomes in this report has been changed slightly as compared to the Impact Pathways in order to increase clarity.

Introduction

This case study evaluation report outlines the degree to which the Inquiry for Indigenous Science Students program (the program or I²S²) has achieved its intended outcomes as assessed against the program's Impact Pathway (Appendix 1). The first section of this report describes the I²S² program and the case study methodology employed to evaluate the intended impact of the program. The second section of the report outlines the key findings of the case study in the context of the evaluation framework and the outcomes of the program. The final section of the report includes a discussion around the findings of the case study alongside the recommendations for the program. The case study considers the program's progress as at September 2019, which is prior to the program shifting to a primarily online model in early 2020.

History of the program

I²S² is part of the Indigenous STEM Education Project, delivered by CSIRO and funded by the BHP Foundation, which aims to improve the engagement, participation, and achievement of Aboriginal and/or Torres Strait Islander students by providing supported pathways throughout primary, secondary, and tertiary education, and into employment. I²S² is one of six programs that comprise the Indigenous STEM Education Project, the others being Science Pathways for Indigenous Communities, Purposeful, Rich Indigenous Mathematics Education (PRIME) Futures[2], the Indigenous STEM Awards, Bachelor of Science (Extended)[3], and the Aboriginal Summer School for Excellence in Technology and Science (ASSETS). I²S² was first implemented in 2015 after a period of development, including close consultation with experts in Indigenous scientific knowledges.

Program design

I²S² is aimed at Aboriginal and/or Torres Strait Islander students in Years 5 to 9; however, the program is delivered to both Aboriginal and/or Torres Strait Islander and non-Indigenous students in those year levels. The program provides teacher professional learning to embed Aboriginal or Torres Strait Islander[4] scientific knowledges through hands-on inquiry-based projects (see Appendix 2 for a list of the I²S² inquiry topics) to increase student engagement and achievement in science. The key objectives and components of the program are described below.

A list of related and similar science inquiry or Indigenous science programs in Australia is provided in Appendix 3.

Program outputs and outcomes

I²S² learning objectives

Teachers who complete and implement the I2S2 program are intended to be able to:

- Utilise knowledge, understandings, and resources from the program to increase the engagement and achievement of Aboriginal and/or Torres Strait Islander students in science.
- Appropriately and effectively link Aboriginal and/or Torres Strait Islander knowledges and histories to the science curriculum.
- Utilise Science Inquiry Skills and apply them to the I²S² program.
- Demonstrate an understanding of the critical importance of schools in building strong and positive relationships with parents/carers and the community.

Aboriginal and/or Torres Strait Islander context

One of the key aspects of I²S² is the use of Aboriginal and Torres Strait Islander scientific and ecological knowledges. I²S² comprises a set of units based on inquiries (where students investigate a question, conduct experiments, and evaluate findings) that involves a context related to Aboriginal and/or Torres Strait Islander peoples' knowledge and understanding. For example, the 'Throw it Far' inquiry involves the experience and exploration of the design and construction of spears and spear throwers with Aboriginal and/or Torres Strait Islander knowledge and physics.

Inquiries and connection to curriculum

The Australian Curriculum comprises three strands: Science Understanding, Science as a Human Endeavour, and Science Inquiry Skills. The I²S² program develops and supports the incorporation of inquiry resources using Aboriginal and Torres Strait Islander contexts for participating schools into their existing science curriculum. The inquiries aim to provide Indigenous and non-Indigenous students with the opportunity to demonstrate their knowledge of scientific principles and practices through the broader context of Indigenous practices. The program is offered to students in Year 5 through to Year 9, with two inquiries available for each year level[5] (see Appendix 2).

[2] PRIME Futures concluded in late 2019.

[3] Delivered by the University of Melbourne

[4] 'Aboriginal or Torres Strait Islander' refers to the two distinct First Nations groups of Australia, including their cultures and knowledges. 'Aboriginal and/or Torres Strait Islander' refers to First Nations peoples, and acknowledges that some people identify as both Aboriginal and Torres Strait Islander.

[5] At the time the case study was conducted, there were eight inquiries available. In early 2020, an additional two inquiries ('In the Mix' and 'Perfect Pitch') were added, bringing the total to 10 inquiries.

Inquiries can be assessed using multi-modal techniques (i.e., presentations, group work); this methodology allows students to demonstrate learnt concepts and content in a way that is flexible to students and their needs (i.e., literacy level, English as a second language). Each inquiry requires approximately 10 hours to complete. Each school participating in the program must complete one inquiry per year level, and there are scaffolded, guided, and challenge types of inquiries. The I²S² program is designed so teachers can design their own inquires after becoming confident in the process. The program resources identify content descriptions in the Australian Curriculum that can be related to an Aboriginal or Torres Strait Islander context and developed into a hands-on scientific inquiry.

Teacher professional learning

I²S² includes a professional learning course for teachers. The professional learning component of the program aims to increase the teacher's knowledge of inquiries and improve their capacity to engage with and deliver the program to Aboriginal and/or Torres Strait Islander students. The professional learning component of the program is delivered in two phases, the first of which is the face-to-face training sessions administered by the Coordinators. Each face-to-face session lasts for approximately 2 hours. Teachers are given the opportunity to attend four teacher professional learning sessions across 2 weeks, including modules covering: program overview, cultural considerations[6], 'unpacking the Scaffolded Inquiry', and 'unpacking the Guided Inquiry'. The second component of teacher professional learning is delivered online. The online training involves 4 to 8 hours of interactive lessons designed to complement the face-to-face teacher modules. The online modules are tailored to each specific year level.

Coordinator support

Teachers (and heads of curriculum and heads of department) were also provided individualised support from Coordinators, who were responsible for a geographic region with multiple schools. The primary role of a Coordinator was to 'work with teachers and Indigenous students in implementing student-centred inquiry-based STEM projects in schools and in nurturing and encouraging students' interest in STEM.'[7] Each Coordinator delivered face-to-face training and follow-up visits, including modelling the delivery of inquiry units in the classroom. Coordinators answered teacher questions, facilitated the sourcing of materials, and generally supported teachers to feel confident and be capable of working with an inquiry-based learning approach and embedding Aboriginal and/or Torres Strait Islander knowledges.

Many Coordinators were Aboriginal and/or Torres Strait Islander people, who drew on their experiences and knowledges, including of the local area. Coordinators also provided teachers with a list of resources available in each area, such as museums, libraries, or individuals.

Online learning program

In November 2018, a pilot online learning program was developed to provide an opportunity for teachers to readily access two inquiries online (Year 5 'What's Cooking?' and Year 7 'Throw it Far'). The program allowed teachers to work through the content at their own pace while providing them with the option to customise the content to suit their own competency level in cultural considerations and inquiry-based learning. Participants were required to complete face-to-face training, which was then followed by online learning modules. After completing the online learning modules, participants could access other inquiry resources and materials for the classroom. As part of the implementation of the inquiries, teachers had access to coaching and support throughout the first term implementing the program.[8] As part of a plan to increase the scale of the program, in early 2020, the I²S² program shifted to a primarily online model with 10 inquiries available (two for each year level): What's Cooking? and Keeping Cool (Year 5); Let's Stick it Together and Grow and Survive (Year 6); Throw it Far and In the Mix (Year 7); Fire: A Burning Question and Rock On (Year 8); and Burn and Grow and Perfect Pitch (Year 9). The inclusion of the two additional inquiries ('Perfect Pitch' and 'Rock On') was in response to feedback from program participants.

Program reach

At the time the case study evaluation was conducted, the I²S² program was available in regional and metropolitan schools in Queensland, South Australia, Western Australia, and New South Wales. The schools were first selected using three criteria: geographical distribution, relatively high percentage of Aboriginal and/or Torres Strait Islander students at the schools (above 15 per cent), and having surrounding feeder schools in the region. As part of the initial recruitment phase of the program, several high schools and primary schools were paired together to create clusters. The clusters aimed to provide an opportunity for schools to support each other, whereby classroom materials and knowledge (such as lessons learnt) could be shared between schools. Since 2014, a cumulative total of 513 schools, 548 teachers, and 11,375 Aboriginal and/or Torres Strait Islander students have participated in the program.

[6] A flyer with an overview of this module states that "The cultural considerations module provided participants with foundational knowledge and understanding of key cultural considerations to help [teachers] recognise the diversity of Aboriginal and Torres Strait Islander cultures and identities. Participants explore key topics and relate them to their own personal perspective and worldview which is imperative when beginning to construct understanding of Aboriginal and Torres Strait Islander ecological knowledge required to effectively deliver the I²S² inquires."

[7] Taken from an advertised CSIRO Position Description for an 'I²S² Coordinator' in 2018. The titles of these positions were changed to 'Education Advisers' when the program shifted to an online model of delivery.

[8] A collaboration hub where teachers could engage and invite professional dialogue with other schools and teachers across Australia was originally planned but was not pursued.

Evaluation

Scope and purpose

The purpose of this report is to present the key findings of the evaluation case study of the I^2S^2 program. The key evaluation questions guiding the evaluation were:

- To what extent has the I^2S^2 program achieved its intended outcomes?
- What challenges and barriers were experienced in implementing and operating the program?
- What were the success factors that contributed to the program's achievement of outcomes?

The Impact Pathway (see Appendix 1) outlines the inputs, activities, outputs, expected outcomes, and intended longer-term impacts. This case study seeks to provide evidence for the achievement of eight outcome areas outlined in the Impact Pathway:

Short-term outcomes

- Increased student engagement and (academic) results[9]
- Increased student aspiration, sense of value, and school belonging
- Increased teacher capacity in both inquiry and Aboriginal and Torres Strait Islander context
- Increased community and parental/carer engagement and schools have increased cultural competency delivering Aboriginal and Torres Strait Islander contextualised inquiries in partnership with families and community[10]

Intermediate outcomes

- Increased number of Aboriginal and/or Torres Strait Islander (and non-Indigenous) students pursuing STEM pathways, including in Years 10 to 12, university, and alternatives
- Identification of 'best practice' in high expectations science inquiry education and teacher professional learning, and adoption of this 'best practice' by states and territories Schools supporting other STEM programs (e.g., ASSETS, Creativity in Research, Engineering, Science and Technology [CREST] Awards, PRIME Futures)
- School culture of high expectations – also benefitting other subject areas

Research reflection and position

The CSIRO evaluation team consisted of five researchers during the period of data collection, analysis, and report writing. One team member was a Wiradjuri woman, and the remaining evaluation team members were non-Indigenous. Team member world views, while varying, were privileged in many ways and, through enculturation, were largely based on western modes of theoretical knowledge (Dew, McEntyre, & Vaughan, 2019). Through this case study, the evaluation team had the opportunity to influence and be influenced by the research through processes of reflexivity and development (Attia & Edge, 2017). The evaluation team's development and methodology were informed by the writings of Aboriginal and/or Torres Strait Islander researchers and their colleagues (for example Hogarth, 2017; Jackson-Barrett, Price, Stomski, & Walker, 2015; Martin & Mirraboopa, 2003; Nakata, 2002, 2007; Rigney, 2006; Yunkaporta, 2009) and conversations with Aboriginal and/or Torres Strait Islander CSIRO colleagues with expertise in engaging with Aboriginal and/or Torres Strait Islander peoples and communities. These perspectives informed the development of a general approach that the evaluation team aimed to apply throughout the project, including recognising strengths, complexity, and researcher positions; researchers as learners; and contributing to positive change and focusing on utilisation. The time spent at the eight schools in the case study also provided the evaluation team with the opportunity, to a limited degree, to understand the school environments in which I^2S^2 was being delivered.

[9] The original Impact Pathway included attendance as part of this outcome. As discussed in the Third Evaluation Report (Cherry, Banks, Mudhan, & McNeilly, 2019), attendance is not a realistic outcome of I^2S^2 and was removed from the Impact Pathway. This decision was supported by Coordinators and teachers, and substantial evidence in the research literature. One Coordinator explained that having attendance as a key performance indicator is not an effective measure because: "There are too many outside variables that are impacting on student attendance…A student is sick for two weeks and their attendance drops by 20 per cent. I just think there are so many factors outside of our program that either way I don't think it would be fair to say that our program is increasing attendance or that student attendance is decreasing because of our program" and "The only way I can see attendance being useful is if teachers were looking at specific students who they know don't attend because they're not engaging and looked almost on a case study basis on whether or not the student's attendance is improvement".

[10] Originally these were two separate outcomes but the analyses revealed they were closely linked and were therefore combined into a single outcome area.

Methodology

The methodology for the evaluation of the I²S² program comprised multiple methods and data sources. The primary methodology was a case study of eight schools in three states that implemented the program. A case study methodology was selected due to its ability to analyse and explore the voice of program participants in detail (Hudson, 2017; Kelaher et al., 2018; Muir & Dean, 2017). Several focus groups and interviews with students, teachers, parents/carers, principals, and community leaders were conducted at each school. Other methods included collecting teacher assessments of student engagement and achievement and the analysis of jurisdictional administrative data. The methodology for the case study evaluation and ongoing monitoring and the associated informed consent processes were approved by CSIRO's Social and Interdisciplinary Science Human Research Ethics Committee.

Interviews and focus groups

A series of focus groups and interviews were conducted by members of the CSIRO evaluation team with students, parents/carers, and teachers (including heads of department and heads of curriculum) from eight schools, and Coordinators. The eight schools were located in three jurisdictions, and were selected based on ensuring a range of metropolitan and urban sites and a relatively high percentage of Aboriginal and/or Torres Strait Islander student enrolments[11]. All schools had implemented I²S² for at least 2 years. Focus groups and interviews were semi structured, with a list of questions used as a guide for the discussions (see Appendix 4). Interview and focus group participants were asked about their level of engagement, how well the inquiries integrated into the existing curriculum, how the community engaged with the program, and any suggestions they had to improve the program. Specifically, students were asked in focus groups to explain their experience of the inquiries, how they perceived Aboriginal and Torres Strait Islander scientific knowledges being integrated into the classroom, and what they enjoyed most about the program. Coordinators were also interviewed and were asked about a range of topics, including stakeholder engagement and how they would administer the program differently in the future.

Coordinator feedback was not included as part of the assessment of achievement, but was used to provide context for the findings. A total of 159 participants took part in the case study (Table 1).

Table 1. Interview participants by stakeholder group and distribution across states

PARTICIPANT GROUP	NUMBER
Students	101
Parents/carers	14
Educators (including teachers, Aboriginal education workers, teacher assistants and aides, heads of department, and heads of curriculum)	36
Coordinators	8*
Total	159

* The data from Coordinator interviews were used to understand the context of the evaluation findings; they were not used to directly assess the achievement of outcomes.

A qualitative approach was undertaken to synthesise and understand the data from the interviews and focus groups. Specifically, a thematic analysis was conducted, which comprised of identifying, analysing, organising, describing, and reporting on themes within the interview and focus group data (Nowell, Norris, White & Moules, 2017). Several stages of coding were undertaken; the first stage involved identifying key findings (e.g., the appeal of hands-on activities) for each outcome area and stakeholder group, and how frequently the theme was expressed by each group. The measure of frequency or commonness was based on the following scale: very common, common, occasional, and uncommon. Some outcome areas did not have sufficient findings to warrant reporting on frequencies. An extensive number of quotes from participants are provided for each outcome area, which provide evidence for each outcome area and ensure that participant voices were privileged and heard clearly and without filters (Mockler & Groundwater-Smith, 2015).

[11] No minimum percentage was identified but the evaluation team's judgement was used to select schools with sufficient numbers of Aboriginal and/or Torres Strait Islander students so their voices were represented and heard.

Each participant was provided with a participant information sheet and privacy statement and gave their written informed consent to be part of the study and to be audio recorded through a participant consent form. Students required parental or guardian consent as well. The consent process conformed to the AIATSIS Guidelines for Ethical Research in Australian Indigenous Studies[12]. All participants, including Aboriginal and Torres Strait Islander students, provided free, prior, and informed consent to participate, including using multiple information formats at different times covering the purpose of the evaluation research, and what participation meant. Local stakeholders, including community members, for each case study school were engaged in a planning process to ensure a respectful and culturally responsive approach was followed. Focus groups with students were attended by at least one staff member of the school, and/or a minimum of two CSIRO evaluation staff. Each recording was transcribed and de-identified for analysis. The quotes included in this report are de-identified to protect the confidentiality of the participants, including substituting some third person singular pronouns (he, she) with third person plural pronouns (they, them) where appropriate, and removing references to specific geographical locations or other potentially identifying information.

Achievement and engagement data

As part of the regular program monitoring of I^2S^2, teachers are asked to complete pre- and post-inquiry assessments of students' engagement, attendance, and academic achievement (grades for the school subject Science) using individualised rubrics for each inquiry (see Appendix 5 for an example). These data have been reported in the Second and Third Evaluation reports for the Indigenous STEM Education Project (Cherry et al., 2019; Ma Rhea et al., 2018). The most recent data are provided in this report (from 2018 and 2019).

As detailed in the Third Evaluation Report, attendance was removed as an indicator due to the limited impact that a science lesson-based program could have on overall attendance. Data were available from three jurisdictions. Teachers were provided detailed assessment rubrics to assess student academic achievement and engagement levels (on five-point scales of A, B, C, D, and E).

Jurisdictional data

To supplement the teacher assessments of achievement and engagement data, three jurisdictions were requested to provide data on achievement, engagement, and STEM course selection at I^2S^2 schools and comparison schools. One jurisdiction provided the requested data, but due to confidentiality concerns[13], data were only provided at the whole-of-year level for each school rather than at individual class level, which reduced the ability to analyse the impact of I^2S^2. Another jurisdiction provided Year 8 science scores on a standardised test for three I^2S^2 schools and several comparison schools with similar characteristics. The final jurisdiction did not provide any data.

Limitations

As with all evaluations, there were several potential limitations to the methodology employed for this case study. Limitations are discussed for each of the methodologies.

Qualitative data collection was the method best suited to understanding the experience of I^2S^2 among stakeholders, including educators, students, and parents/carers; however, there are several potential limitations (Anderson, 2010). Focus groups and interviews rely on a participant's ability to accurately and honestly relay their thoughts and opinions to the researchers. A proportion of students were observed to be reticent to talk, likely because of the fear of embarrassment in front of their peers or nervousness with the interviewers. Several tactics were used to overcome these situations, including introductory questions unrelated to the research to put participants at ease, prompting and reframing questions for some students, and ensuring a relatively large number of participants were involved in eliciting a range of views. Similarly, some teachers may have been reluctant to share negative opinions of the program with CSIRO employees. To address this potential issue, the researchers emphasised that the findings would be entirely de-identified, all data would be kept strictly confidential, and that the focus of the evaluation was on identifying strengths and contributing to continuous improvement. The researchers did not observe any significant reticence to be forthcoming among the educators involved.

[12] Superseded by the AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research in October 2020.

[13] This approach of providing only year level data was standard practice for this jurisdiction and not specific to the I^2S^2 data request.

The potential for some Aboriginal and/or Torres Strait Islander peoples to acquiesce to non-Indigenous researcher's questions was also considered (Shahid, Durey, Bessarab, Aoun, & Thompson, 2013). Although this remained a possibility, the interviews took place in physical environments where participants likely felt comfortable and familiar (such as library rooms and classrooms) and the questions were not contentious or overly personal. Finally, there were time limitations with the school-based interviews and focus groups because they were conducted during school time under a relatively strict time frame. Participants may have felt rushed or unable to fully express their thoughts. There were few instances where the interviewees felt they needed more time to express their perceptions of the program; the option of contacting the researchers via email was provided to these participants.

All teachers involved in the program[14] are asked to complete a pre- and post-assessment of student engagement and achievement in science (in jurisdictions that have approved this monitoring methodology and principals have provided their consent). Although teachers were provided with a detailed rubric for each inquiry, there was a potential for different interpretations that may have led to systematic biases in the assessments. However, the sample size was relatively large (e.g., n = 4,268 students in 2018) and consisted of a range of school types in three jurisdictions. In addition, teachers were encouraged to reference administrative, school-based data when making their assessments. There was also the potential that teachers would be biased towards showing improvement among students; however, there were a significant number of assessments that showed decreases in engagement and achievement levels. Finally, pre- and post-inquiry assessments were likely made when different science units were being taught (for example, biological science in term 1 and chemical science in term 2). This could mean that students may have variable academic performance due to the content being taught rather than due to I^2S^2; however, I^2S^2 is primarily focused on improving inquiry skills and engagement levels that are predicted to occur across any science content area.

As briefly mentioned previously, one jurisdiction provided sufficiently detailed data on achievement, engagement, and STEM course selection that could be included in this report. The main potential drawback with these data was the analysis level (year level rather than class or student level) might have been too general to indicate any changes due to the I^2S^2 program. This is because the program may have only operated in a subset of classes in any year level of a school and different numbers of inquiries may have been delivered in different classes. Data were not available at any lower level of analysis, and therefore caveats have been applied to the interpretation of the analyses.

Finally, this case study evaluation was undertaken only a few years' into the implementation of I^2S^2. I^2S^2's ambitious goals of shifting the culture of schools, helping build community connections, enhancing teacher confidence and capability, and improving student results requires long-term, sustained efforts that were only beginning to be seen at this point in the program's evolution.

[14]Teachers from one jurisdiction did not take part in this element of monitoring the program because of the decision by CSIRO not to pursue research approval in that jurisdiction. The decision was made because the specific requirements of that jurisdiction were deemed to be too onerous given the time and resource constraints of the evaluation and program teams.

Findings

Findings are grouped under each of the program's eight intended outcomes (two outcomes have been combined because of their similarity). The findings presented below reflect the responses of participants and available data as at September 2019. A brief outline of relevant definitions and the specific indicators used to assess the intended outcomes of I^2S^2 are provided at the beginning of each section. The evaluation rubric used to assess the achievement and/or progress towards each outcome comprised three categories[15]:

1. Transformative – The outcome was fully achieved, and there was evidence of substantial, widespread positive shifts.
2. Effective – The outcome was substantially achieved, and there was ample evidence of positive shifts but sometimes not in every school or situation.
3. Emerging – The outcome was showing early signs of achievement, and there was evidence of positive shifts beginning to be developed.

For some outcomes, there was evidence of achievement but not that the I^2S^2 program directly influenced that outcome. The level of evidence used to make the assessments is also for each outcome provided based on the following scale:

1. High – multiple sources and/or clear evidence
2. Medium – one or more sources and/or relatively clear evidence
3. Low – single source and/or unclear evidence

[15] Although some evaluation rubrics contain five or more categories or levels, it was decided that these scales can sometimes misrepresent the level of accuracy possible in an outcome evaluation. The three levels selected for this evaluation were deemed a more realistic categorisation for the achievement of outcomes, and reflect the innovative nature of the Indigenous STEM Education Project. In addition, the 'emerging' level has been employed to align with the strengths-based approach of the evaluation.

Increased student engagement and academic results (Outcome 1)

Key message

The program led to increases in engagement and academic achievement among many students, particularly low achieving students. The hands-on, inquiry-based activities incorporating Aboriginal and Torres Strait Islander knowledges were engaging for the majority of students.

Definitions

Student engagement is defined as the student's active participation in school activities and the student's genuine interest and aptitude for learning (Dunstan, Hewitt, & Tomaszewski, 2017). Academic results in science are defined as the demonstration of knowledge in science and the attainment of learning objectives as represented in academic performance (York, Gibson, & Rankin, 2015).

Indicators and measures

The indicators and measures used to assess Outcome 1 were:

AREA	INDICATORS	MEASURES
Student engagement	Increase in student participation in classroom activities and level of concentration and time spent on classroom activities	• Teacher assessment of individual student engagement pre- and post-inquiry (before and after the student) • Student self-reports on levels of own engagement • Administrative data from one jurisdiction on student effort from 2014 to 2018
Student academic results	Increase in student science grades after participating in I^2S^2 inquiries	• Teacher assessment of individual student science grades pre- and post-inquiry • Student self-reported increases in academic success • Administrative data from one jurisdiction on student academic achievement from 2014 to 2018

Findings

Qualitative measures of student academic achievement and engagement

The majority of educators, students, and parents/carers indicated that I²S² increased student engagement and academic results. A summary of the key findings is presented in Table 2, including the frequency among the evaluation participant groups.

Table 2. Outcome 1: Key qualitative findings

FINDING	FREQUENCY
Educators	UN O C VC
I²S² inquiries were different to typical science units	
Hands-on and outdoor activities were engaging	
The inquiries were engaging for students who were normally disengaged	
Academic achievement was not as dependent on literacy and writing skills	
Embedding Aboriginal and Torres Strait Islander knowledges was highly engaging for Aboriginal and/or Torres Strait Islander students	
Embedding Indigenous knowledges was engaging for non-Indigenous students	
Potentially not engaging enough for higher-performing students	
Appeal of inquiry-based learning, independent observation, and problem solving	
Some observed improvement in terms of achievement, although often short-lived	
Increase in engagement, if not achievement	
Allowed for a high level of participation	
Improved engagement observed in other subject areas	
Engaged due to involvement of community members	
Students pursuing further opportunities in science	
Engagement not always apparent	
Potentially some impact on school attendance	
Inquiry-based learning a challenge for some students	
Students	UN O C VC
Engaging because of hands-on (outdoors), activity-based delivery and real-world applications	
High recall of inquiry methods and findings	
High recall of Aboriginal and Torres Strait Islander practices and scientific knowledges	
Recall of theoretical/instructional content and outputs/assessments	
Recall and understanding of scientific concepts taught	
Enjoy working in groups, independently, having control over experiment, and trusted by teacher	
Discussing inquiry with parents/carers as an indicator of engagement	
Inquiries were fun, interesting, and different	
General engagement by Aboriginal and Torres Strait Islander cultural content	
Inquiry encouraged problem solving	
Evidence of applying learning	
Opportunities identified for improving/enriching inquiries (move to challenges)	
Multi-dimensional nature of the program	
Parents/Carers	UN O C VC
Not sure of what their children did or how they responded	
Some examples of student engagement reported by parents/carers	
Students respond well to practical, activity-based learning	
Content taught in an engaging way, teachers did a good job	
Improved student achievement	
Parents/carers think their children enjoy science	
Some ideas for additional inquiries (move to what works)	

Note: Frequency was categorised into 'VC = very common', 'C = common', 'O = occasional', and 'UN = uncommon' and is denoted by different proportions of coloured cells.

Hands-on, inquiry-based learning led to increased engagement and understanding

For many students, the opportunity to have a practical, inquiry-driven component in their science unit was highly engaging and preferable to other curriculum content that was textbook based. In particular, the most engaging aspect of I^2S^2 was the opportunity to be more hands-on with science. Students felt that the hands-on activities allowed them to better understand and explore concepts, for example *"I found it easy to learn when we were doing hands-on because you could go in-depth with it and actually learn what you're doing better"*. Another student explained that the hands-on aspect of the units provided them with the opportunity to recognise their mistakes and adapt their approach to the inquiry, such as trying different burning techniques with the 'Burn and Grow' inquiry. Some students explained that science units can often be overwhelming and content heavy, which makes it difficult to retain information. One student explained that the I^2S^2 inquiries allowed them to learn at their own pace, with one student stating: *"I like hands-on things, not like listening because it's hard to like to get everything in at once"*. These sentiments were echoed by many teachers, with one teacher explaining that the inquiry process allowed them to teach students step by step throughout the unit. One teacher explained: *"[we] were definitely able to explain a lot more...if I go through what the scientific method is, they won't understand each component. But if I question them for each part, they'll be able to answer it"*. While another teacher explained that the hands-on component allowed students to *"make that connection and the relevance of what's being taught"*.

Being outside the classroom and having fun were also appealing elements of the inquiries. The activities were qualitatively different from regular science units. Disengaged students in particular seemed to benefit from these aspects, as one teacher said: *"the disengaged [student]...he got involved in the hands-on stuff, and he didn't at all in the [previous science] unit we just did"*.

Students explained that it was beneficial to apply their learning in real time during the practical, hands-on components of the units. Students felt that having the agency to control their learning improved their understanding of the content and their retention of the scientific principles. One Year 8 student explained: *"...I guess it's just more interesting when you can do it yourself, you sort of learn more when you're interested in what you're doing"*. While another student explained: *"...[I] have to do [it] to learn it, not be told...it doesn't stick in my head. But doing [the hands-on activities], it starts more in my head and [makes it] easier for the exams. That's what I enjoy most about it"*. Teachers felt that the units allowed the students to be involved in their own learning as opposed to being taught passively: *"...for [students], it didn't feel like they were being quizzed or feeling that they were forced through a science lesson...They knew that by pushing themselves and asking those questions* [they would learn]".

Another teacher added: *"... the inquiries are different enough that they're interested, they want to see how it goes and what happens...I really like that they're given a choice but not so much of a choice that it's going to be completely wrong"*. When parents/carers were asked about whether their child had mentioned the I^2S^2 inquiries to them, the most frequent responses was that children had spoken about the hands-on component of the inquiry, indicating high levels of engagement. One parent/carer who had been involved in the hands-on part of an inquiry with their child explained that: *"I think when I did it with the kids, they all really enjoyed it. I don't think there was a time when they didn't really enjoy it. Yes, I like the hands-on side of things"*.

Teachers felt that the practical component of the units created an opportunity to engage students who may ordinarily miss out or not be engaged in the classroom. Teachers explained that more practical and tactile learning could potentially: *"bridge a gap of engagement that wasn't there for some of the students"* and assist those students who may prefer speech or practical methods of learning and assessment. One teacher commented that the inquiries might be viewed by some students as *"slightly naughty* [lighting fires]" and the students "*get to do it and they're...learning from it"*. Similarly, Coordinators explained that they observed an apparent increase in engagement in some students during the practical components of units, particularly those students who did not engage with science previously or those who may have had behavioural issues in class.

Many students who were interviewed were extremely motivated to engage with the program and the inquiries as it allowed them to be in a new or different learning environment. One student explained that they preferred being outside as they were *"Not a big fan of being in class"*. While another student explained that they felt it was easier to complete the practical component of the unit outside stating, *"I like going outside. We do lots of pracs inside too, like in our workbenches, but it's much better going outside"*.

One teacher explained that science classes are often theory heavy and students do not often get the opportunity to get out of the classroom, experiment, and be hands-on. One teacher noted that classes are mostly: *"...theory based. Whereas that unit [I2S2], they were really excited because they were...outside a little bit. They were experimenting, throwing things around, doing all that sort of stuff which they don't usually get to do in their science class"*. One parent/carer echoed these comments explaining that students are: *"stuck in the classrooms too much"*. Coordinators, who regularly delivered units to classes to model the delivery of I^2S^2 units to teachers, explained that they often observed an improvement in student behaviour during I^2S^2 units, which is an indicator of increased engagement.

Aboriginal and Torres Strait Islander knowledge systems were engaging

In addition to hands-on learning increasing engagement and understanding, the interviews and focus group participants indicated that many students who were involved in the case study were highly engaged with the Aboriginal and Torres Strait Islander knowledges presented as context in I²S² units. Coordinators also felt that including Aboriginal and Torres Strait Islander knowledges as context in the curriculum was a meaningful way to create long-awaited change. One Coordinator explained that presenting these knowledge systems through a science lens is new and engaging for students. One Coordinator explained: *"a lot of kids crave to learn about other cultures and learn about differences and when you're engaged with it through a science lens, that's something a lot of people haven't done before".* Students echoed these sentiments and felt that the content was particularly engaging because it was something different. When asked if they enjoyed learning about these knowledge systems students mostly responded by describing the experience as "*pretty cool*" or "*interesting*". Students noted that Aboriginal and Torres Strait Islander knowledges are not explicitly taught as part of the curriculum, apart from "*... in history, but that's rarely*" or during annual school events such as "NAIDOC week". Many students wanted more community members or Elders to be involved in the I²S² units. Students felt that they would be able to ask more questions and felt that Elders: *"know it more than anyone*".

Students felt that the content was interesting because they could compare much of the Aboriginal and Torres Strait Islander knowledges to everyday activities they undertake. Several students echoed these sentiments stating: "*It was good to be able to do something that we can use in our daily lives. If we want to start a fire and we don't have anything, to be able to learn that"* and *"I was very interested to learn how they were able to grow more seeds and how they started fires without the technology we have today"* and *"It was just interesting because, like, how they relied on stuff without technology, like we do today. So, yeah, I found that interesting"*. Teachers felt that the units promoted a sense of wanting to share and be involved in the unit. One teacher described that students often contributed to the conversation:

It was nice to see them wanting to contribute every single science lesson because they'd be like 'You know, my grandma or aunty does this.' That was really cool. So, then I think the other kids hearing that, 'Hang on, Johnny over here does this on their weekends?' That it kind of linked to real life and it wasn't just this abstract thing that people don't use.

For many parents/carers, their children reported that the Indigenous science knowledges component of the program was engaging. Some parents/carers explained that their children had already engaged with Indigenous science and culture with family, and for their children the most engaging component of the program was the science content itself. One parent/carer commented that:

...given that my children have gone through the local primary school down here as well, they've actually done a fair bit of local cultural heritage throughout all her schooling...So it probably wouldn't have been anything in her mind forefront that – if she had have learnt something different to what she had previously known she would've probably expressed it, but I think she talked more about the plant and the different plants they seed with the fire and all the rest of it. So that's what she took away from it I'd say, the science element of it.

Multi-modal assessment and demonstrated understanding of science concepts (recall)

Coordinators acknowledged that I²S² units make up a relatively small proportion of the overall curriculum, and up to half of the science curriculum (two terms of lessons per year for Years 5 to 9), and would therefore have a corresponding impact on student achievement results. One Coordinator explained that the program's attribution to grades is an unreliable measure of success as students may gradually improve their grades over time and *"kids who were sitting at quite a high level don't improve that much".* Although Coordinators felt that grades as a measure of program success might not be reliable, a few Coordinators explained that the program provided students with more opportunities to achieve. Specifically, teachers felt that the nature of the inquiry and the units themselves provided alternative measures to assess their students. One Coordinator explained that the program offered teachers an opportunity to assess students more flexibly; some examples provided by the Coordinator include oral presentations, photography, and videos. For one Coordinator, the program provided teachers with *"as much scope as possible to assess the kids' knowledge and learning"*. In particular, Coordinators felt that the program's ability to reach and accommodate each student was highly valuable. One Coordinator noted that:

If you're only teaching one way and assessing one way, it's only going to be suitable for a particular subset of students but if you get diversity in delivery methods, you're allowing more opportunity for all students to demonstrate their science understandings and skills, so it's about giving everyone a go but I wouldn't say that Aboriginal kids or Torres Strait Island kids or non-Indigenous kids engage lesser or higher. All kids engage in [the I2S2] learning activity.

The program allowed teachers the flexibility to deliver the units and assessments to suit the needs of their students. One teacher explained that the ability to personalise assessment was useful for some students, especially those who may not have a high level of literacy skills stating:

Yeah because there are some kids, I know one boy in my class, he's actually really good with science and it gives him a chance to get a C and there's no way he's getting a C in anything else because he just, you know his literacy level's so low.

Teachers felt that the program allowed students to understand the content effectively before approaching the assessment. One teacher explained how the scaffolded approach to learning ensured students understood the language and concepts necessary to achieve:

That's another thing with this program, with those assessment tasks, because you do the scaffolded first and then you do the assessment, they've already done it so they kind of already understand what's expected and the questions are the exact same for each inquiry. So, I mean I've got a group of kids who've done, like I said, three now. So the literacy level, I guess that helps because they're like 'Oh yeah, we've seen it before.' And they're getting used to how they should respond and what they need to put in. But yeah, I'll just write for them or speak it to them.

Several Coordinators that many students initially struggled with the science content as they did not have a strong understanding of basic inquiry skills prior to the I²S² units. Coordinators explained that Science Inquiry Skills are often overlooked or rushed through in the science curriculum. One Coordinator described that:

Science inquiry skills…are not really a major focus, and I think that is a loss for the students, because they are the skills that you could transfer between different units of science work and different content areas of science, and they can continue to build on those throughout their schooling years.

Most students echoed the comments made by the Coordinators, explaining that initially they found it difficult to understand the inquiry process and science concepts as it was something they had not or rarely encountered. Students felt that they needed more assistance to understand the inquiry process but, more importantly, the aim of the inquiry activity. These comments are unsurprising as most teachers felt that students struggled to move from a linear learning model to inquiry-based learning. When students were asked about their initial experience of the program, students responded by describing the experience as initially "*confusing*", "*difficult*" and even "*strange*" but almost always followed with comments such as "*but then after I was like – oh* [understanding]". Students felt that revision, research, and practice meant that they felt confident to pursue the inquiry and test their group's hypothesis. One student explained:

We had no idea what we were doing to begin with but the more we researched it and the more we actually did it over and over again, we actually understood and figured out what we were doing and understood what was happening.

Most students felt that the inquiries and content were at a level appropriate for their grade level and abilities. When asked about the difficulty of the inquiries, some students felt it was "*easy*" but most students described the activities as "*hard, but fun*" and "*challenging*". The majority of students could readily recall and explain the inquiry (or inquiries) they had participated in. When asked during the focus groups, several students recalled both the required steps to complete the inquiry and the scientific principles taught. Many teachers could recall instances where their students had spoken about what they had learnt during I²S² units. One teacher mentioned: "*One of the students was like, that's a salt tolerant plant because I purely said this survives in the saltwater, and [the student is] like, oh, it must be salt tolerant. They remembered it*". While another teacher explained that giving students the freedom to have that responsibility to learn allowed them to develop those critical thinking skills that are important for retention and development:

…with taking a lot of those restrictions off, a lot of them have a chance to flourish and take…their own thoughts and ways of developing on and by the end of that term… they'll remember what was fun about it, the result and they've got the pictures and they've got everything that they've done to prove that they'd done it.

Quantitative measures of student academic achievement and engagement

Table 3 presents the academic achievement data as assessed by teachers for students involved in I²S² in 2018 and 2019 for which jurisdictional approval was obtained (three jurisdictions, which represented the majority of students involved in I²S²). The assessments were made by teachers on students' understanding of science as described in a rubric (including science strands and sub-strands). Paired t-tests (P value) and Cohen's d effect sizes (d) were calculated using the means, sample sizes, and standard deviations of students' pre- and post-inquiry grades. The P value is calculated from a statistical test (paired t-test) and is a measure of the probability that the observed difference could have occurred by random chance. Cohen's d is a measure of effect size, that is, how large the effect is and therefore indicates the practical, rather than statistical significance, of results. The table also includes the data for low achieving students, operationalised as receiving a grade 'D' or 'E' before participating in an I²S² inquiry. In 2018, more students received a passing grade ('A', 'B', or 'C') after taking part in the inquiries (82.5 per cent compared to 78.4 per cent), and a paired t-test showed a high statistically significant increase in mean grades (from 3.19 to 3.28), but the effect size was very small, indicating that the magnitude of the difference was negligible.

In 2019, the mean grades among all students decreased slightly after the inquiry (from 3.27 to 3.23), and although this difference was statistically significant (p = .013), the effect size indicates it was not meaningful. However, the results for all low achieving students indicated a greater impact. In 2018, 48.5 per cent of students who achieved a 'D' or 'E' increased their grades after an I^2S^2 inquiry, and the mean achievement increased from 1.78 to 2.34, which was statistically significant (p <.000) and a meaningfully large difference (Cohen's d = 0.85). The results in 2019 were similar but the changes were not as substantial, with the mean science grade increasing from 1.82 to 2.20 (p <.000 and d = 0.62). Therefore, I^2S^2 had a more considerable effect on low achieving students compared to all students. The combination of more engaging, hands-on activities presented in a culturally competent way, could be the cause of increased levels of achievement, and/or it could be, in part, due to a regression to the mean effect. The best way to control for regression to the mean is to design a randomised control trial; however, this was not feasible here. Therefore, the only option to estimate regression to the mean was to mathematically use the formula *Prm*=100(1–*r*), where *Prm* is the per cent regression to the mean and *r* is the correlation between the two measures (Trochim, 2020). For all students in 2018, the Pearson correlation coefficient was r = 0.715 and the per cent regression was estimated to be 28.5 per cent. Therefore, for the sample of all low achieving students, regression to the mean may account for around 28.5 per cent of the change in mean. However, even if 28.5 per cent of the change was a regression artefact, the I^2S^2 intervention would still account for a sizeable amount of the mean increase in academic achievement. Figure 2 graphically presents these achievement data.

Table 3. Student academic achievement before and after I^2S^2 inquiry (2018 and 2019)

		ALL STUDENTS	ALL LOW ACHIEVING STUDENTS
2018		**n = 4,268**	**n = 926**
Per cent change in academic achievement	Up	23.1	48.5
	Same	61.3	47.1
	Down	15.6	4.3
Per cent with passing grade	Before	78.4	0.0
	After	82.5	41.8
Paired t-test	Before inquiry	Mean = 3.19	Mean = 1.78
		Standard deviation = 1.00	Standard deviation = 0.41
	After inquiry	Mean = 3.28	Mean = 2.34
		Standard deviation = 0.97	Standard deviation = 0.84
	t-test results	r = 0.715	r = 0.370
		t (4,267) = -8.08	t (925) = -21.81
		p < .000	p < .000
Effect size	Cohen's d	0.09 (none)	0.85 (large)
2019		**n = 2,232**	**n = 467**
Per cent change in academic achievement	Up	20.2	39.7
	Same	57.0	51.2
	Down	22.8	9.1
Per cent with passing grade	Before	79.3	0.0
	After	78.0	34.0
Paired t-test	Before inquiry	Mean = 3.27	Mean = 1.82
		Standard deviation = 1.00	Standard deviation = 0.39
	After inquiry	Mean = 3.23	Mean = 2.20
		SD = 1.02	Standard deviation = 0.78
	t-test results	r = 0.693	r = 0.250
		t (2,231) = 2.49	t (466) = -10.68
		p = .013	p < .000
Effect size	Cohen's d	0.04 (none)	0.62 (medium)

Note: SD = standard deviation. The total number of students is higher than the two subcategories of Aboriginal and/or Torres Strait Islander and non-Indigenous (in Tables 3 to 8) because some students did not identify as either. Grades were converted to numeric scores to enable a t-test (paired two sample for means): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

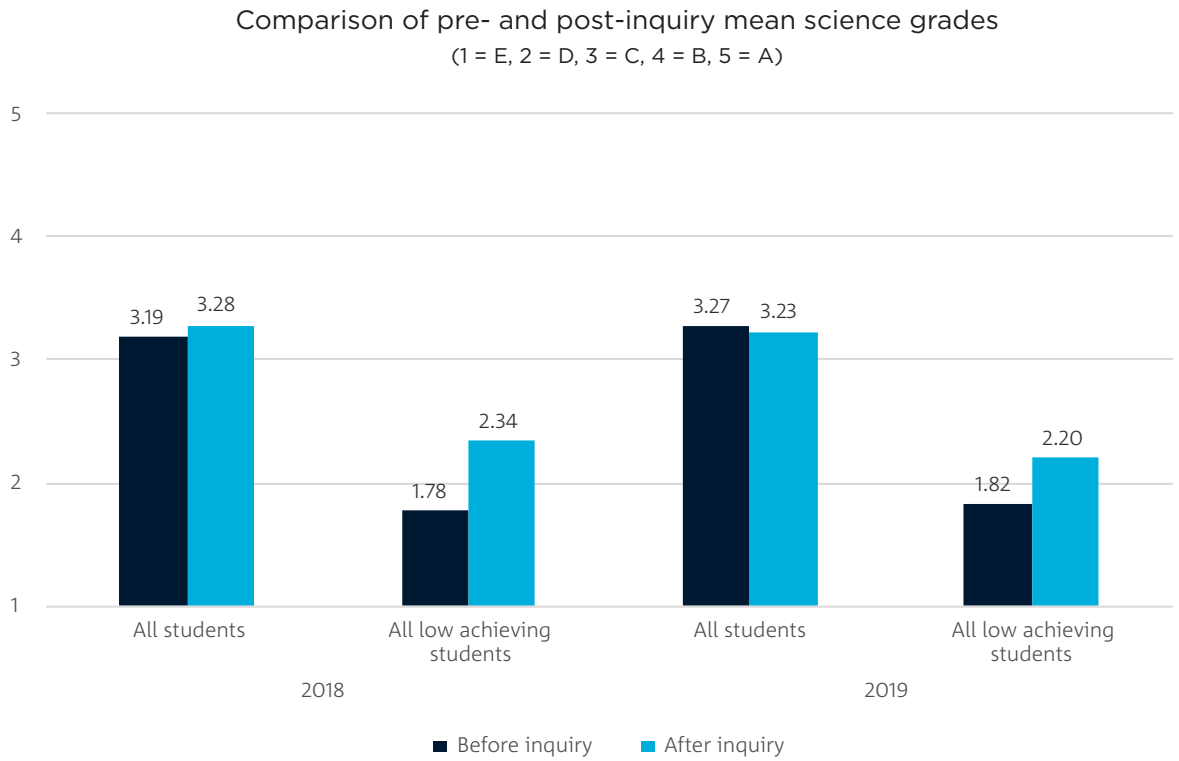


Figure 2. Changes in academic achievement for all students (2018 and 2019)

For Aboriginal and/or Torres Strait Islander students, the results were similar to the sample of all students. Around a quarter of students were assessed at a higher grade after the inquiry, and the overall mean increased from 2.74 to 2.85 ($p < .000$); however, the effect size was relatively small ($d = 0.12$) (Table 4). In 2019, the mean academic achievement did not change after the inquiry for all Aboriginal and/or Torres Strait Islander students.

Low achieving Aboriginal and/or Torres Strait Islander students showed substantial improvements, even after considering potential regression artefacts. In 2018, 46.3 per cent of students increased their grades, and the mean increased from 1.70 to 2.16 ($p < .000$) with a medium effect size ($d = 0.75$). The results in 2019 were similar, with the mean achievement increasing from 1.76 to 2.16 ($p < .000$), resulting in a medium effect size ($d = 0.63$). Figure 3 presents the pre- and post-achievement means.

Table 4. Aboriginal and/or Torres Strait Islander students' academic achievement before and after I²S² inquiry (2018 and 2019)

		ABORIGINAL AND/OR TORRES STRAIT ISLANDER STUDENTS	ABORIGINAL AND/OR TORRES STRAIT ISLANDER LOW ACHIEVING STUDENTS
2018		**n = 933**	**n = 348**
Per cent change in academic achievement	Up	25.2	46.3
	Same	58.2	47.4
	Down	16.3	6.3
Per cent with passing grade	Before	62.7	0.0
	After	69.2	37.4
Paired t-test	Before inquiry	Mean = 2.74	Mean = 1.70
		Standard deviation = 0.96	Standard deviation = 0.46
	After inquiry	Mean = 2.85	Mean = 2.16
		Standard deviation = 0.93	Standard deviation = 0.85
	t-test results	r = 0.633	r = 0.363
		t (932) = -4.19	t (189) = -7.69
		p < .000	p < .000
Effect size	Cohen's d	0.12 (small)	0.76 (medium)
2019		**n = 541**	**n = 186**
Per cent change in academic achievement	Up	23.1	40.3
	Same	55.8	52.7
	Down	21.2	7.0
Per cent with passing grade	Before	64.9	0.0
	After	66.0	32.6
Paired t-test	Before inquiry	Mean = 2.83	Mean = 1.76
		Standard deviation = 0.96	Standard deviation = 0.43
	After inquiry	Mean = 2.83	Mean = 2.16
		Standard deviation = 0.96	Standard deviation = 0.80
	t-test results	r = 0.637	r = 0.437
		t (540) = -0.05	t (189) = -7.69
		p = 0.958	p < .000
Effect size	Cohen's d	0.00 (none)	0.63 (medium)

Note: 'Low achieving' was operationalised as receiving a 'D' or 'E' grade before the I²S² inquiry. SD = standard deviation. The total number of students is higher than the two subcategories of Aboriginal and/or Torres Strait Islander and non-Indigenous because some students did not identify as either. Grades were converted to numeric scores to enable a t-test (paired two sample for means): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

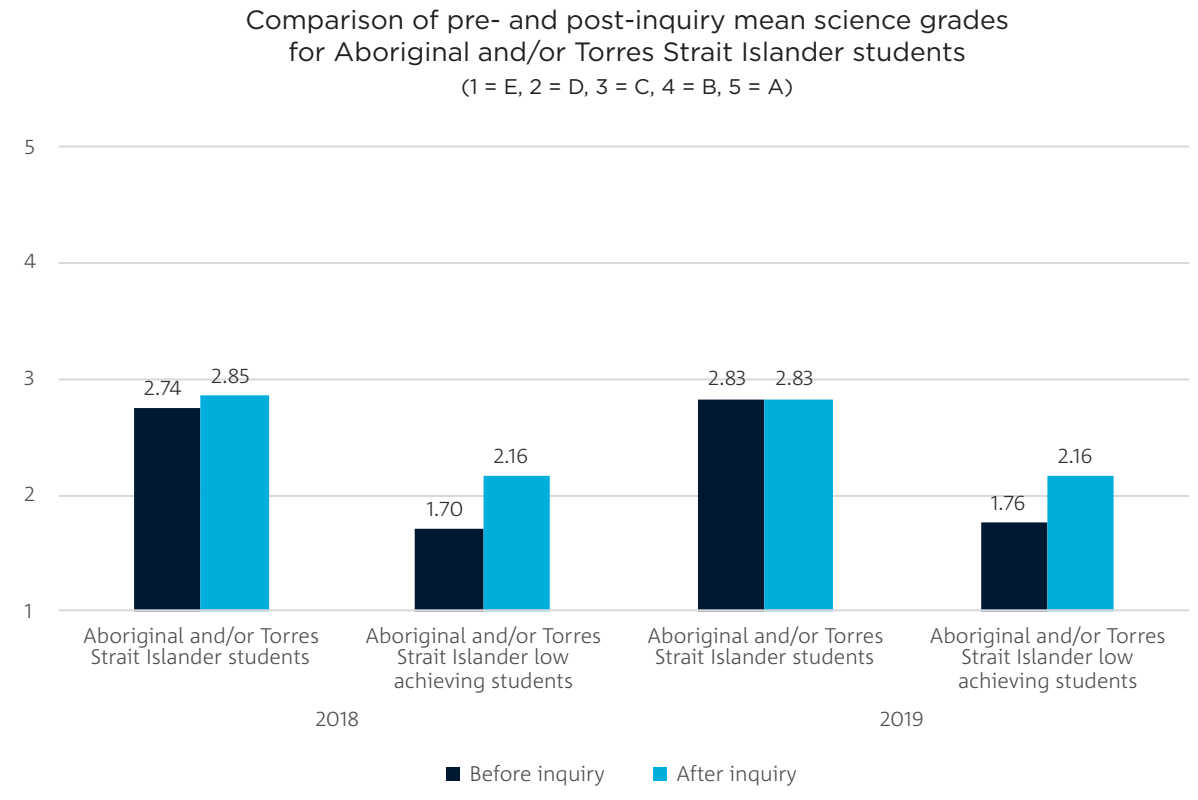


Figure 3. Changes in academic achievement for Aboriginal and/or Torres Strait Islander students (2018 and 2019)

Based on the achievement data provided by teachers, non-Indigenous students overall had modest improvements in academic achievement in 2018 and a slight decrease in 2019 (Table 5). However, low achieving non-Indigenous students showed considerable mean increases after taking part in the inquiries. In 2018, 46.9 per cent of low achieving students received a passing grade after the inquiry units. The mean achievement score increased from 1.82 to 2.44 ($p < .000$) with a large effect size ($d = 0.96$). The results in 2019 were not as large, but the increase from 1.86 to 2.22 was statistically significant ($p < .000$) and meaningful (effect size $d = 0.63$). Figure 4 shows the changes in mean academic achievement for non-Indigenous students.

Table 5. Non-Indigenous student academic achievement before and after I²S² inquiry (2018 and 2019)

		NON-INDIGENOUS STUDENTS	NON-INDIGENOUS LOW ACHIEVING STUDENTS
2018		**n = 3,244**	**n = 539**
Per cent change in academic achievement	Up	22.8	52.8
	Same	61.3	43.8
	Down	15.9	3.4
Per cent with passing grade	Before	83.4	0.0
	After	86.8	46.9
Paired t-test	Before inquiry	Mean = 3.34	Mean = 1.82
		Standard deviation = 0.97	Standard deviation = 0.39
	After inquiry	Mean = 3.42	Mean = 2.44
		Standard deviation = 0.94	Standard deviation = 0.84
	t-test results	r = 0.707	r = 0.370
		t (3,243) = -6.62	t (538) = -18.52
		p < .000	p < .000
Effect size	Cohen's d	0.09 (none)	0.96 (large)
2019		**n = 1,684**	**n = 276**
Per cent change in academic achievement	Up	19.3	39.4
	Same	57.3	50.0
	Down	23.4	10.6
Per cent with passing grade	Before	83.6	0.0
	After	81.4	35.1
Paired t-test	Before inquiry	Mean = 3.39	Mean = 1.86
		Standard deviation = 0.97	Standard deviation = 0.35
	After inquiry	Mean = 3.34	Mean = 2.22
		Standard deviation = 1.00	Standard deviation = 0.76
	t-test results	r = 0.637	r = 0.081
		t (1,683) = 2.89	t (275) = -7.58
		p = .004	p < .000
Effect size	Cohen's d	0.06 (none)	0.63 (medium)

Note: 'Low achieving' was operationalised as receiving a 'D' or 'E' grade before the I²S² inquiry. Grades were converted to numeric scores to enable a t-test (paired two sample for means): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

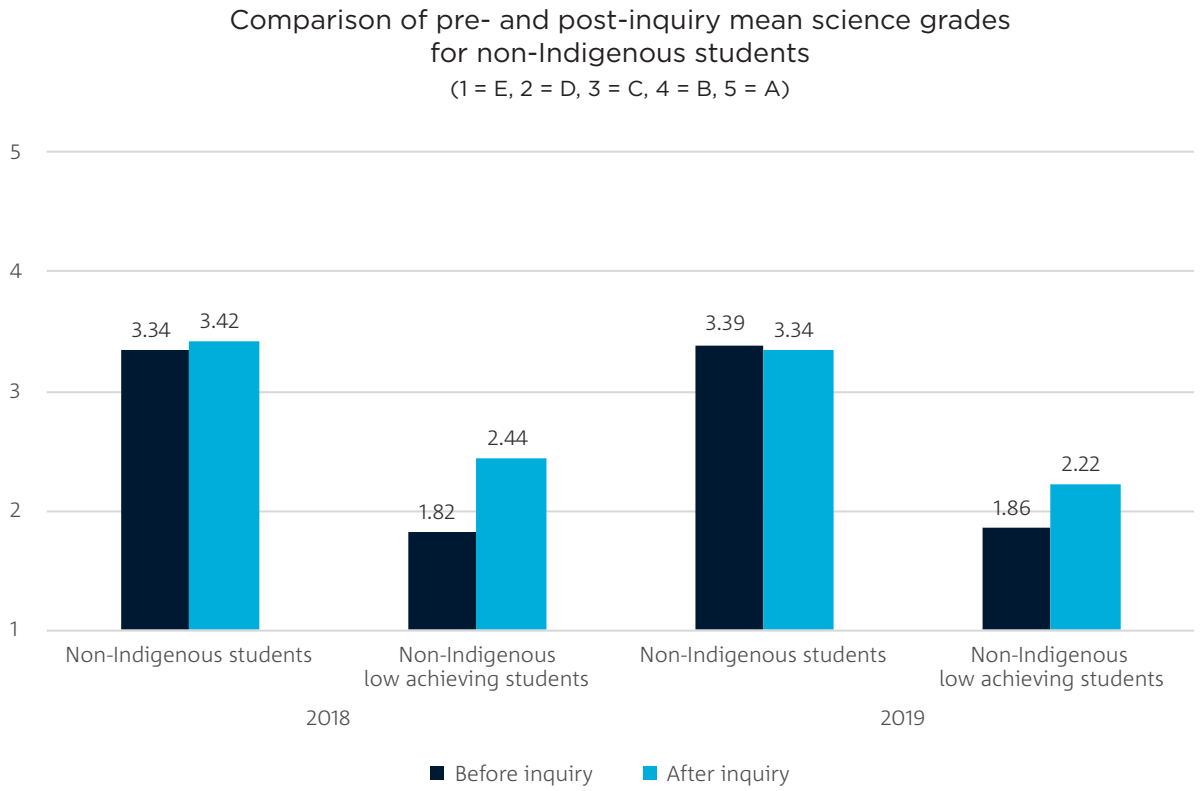


Figure 4. Changes in academic achievement for non-Indigenous students (2018 and 2019)

Table 6 presents the results for all students in terms of engagement before and after students took part in the I²S² inquiry units. Mean engagement levels for all students show modest increases in 2018 and 2019, which although statistically significant (the results were likely not due to chance), had no meaningful effect (d = 0.08 and 0.05, respectively).

However, engagement among low achieving students increased more markedly. In 2018, the mean engagement level increased from 2.60 to 2.95 (p <.000), although the effect size was small (d = 0.35). Mean engagement levels in 2019 increased from 2.27 to 2.65 (p < .000) and the effect size was relatively small (d = 0.43), however, it was larger than in 2019 and approaching the medium level. Figure 5 shows the results in chart form.

Table 6. All students' engagement before and after I²S² inquiry (2018 and 2019)

		ALL STUDENTS	ALL LOW ACHIEVING STUDENTS
2018		n = 4,263	n = 906
Per cent change in engagement	Up	24.7	39.0
	Same	57.7	49.5
	Down	17.5	11.5
Paired t-test	Before inquiry	Mean = 3.60	Mean = 2.60
		Standard deviation = 1.06	Standard deviation = 0.98
	After inquiry	Mean = 3.68	Mean = 2.95
		Standard deviation = 1.02	Standard deviation = 1.00
	t-test results	R = 0.706	r = 0.612
		t (4,262) = -6.47	t (905) = -11.99
		p < .000	p = < .000
Effect size	Cohen's d	0.08 (none)	0.35 (small)
2019		n = 2,062	n = 415
Per cent change in engagement	Up	23.5	35.7
	Same	55.5	51.6
	Down	21.0	12.7
Paired t-test	Before inquiry	Mean = 3.52	Mean = 2.27
		Standard deviation = 1.08	Standard deviation = 0.84
	After inquiry	Mean = 3.57	Mean = 2.65
		Standard deviation = 1.06	Standard deviation = 0.96
	t-test results	r = 0.666	r = 0.432
		t (2,061) = -2.51	t (414) = -8.20
		p = .012	p < .000
Effect size	Cohen's d	0.05 (none)	0.43 (small)

Note: Engagement was assessed by teachers on a five-point scale (the higher the level, the higher the level of engagement): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

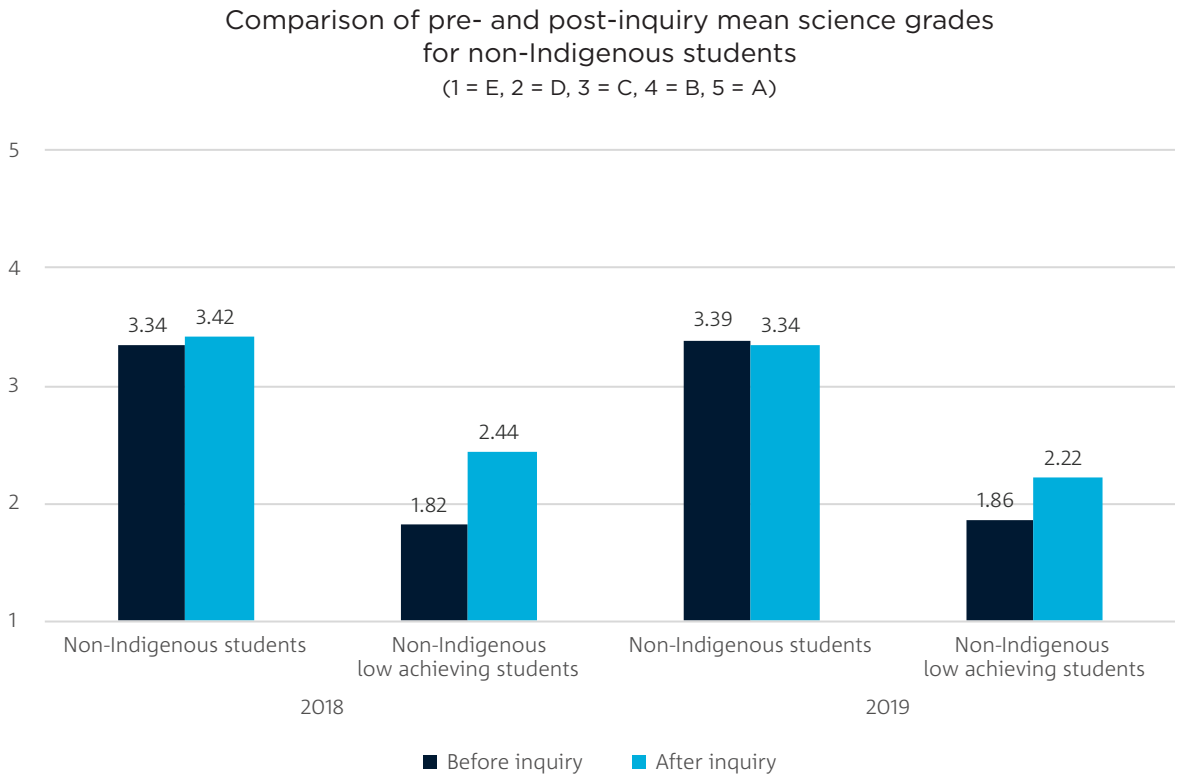


Figure 5. Changes in engagement for all students (2018 and 2019)

Similarly, for Aboriginal and/or Torres Strait Islander students, mean engagement levels increased overall, but more considerably for low achieving students (Table 7). In 2018, for all Aboriginal and/or Torres Strait Islander students, mean engagement increased from 3.13 to 3.25 ($p < .000$) but the increase was not meaningful ($d = 0.11$). In 2019, mean engagement levels rose from 3.11 to 3.17, but the change was neither statistically nor meaningfully significant.

For low achieving Aboriginal and/or Torres Strait Islander students, engagement levels increased moderately in 2018 (from 2.45 to 2.81, $p < .000$, $d = 0.36$) and 2019 (from 2.22 to 2.63, $p < .000$, $d = 0.47$). In both years, the increases had effect sizes in the small to medium range. Figure 6 presents the mean levels of engagement pre- and post-inquiry.

Table 7. Aboriginal and/or Torres Strait Islander student engagement before and after I²S² inquiry (2018 and 2019)

		ABORIGINAL AND/OR TORRES STRAIT ISLANDER STUDENTS	ALL ABORIGINAL AND/OR TORRES STRAIT ISLANDER LOW ACHIEVING STUDENTS
2018		n = 968	n = 352
Per cent change in engagement	Up	30.1	41.5
	Same	50.9	46.6
	Down	19.0	11.9
Paired t-test	Before inquiry	Mean = 3.13	Mean = 2.45
		Standard deviation = 1.08	Standard deviation = 0.94
	After inquiry	Mean = 3.25	Mean = 2.81
		Standard deviation = 1.08	Standard deviation = 1.01
	t-test results	r = 0.650	r = 0.583
		t (967) = -4.03	t (351) = -7.45
		p < .000	p = < .000
Effect size	Cohen's d	0.11 (none)	0.36 (none)
2019		n = 486	n = 167
Per cent change in engagement	Up	25.5	40.5
	Same	50.6	43.6
	Down	23.8	16.0
Paired t-test	Before inquiry	Mean = 3.11	Mean = 2.22
		Standard deviation = 1.11	Standard deviation = 0.85
	After inquiry	Mean = 3.17	Mean = 2.63
		Standard deviation = 1.05	Standard deviation = 0.94
	t-test results	r = 0.594	r = 0.385
		t (485) = -1.31	t (166) = 5.44
		p = 0.192	p < .000
Effect size	Cohen's d	0.05 (none)	0.47 (small)

Note: Engagement was assessed by teachers on a five-point scale (the higher the level, the higher the level of engagement): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

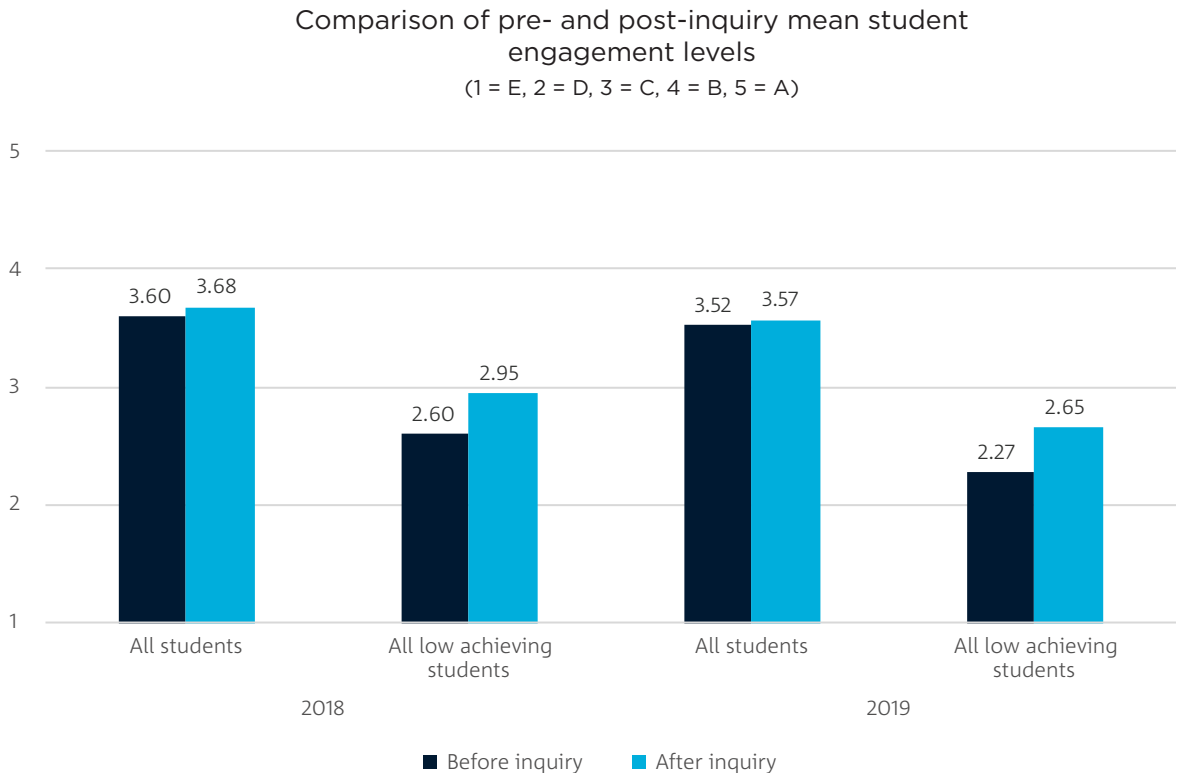


Figure 6. Changes in engagement for Aboriginal and/or Torres Strait Islander students (2018 and 2019)

For all non-Indigenous students, engagement levels increased minimally comparing pre- and post-inquiry levels. In 2018 and 2019, the increases were statistically significant (from 3.74 to 381, and from 3.63 to 3.68, respectively), but the effect size was small to non-existent (d = 0.07 and 0.05, respectively) (Table 8).

The engagement of low achieving non-Indigenous students improved more considerably, from 2.66 to 3.02 in 2018 ($p < .000$ and $d = 0.37$) and from 2.29 to 2.66 in 2019 ($p < .000$ and $d = 0.41$). Figure 7 presents the mean engagement levels.

Table 8. Non-Indigenous student engagement before and after I²S² inquiry (2018 and 2019)

		ALL NON-INDIGENOUS STUDENTS	ALL NON-INDIGENOUS LOW ACHIEVING STUDENTS
2018		**n = 3,195**	**n = 515**
Per cent change in engagement	Up	23.3	38.9
	Same	59.2	49.2
	Down	17.5	11.9
Paired t-test	Before inquiry	Mean = 3.74	Mean = 2.66
		Standard deviation = 1.00	Standard deviation = 0.96
	After inquiry	Mean = 3.81	Mean = 3.02
		Standard deviation = 0.97	Standard deviation = 0.96
	t-test results	r = 0.694	r = 0.596
		t (3,194) = -4.75	t (514) = -9.19
		p < .000	p = < .000
Effect size	Cohen's d	0.07 (none)	0.37 (small)
2019		**n = 1548**	**n = 247**
Per cent change in engagement	Up	23.1	32.7
	Same	57.0	57.1
	Down	19.9	10.2
Paired t-test	Before inquiry	Mean = 3.63	Mean = 2.29
		Standard deviation = 1.04	Standard deviation = 0.83
	After inquiry	Mean = 3.68	Mean = 2.66
		Standard deviation = 1.04	Standard deviation = 0.97
	t-test results	r = 0.669	r = 0.464
		t (1,547) = -2.40	t (246) = -6.22
		p = .016	p < .000
Effect size	Cohen's d	0.05 (none)	0.41 (small)

Note: Engagement was assessed by teachers on a five-point scale (the higher the level, the higher the level of engagement): A = 5, B = 4, C = 3, D = 2, and E = 1. All p values are two tailed. The magnitude of Cohen's d effect size is generally categorised as 0.2 is small, 0.5 is medium, and 0.8 is large. r = Pearson correlation coefficient.

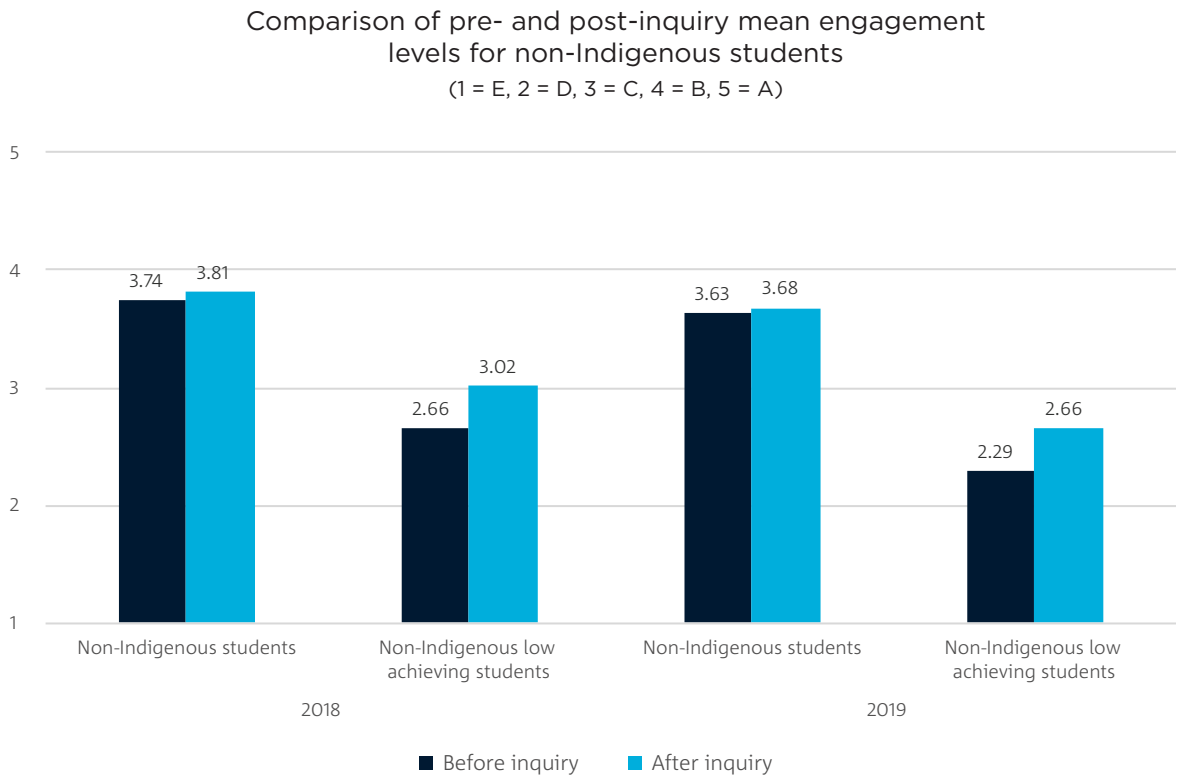


Figure 7. Changes in engagement for non-Indigenous students (2018 and 2019)

Student science grades data from two jurisdictions were obtained. A portion of these data has been analysed to understand whether the implementation of I²S² in schools impacted the achievement in science. The data analysed were from 2018. For one jurisdiction, 43 schools that had implemented I²S² were compared to all other schools in the same jurisdiction on different dimensions, including Index of Community Socio-Educational Advantage (ICSEA) scores, remoteness, and the proportion of Aboriginal and/or Torres Strait Islander students. Not every I²S² school implemented the program in every class in every relevant year level (Years 5 to 9); however, year-level data was the only type available for analysis. The complete analyses are presented in Appendix 6.

Aggregated student science grades in I²S² schools were not higher than comparison schools overall based on statistical comparisons of mean student grades. However, when comparisons were made with schools of similar ICSEA values and the percentage of Aboriginal and/ or Torres Strait Islanders students enrolled at schools, I²S² schools had higher mean science grades in some year levels. For example, for schools with ICSEA scores less than 901, I²S² schools had higher mean science grades for Year 7 students (3.30 compared to 3.07, $t(3,176) = 5.99$, $p < .000$, $d = 0.24$), Year 8 students (3.08 compared to 2.94, $t(3,052) = 3.11$, $p = .002$, $d = 0.13$), and Year 9 students (3.13 compared to 3.00, $t(3,028) = 2.78$, $p = 0.005$, $d = 0.12$). Year 5 students in I²S² schools also performed better than comparison schools with ICSEA scores of 921 to 940 (3.32 compared to 3.20, $t(4,099) = -2.16$, $p = 0.03$, $d = 0.14$).

Similarly, for schools with higher proportions of Aboriginal and/or Torres Strait Islander students, some year levels of I²S² schools did better than comparison schools. Specifically, Year 8 students in I²S² schools with between 17 and 33 per cent Aboriginal and/or Torres Strait Islander students had higher mean grades than comparison schools (3.38 compared to 3.30, t(4,136) = -2.27, p = 0.02, d = 0.08). Year 7 students at I²S² schools with over 33 per cent Aboriginal and/or Torres Strait Islander students had higher mean science grades than comparison schools (3.26 compared to 2.96, t(1842) = -5.96, p <.000, d = 0.30). I²S² schools in one year level/remoteness category had statistically significant higher mean science grades than comparison schools: Year 5 students in Inner Regional areas performed better (3.47 compared to 3.35, t(10,452) = -2.95, p = 0.003, d = 0.14).

Therefore, I²S² may be having a more pronounced impact in more disadvantaged areas and schools with higher proportions of Aboriginal and/or Torres Strait Islander students.

Another jurisdiction provided data on Year 8 science scores on a standardised test for three I²S² schools and several comparison schools with similar characteristics. Table 9 shows these data for Aboriginal students in 2018. As can be seen, Aboriginal students in I²S² schools fared slightly better than Aboriginal students in comparison schools (77.2 per cent compared to 76.5 per cent). No statistical tests were conducted because the data were provided in highly aggregated form. Similarly, when science scores were divided into sextiles (six groups), the proportion of students in the top two levels (8.1 per cent) was higher than a matched set of comparison schools (2.8 per cent).

Table 9. Year 8 science scores in 2018 for Aboriginal and/or Torres Strait Islander students

	MEAN SCORES
I²S² schools (n = 3 schools and n = 62 students)	77.2
Comparison schools (n = 8 schools and n = 284 students)	76.5
	Proportion of students in top two levels
I²S² schools (n = 3 schools)	8.1 %
Comparison schools (n = 24 schools)	2.8 %

Note: Comparison schools were selected based on school characteristics, including the proportion of Aboriginal and/or Torres Strait Islander students, Family Occupation and Education Index values, and remoteness area.

ASSESSMENT AGAINST INDICATORS

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Student engagement	Increase in student participation in classroom activities and level of concentration and time spent on classroom activities	Transformative	High
		Effective	Medium
		Emerging	Low
Student academic results	Increase in student science grades after participating in I²S² inquiries	Transformative	High
		Effective	Medium
		Emerging	Low

Increased student aspiration[16], sense of value/worth, and school belonging (Outcome 2)

Key message

The program helped encourage many Aboriginal and/or Torres Strait Islander students to feel more pride, sense of value/worth, and belonging.

Definitions

Self-value/worth is defined in the literature as an individual's positive perception or view of one's self. Individuals with self-value/worth can demonstrate positive social relationships, positive self-esteem, and the ability to self-regulate emotions and behaviour. A sense of value or self-worth is a contributing factor in how children perceive themselves, their overall wellbeing and resilience (Gavidia-Payne, Denny, Davis, Francis, & Jackson, 2014). Research indicates that a strong sense of pride in Aboriginal and Torres Strait Islander culture and heritage assists young peoples to build strong self-worth and value (Dobia & O'Rourke, 2011). Additionally, the literature reflects that teacher practices and their inclusion of Aboriginal and Torres Strait Islander knowledges positively affects Aboriginal and/or Torres Strait Islander students, specifically their perception of self (Hart, Whatman, McLaughlin, & Sharma-Brymer, 2012).

School belonging is defined as the extent to which a student feels they are accepted, included, supported, and respected by their peers and school staff (Allen, Kern, Vella-Brodrick, Hattie, & Waters, 2018). For all students, including Aboriginal and/or Torres Strait Islander students, it is important that the schooling environment is nurturing, engaging, and focuses on achievement. For Aboriginal and/or Torres Strait Islander students, emphasis should be placed on how the school environment reflects heritage and culture, thus the school must have firm values that address racism, ignorance, and how best to include Aboriginal and/or Torres Strait Islander families in meaningful ways (Price, 2012; Riley, 2015).

Indicators and measures

The indicators and measures used to assess Outcome 2 were (see Hunt, 2010,2012; Morley, 2015; Tsou, Green, Gray, & Thompson, 2018; Walter, 2015):

AREA	INDICATORS	MEASURES
Sense of value	Increase in student's sense of value and esteem	Student, teacher, and parent/carer self-reported increases in the sense of value and esteem for themselves, their students, and their children
School belonging	Increase in student's feeling that schools promote the inclusion of Aboriginal and/or Torres Strait Islander students, families, and knowledge systems	Student, teacher, and parent/carer self-reported increases in school belonging for themselves, their students, and their children

Findings

Table 10 outlines the findings from the case study interviews and focus groups. In terms of feeling increased belonging and a sense of value, several teachers reported that I²S² encouraged and empowered Aboriginal and/or Torres Strait Islander students to feel an increased sense of pride and confidence. One teacher relayed a story about one student who was: *"...the most culturally aware..."* and during the What's Cooking inquiry, "*...he was going out to [Area] and he came back with a whole heap of native foods and gumby gumby and stuff like that and we made it up*", which was an opportunity for the student to contribute and express their cultural knowledge. Another teacher spoke at length about encouraging students to voluntarily share what they knew, and how I²S² created safe spaces to share cultural knowledge, and feel positive about it:

At one point one of the boys said, 'That's not how it is for me,' and so then we talked about how it was for him and what knowledge he had from his background, and he was really open about talking to everyone about it and saying, 'Well this is what my poppa has told me' and then we kind of had a great discussion about that. Then we talked about some of the other kids, what they knew, and that was really interesting. Then we did quite a bit of background knowledge about traditional methods and fire starting and the reasons why those methods were used and how it's different to what methods you use now. We had some really great discussions, but in a really safe space for those students to feel open to talking about that sort of really personal stuff.

[16] 'Student aspiration', particularly to follow STEM education and career pathways, is covered in Outcome 5 rather than in this section to avoid repetition.

Table 10. Outcome 2: Key qualitative findings

FINDINGS	FREQUENCY			
Teachers	UN	O	C	VC
Enables Aboriginal and/or Torres Strait Islander students' confidence to contribute their knowledge and introduce cultural elements to class			■	
Generates and allows for the expression of pride in Aboriginal and/or Torres Strait Islander heritage			■	
Students	UN	O	C	VC
Strong identification with I^2S^2 Indigenous content and interest in learning more			■	
Statements of pride made by students	■			
I^2S^2 is inclusive	■			
Confidence to speak up	■			

Note: Frequency was categorised as 'VC = very common', 'C = common', 'O = occasional', and 'UN = uncommon'.

The program placed value on Aboriginal and/or Torres Strait Islander students and the knowledge they held. One teacher explained that the I^2S^2 program provides a safe opportunity for Aboriginal and/or Torres Strait Islander students to share their knowledge with their peers: "[Aboriginal and/or Torres Strait Islander students] *felt good and proud*...[and] *were able to tell their classmates. So, it made them feel good that they knew*". In addition, several teachers observed that Aboriginal and/or Torres Strait Islander students demonstrated increased leadership during the I^2S^2 units. Several students shared their own knowledge and experiences with their class and helped peers where needed. One teacher said that: "*I had* [student name] *last year and he just took charge of the fire* [inquiry] *and said this is what happens*", while another teacher stated that:

...a lot of the students were going to him when they were having trouble with something so he could explain it...he was...almost the junior teacher in the classroom because he knew about this and he could explain to them what they were doing wrong... he liked being able to help a lot more people.

Similarly, Coordinators observed Aboriginal and/or Torres Strait Islander students engaging more with their peers and contributing to the units. One Coordinator explained that they observed a student actively engage in an I^2S^2 unit and guide other students. The Coordinator noted that the student guided students using his personal understanding of Aboriginal and Torres Strait Islander knowledge: *'We don't do it that way,' but he had flipped from trying to disrupt the class any way he could to all of sudden being engaged in what the class was talking about, and actually sharing some of his knowledge with the class.*

Non-Indigenous students also saw benefits from the exposure to Aboriginal and Torres Strait Islander knowledges. Some teachers explained that students are rarely given the opportunity to explore Aboriginal and Torres Strait Islander culture and knowledge systems. One teacher explained that often students:

...aren't even aware that there are other cultures...so [the program] forces them to have to be exposed to them as well, which is good. And it still meshes it in with the science.

Some teachers felt that I²S² provided students with the time to ask cultural questions they may not have had the opportunity to ask before. One teacher explained that the I²S² units "*...gave an opportunity for some of our non-Indigenous kids to ask the questions that they'd love to ask but feel awkward asking all the time*". Another teacher felt that the program was critical in allowing their school and community members to cross over the cultural divide stating:

I think...the critical point...for people to recognise that Indigenous culture is a culture but has a science, whereas most people say 'no, Indigenous people, they don't know anything about science'. But you've got the three things that [I²S²] were doing, the woomeras, the fire making, the seeds, that's all science. And as long... as the Indigenous side is put forefront...then you're starting to cross that cultural divide which I think is the more significant impact that this program has.

One teacher explained that it was not always straightforward creating these spaces:

I've got the Indigenous kids who go 'nah'. They feel like they're almost being singled out, I guess. So that can be a thing. Some of the Indigenous kids loved it because they knew stuff about it and they wanted to contribute and that was really cool to see. Then there were others who didn't want to be associated with it.

Other teachers felt that the program was an opportunity for Aboriginal and/or Torres Strait Islander students to assist non-Indigenous students to understand some of the activities and content. One teacher explained that:

...it opened the door for all the other boys to be like, 'Tell me stuff. Like what do you call that? What do you call that? What's this? What's that?' and it opened the dialogue. The Indigenous kids [were] *interested. It really benefited the non-Indigenous kids because it gave them the opportunity to ask that stuff without feeling awkward.*

Another teacher talked about the increased focus among some students that the use of Aboriginal and Torres Strait Islander contexts led to:

...one of my students who is traditionally a pain in the backside, he had a lot to give in terms of information about traditional fire starting and he had a lot to say about flint and steel and that sort of stuff, whereas usually I'm trying to get him to stop talking about the weekend.

An increased sense of pride among students emanating from the ability and context to contribute knowledges was another finding. Two teachers conveyed this:

Some of those boys that got it quickly took a lot of pride in then showing other kids how to do it as well. Kids like [student] *who...traditionally don't do particular well in a mainstream classroom but once he saw that success, he was keen to show everybody else how to be successful.*

I think definitely [Aboriginal and/or Torres Strait Islander students] *felt pride because they're not really quiet but they don't talk up often. So, it was nice to see them wanting to contribute every single science lesson because they'd be like 'You know, my grandma or aunty does this'. That was really cool. So, then I think the other kids hearing that, 'Hang on, Johnny over here does this on their weekends?' That it kind of linked to real life and it wasn't just this abstract thing that people don't use.*

Several students also verbalised the link between I²S² science units and a sense of inclusiveness, belonging, and confidence. Some students simply expressed gratitude about learning more about culture, which some students had little or no prior knowledge of:

I like it because it's bit of my culture...

...half of my family is [Aboriginal]*, so it was interesting to learn stuff about what maybe people from further back in the generations were doing, because they don't really do it nowadays.*

I loved it because I'm...half Aboriginal and half [non-Indigenous]*, so it's quite fun doing this...*

...it was good because I like learning more about my culture too.

Other students went further and expressed feelings of pride and belonging. One student said:

They [ancestors] *must have been very strong to do it. Definitely, because I made my dad's Father's Day present with it* [resin] *and it's hanging up and there's something with a picture of me and him and my pog...*

...this is our history and we deserve to know it.

For many students, the opportunity to engage with these knowledge systems in the classroom was rare or non-existent previous to I²S². Several students felt: *"Happy because we're actually getting to learn that and they're teaching that"*. Other students articulated the sense of comradery when undertaking group activities centred on engaging content. One learner said: *"Because everyone was engaging with each other...*[it led to higher]*... morale"*. Another student voiced the feeling of confidence when learning as a group: *"...for me, if we do more group activities* [it]*...help*[s] *me put my hand up and...not be afraid".* This relates to another student's feeling that I²S² may have prompted more questions being asked:

I've always been told by my parents [and carers] *that I'm not really one of those people that goes and asks questions. I'm more like try and work it out by myself. But...I have gone more with asking for help if I do really need it.*

Although not part of the evaluation, it is useful to understand that Coordinators also felt that including these knowledge systems created a safe and productive learning space for Aboriginal and/or Torres Strait Islander students. These sentiments were reflected in comments like:

I think it probably actually makes [Aboriginal and/or Torres Strait Islander students] *feel a bit more comfortable that* [the] *education system is acknowledging the Indigenous people*[s] *of this country and I think there's going to be a lasting impact in terms of...Aboriginal and*[/or] *Torres Strait Islander kids that a system is recognising and privileging their knowledge, and the knowledge of their culture.*

Additionally, Coordinators explained that students would be able to experience a strength-based approach to learning about Aboriginal and Torres Strait Islander culture and knowledge systems, specifically that knowledge that is not creative arts or related to cultural practices (i.e., dancing, singing, and ceremony). One Coordinator noted:

I think there is this [misplaced] *perception that Aboriginal and Torres Strait Islander culture is* [only] *really strong in music and the kids are really sporty, and that is the pinnacle of it, and so it is opening up this whole new area and showing them that science looks different for different cultures because they have developed it in a different way...I think...the biggest impact is...showing people a new perspective.*

Finally, one Coordinator felt that the program also created a safe space for teachers to engage with their students in a different way. The Coordinator explained they the inquiry units facilitated:

"Teachers...ask[ing] *some of those questions* [of students] *that they probably wouldn't ask anybody else. So, you can have some really good, frank conversations, and they can ask questions that they'd been too scared to ask anybody else".*

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Sense of value	Increase in student's sense of value and esteem	Transformative	High
		Effective	Medium
		Emerging	Low
School belonging	Increase in student's feeling that schools promote the inclusion of Aboriginal and/or Torres Strait Islander students, families, and knowledge systems	Transformative	High
		Effective	Medium
		Emerging	Low

Increased teacher capacity in both inquiry and Aboriginal and Torres Strait Islander context (Outcome 3)

Key Message

Despite many challenges and barriers, I²S² improved the capacity of teachers in both inquiry and incorporating Aboriginal and Torres Strait Islander contexts, including expanding and adapting beyond the specific I²S² inquiry units.

Definitions

Capacity is broadly defined in the literature as the individual or collective recognition of existing abilities to address obstacles or problems (Taylor & Govan, 2017). Building capacity for teachers describes the improvement of their existing skills and strengths in their practice. Teacher capacity also includes improving and broadening their network and relationships that seek to achieve shared goals (Taylor & Govan, 2017). National professional teaching standards explain teacher capacity as their ability and level of understanding against key area content, pedagogical knowledge, their professional practice within the school and their professional engagement with their school's community (Australian Institute for Teaching and School Leadership, 2011; Treagust, Won, Petersen, & Wynne, 2015). The national teaching standards have outlined the expected abilities for science teachers as the ability to demonstrate an understanding of the relevant science concepts and interrelationships and the promotion of logic and critical thinking (Australian Science Teachers Association (ASTA), 2009).

The definition of inquiry is broadly considered to be the process by which students learn through their active learning (thinking) and participation (doing) related to the problem, concept, or phenomenon. For this case study, science inquiry refers to the activity-based and curriculum units that are being taught in the classroom.[17] Science Inquiry is a key strand (area) of the national science curriculum, alongside Science Understanding and Science as a Human Endeavour. These key learning areas consider the following competencies: questioning and predicting, processing and analysing data and information, planning and conducting, and evaluation and communicating. The Aboriginal and Torres Strait Islander context in the science curriculum is defined as the Aboriginal and Torres Strait Islander knowledges, histories, and cultures that create the conceptual framework for learning. Specifically, the Aboriginal and Torres Strait Islander context included in the science curriculum refers to the scientific knowledge and traditions that relate to scientific observation, predictions, hypothesising, testing (trial and error), navigation, and sustainability of the environment.

[17] I²S² inquiries adhere to the Hackling inquiry cycle (Hackling, 2005).

Indicators and measures

The indicators and measures used to assess Outcome 3 were:

AREA	INDICATORS	MEASURES
Teacher capacity and confidence in inquiry	Increased teacher capacity/confidence in understanding and delivering inquiry Increased delivery of inquiry-based science units	Teachers' self-reported increase in capacity/confidence to understand and deliver inquiry-based science units Coordinators' general assessments of changes in teacher capacity/confidence in inquiry-based science units Student feedback on teacher capacity/confidence in inquiry-based science units
Teacher capacity and confidence in incorporating Indigenous context	• Increased teacher capacity in incorporating an Indigenous context in the science curriculum	• Teachers' self-reported increase in capacity/confidence to incorporate Indigenous context in science units • Coordinators' general assessments of changes in teacher capacity/confidence to incorporate Indigenous context in science units • Student feedback on teacher capacity/confidence to incorporate Indigenous context in science units

Findings

Table 11 presents an analysis of the most frequent themes arising in the outcome area of increased teacher confidence and capacity. The findings have been clustered into these two broad categories.

Table 11. Outcome 3: Key qualitative findings

FINDINGS	FREQUENCY			
Teachers	UN	O	C	VC
Improvement comes with practice				
Encourages teachers to think about explicit teaching versus inquiry approaches				
I^2S^2 provided impetus to improve practice re teaching Indigenous perspectives				
CSIRO training and support has lifted capacity				
It takes time to develop practice and it's difficult to implement without training				
Increased confidence leads to preparedness to adapt program to local context and individual teaching styles				
Importance of working in partnership with Indigenous Education Officers				
Students	UN	O	C	VC
Teachers' availability and approachability to help and high expectations for students				
Parents/carers	UN	O	C	VC
Science is a good opportunity to teach Indigenous cultural perspectives				

Note: Frequency was categorised as 'VC = very common', 'C = common', 'O = occasional', and 'UN = uncommon'.

Confidence

Many teachers reported increases in confidence because of I²S² professional learning and support from Coordinators. A common finding was that confidence was built over time as teachers practised delivering the content, the Aboriginal and Torres Strait Islander context, and the inquiry model. One teacher encapsulated this by saying: *"...since my time starting* [I²S²] *last year, there's definitely significant increases* [in efficiencies] *with running all these extra programs, so – it's becoming easier and easier"*. Another teacher noted slow but steady increases in confidence that came with delivering inquiry units: *"I'm a little bit confident now that I've done two"*. Some teachers recognised the benefits of incorporating Aboriginal and Torres Strait Islander perspectives but also recognised the effort that would need to be used to become confident, for example *"I feel like it is something that we could work towards, and I reckon that would be very beneficial to the unit and the delivery in involving that Indigenous perspective. But I reckon it's something that we could work towards"*. The hands-on, face-to-face training provided by the program was also identified as beneficial to increasing confidence, as one teacher stated: *"The chance to do it beforehand made me a lot more confident in my delivery of it"*.

Several teachers also acknowledged and appreciated that the increases in confidence led to other benefits. One teacher expressed that with more confidence there was a greater ability to adapt and to facilitate students exploring outside the inquiry units: *"I adhered to the lesson plans stringently last year...with this year I've just branched out because I've felt that there was an interest in learning more. So, I supplemented the lessons and got them to actually independently research things"*. Another teacher concurred with this feeling:

I can see that over time, we're probably going to get more and more confident in saying: 'No, we don't have to stick with those points so much. We can move around a little bit here', as long as we don't lose sight of what it is that we need to assess and what it is we need to have the kids produce.

This process of confidence building leading to adaptation of the I²S² units was exemplified by one teacher that spoke about safety:

And so, this unit does lend itself to the thought process of...what is it we're actually trying to do here? Is it about cooking with heat? Or is this simply about achieving a change of matter? Which is underpinning this? And we came up with the idea, 'Why don't we look at cooling things instead of heating them?' and measure that change, because it's a safer thing to do. It's something that the kids can get more hands-on with. Unless we're using nitrogen, they're not going to burn themselves with ice or go in that direction. So it's something we can evolve it as we go here.

There were significant barriers to increasing teacher confidence to deliver inquiry units and incorporate Aboriginal and Torres Strait Islander contexts (which are discussed in the Challenges and barriers section). However, some teachers had ways or found ways to overcome these challenges. One teacher noted the importance of drawing on the expertise that already existed in the school:

I don't feel confident in including it in all areas of the curriculum, because of my limited knowledge. So, I often go to [Indigenous Education Officers] *to get background or take my class to them to ask the questions, and they're more than willing to step up and take that on.*

The depth and breadth of the I²S² resources was also noted as a facilitator of confidence by one teacher: *"I've enjoyed doing it, for sure. I've actually enjoyed having all of the resources together and just being able to go 'right, I've done this before, I know what it looks like, I can print everything off, it's all there'"*. Some teachers felt comfortable to deliver the content due to their own experiences of living and working in Aboriginal and Torres Islander communities. One teacher described that they were comfortable to deliver the content as they: "*Worked in Indigenous settings for so long, we've seen it, those sorts of things before...".*

For several teachers the success of the program, and the confidence they felt to deliver it in their school, relied heavily on the support provided by the school's principal and/or the head of department (science) or head of curriculum. Teachers acknowledged that their school leadership largely decided what initiatives and programs were administered at the school. Teachers felt more supported to deliver the I²S² program when their leadership explicitly championed the program. One teacher explained that it was easier to deliver the program with the overt support of their principal stating: *"He can tell when it's for* [student's] *benefit and he knows what we want to do work, so he's open to new ideas, which I'm really happy to work with".*

Capacity

The I²S² professional learning, Coordinator support, and resources led to increases in teacher capacity across several areas. For example, the inquiry focus encouraged teachers to consider explicit teaching versus inquiry approaches. One teacher commented:

I think the fact that we...said, 'No, you've got to do an inquiry model on this', is actually good because it does open teachers' eyes up...that explicit teaching is one approach and it suits these types of areas, but for problem solving and all that type of stuff, you've actually got to use a different approach.

Another teacher said that I²S² units were *"where most of* [the inquiry-based learning] *occurs in our school and we're trying to build* [on that]...". Another teacher felt that *"...as the years have progressed, we are getting better with how we do the inquiry set up"*. Moving from a passive teaching model to an inquiry-based model was a challenging transition. Several teachers struggled at the beginning of their training, with one teacher explaining that I²S² units are: *"So different from explicit teaching, and you really want to tell the kids the answers* – [it's challenging] *how to frame those questions without telling the kids the answers, or if they give you the wrong answer"*. However, teachers felt that attending the I²S² professional learning sessions allowed them the appropriate amount of time and hands-on experience to feel comfortable delivering inquiry-based units. One teacher felt confident in their ability to transfer inquiry-based learning to other parts of the curriculum:

...after that unit, I have been trying to look for ways of embedding a couple more pracs. I know...there is...more we can do. So, I'm thinking if I have time either before or after the exam, of teaching them how to look at cross sections or doing a collection of a specific area, seeing what things we can find.

The ongoing support of Coordinators was identified as key to building the capacity of teachers. One teacher marvelled at the dedication of one Coordinator:

I was in an unfortunate position...because I was the only teacher here. [The I²S² Coordinator] *spent a lot of time with me one-on-one and they came in and actually set up the first inquiry with me and then came back and we ran a practical* [unit] *together and so they have helped me set up this scaffolded one, and then we ran it then they came back and I had it four times...that term...and each time they helped me get through the next - once I had done it I had an idea. But I had never done anything like that before.*

This feeling that Coordinators and training lifted the capacity of individual teachers was echoed by another educator: "[Coordinator] *was really awesome and they loved the work that we were doing. And they built* [a teacher at the school]'s *capacity amazingly, so this is her baby"*.

Another indicator of increased capacity was the ability to tailor the resources to students' needs, with one teacher explaining:

I like that I have that flexibility. I personally don't tend to use the entire set of resources. Like the slides and the activity sheets. I tend to take....[what] I think would be relevant to my classes. And it's sort of put it where it's a bit more suitable for them.

I²S² was also seen as providing the impetus to improve practice of teaching Aboriginal and Torres Strait Islander perspectives more broadly, despite the initial feelings that there was little time to become more capable during the 'busyness' of teaching. A teacher commented that I²S²:

...put...[Aboriginal and Torres Strait Islander perspectives] *on my radar...I've got so many things to worry about right now,* [it] *is going to be something that I have to deal with later. And so, I put it on my radar and then we did the units and so it had to be my problem and I found once I started tackling the issue, it was not difficult at all. And I think that can be part of it, like it just seems like another thing we have to do. It's really difficult, I don't know how I'm going to incorporate this. So, in that regard, it's been excellent for my practice. And it has made me more confident about addressing most things with my kids than I was before, even though I still sometimes feel like, 'Oh my god. Who am I to tell you about your own culture?'*

Most students did not or were not able to explicitly share their perspectives on whether teacher capacity had improved in terms of inquiry or Aboriginal and Torres Strait Islander perspectives. However, many students did share their views in terms of the expectations that teachers had for them and the teacher's availability and approachability, which are broad indicators of teacher capacity. For example:

Yeah, she teaches in a way that really suits...[and] *she's starting to change the lessons up a little bit, so kids don't get bored in class and you have more different stuff to do and everything. It's really good.*

The teachers try and help us so that we're not stuck at one place and everybody's achieving higher than us. And they try and help us to get equal with all the other children.

You can also...stay from class when you're having lunch and get extra help.

One student explained that if their teacher could not answer their questions, their teacher would: *"Do some research, ask other teachers in the staffroom... come back the next day and answer our question"*.

Many teachers felt that the program provided high-quality resources that allowed them to understand the content and how best to deliver the units. Many teachers felt that the resources provided clear directions and comprehensive information about each inquiry. One teacher felt the resources were: *"Really comprehensive... you could just go step-by-step, pretty straightforward, and you had all the information there"*. Teachers felt that having these resources was useful because the information was centralised and easy to use.

While another teacher stated:

That's another reason why I love it, everything is just done for us…we did a [state-based curriculum] *unit this term and the comparison was just crazy. With the CSIRO units…you've got the PowerPoints done, you've got the assessment, you've got a scaffolded one, all ready for you.*

Many teachers believed that having the opportunity to work through the inquiry with their Coordinator allowed them to gain a strong understanding of the content, inquiries, and lesson plans. Teachers felt that having the opportunity to learn 'hands-on' alongside Coordinators allowed them to engage with the content more readily. One teacher explained that: "*When you have to actually independently…do it on your own…you're not engaged as much…you're just sitting there listening and stuff like that".* Another teacher felt that having those opportunities to check in with the Coordinator was essential to build capacity to deliver the units effectively.

For other teachers, the hands-on assistance provided a guide on how to engage students. One teacher explained that it was useful to have a Coordinator in the classroom to watch how they should interact with the students during the inquiry, with one teacher saying that is was helpful to see how the Coordinator: *"Asks open-ended questions and kind of picking it out of the kids without giving them the answers. It was just valuable to see how* [the Coordinator] *teaches inquiry".* Additionally, several teachers felt that it was beneficial to have hands-on assistance as it allowed them scope to ask questions in real time throughout the unit and inquiry; one teacher emphasising: *"When you're face-to-face, you can obviously ask a lot more questions".*

Coordinators observed that teachers grew more confident through practice and more experience with delivering the content to students. Coordinators explained that often they would see great improvement in teacher confidence after they had delivered three or four units; one Coordinator said:

You can see as soon as you go into their classroom, on one occasion, you go in the next and they're so much more confident and you might be team-teaching with them. Then the next time you might go in, they might say 'no, I just want you to observe [and] *give me feedback'.*

Most teachers found it useful to have the support of other teachers participating in the I^2S^2 program to help build capacity (and confidence). Teachers felt that having support around them was beneficial to: *"Access new ideas and see how* [other] *people are doing things"* and *"how* [teachers] *could improve"*. One teacher felt that it was useful to speak with other teachers about what methods they use to assess students, what the inquiries should look like, or what the end *"product looked like".* Several teachers found that having a teacher at their school that had already taken the professional learning and implemented the inquiries was very beneficial. Teachers found that the practical information around resources and classroom setup was enormously beneficial, with one teacher relaying that it was useful to have another teacher explain, for example *"Okay, use this, do this, do that, manage this".* For one of the participating schools, teachers found an opportunity to create a working group with several teachers. Some of the teachers had not completed an inquiry with their class before and, for these teachers, the regular catchups as a group provided an opportunity for them to discuss professional learning, and how to improve lessons and structure the curriculum. One of the aforementioned teachers stated that the group:

Definitely had a lot more conversations around the inquiries to help her…just to see how it went to compare from last year as well. So, once we did that PD [professional development], *there was just two of us who got to do it, so the other two didn't. So, then we shared with them what we got out of it and how to do it better. Then we also talked about how we could improve from last year, because I know one class didn't get to finish one of the inquiries. So, then we had a lot of talk about how we can better* [use] *our time and finish it.*

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Teacher capacity and confidence in inquiry	• Increased teacher capacity/confidence in understanding and delivering inquiry • Increased delivery of inquiry-based science units	Transformative	High
		Effective	Medium
		Emerging	Low
Teacher capacity and confidence in incorporating Indigenous context	• Increased teacher capacity in incorporating an Indigenous context in the science curriculum	Transformative	High
		Effective	Medium
		Emerging	Low

Increased community and parental/carer engagement and schools have increased cultural competency delivering Indigenous contextualised inquiries in partnership with families and community[18] (Outcome 4)

Key message

Based on a sample of eight schools involved in the case study, there was widespread enthusiasm for greater parents/carers and community involvement in the school and I²S² specifically. However, there were only a handful of examples of increasing engagement and/or newly established partnerships with parents/carers and community.

Definitions

In Western frameworks, community is most often associated with a group of people who hold a sense of common identity, similar characteristics, and a shared geographical location (Kickett-Tucker, Bessarab, Coffin, & Wright, 2016). Within the context of this outcome, community is defined through the lens of the student, defining community members as stakeholders that contribute to the success of the student (Flouris, Crane, & Lindeman, 2016). The individuals that can be considered part of the student's community include the student's parents (and carers), peers, teachers, and mentors.

For this outcome, community engagement describes a school environment that fosters authentic collaboration and meaningful interaction between the community, its members, and relevant institutions (Lowe, 2017).

Aboriginal and Torres Strait Islander family structures involve an extended family model that often identifies the primary caregiver of a child as the 'parent'. Kickett-Tucker et al. (2016) explain that the 'parent' can be an extended family member, a non-biological caregiver, or a family member such as a brother, aunty, or cousin. The role of parent/carer can encompass many practices at home and school. Parents/carers, adults, Elders, and caregivers have strong influences over young people in their community. Parents (or carers) engage with young people, support their learning, and have an influence on their career pathways (Gavidia-Payne et al., 2014; Pendergast, Allen, McGregor, & Ronksley-Pavia, 2018). For this case study, this outcome defines parental/carer engagement as the resources, time, and energy spent on activities that support the student in achieving their desired education outcomes (Pittaway, 2012).

A partnership is broadly defined as two or more groups that share a purpose or a set of goals that require collaboration and the participation of both parties to achieve their goal. Both groups or subsets of people must work together to achieve their shared goals (Kirby, Held, Jones, & Lyle, 2018). In the context of this outcome, a partnership between student families and community members would be a learning environment that reflects, promotes, and validates the culture of the students in that school. A culturally responsive pedagogy is a teaching method that includes cultural characteristics, perspectives, and experiences of ethnically diverse students as a lens for teaching (Morrison, Rigney, Hattam, & Diplock, 2019).

Indicators and measures

The indicators and measures used to assess Outcome 4 were:

AREA	INDICATORS	MEASURES
Increased community and parental engagement	• Parents/carers and other community members feel more welcome at the school	• Parents'/carers' self-reported increases in feeling welcome at the school, engaged with the school and their children's education, and communication with teachers
	• A wider range of community members are engaged with the school and students' education	• Teachers' perceptions of parental/community increases in feeling welcome at the school, engaged with the school and their children's education, and communication with teachers
	• Parents/carers have increased communication with teachers	
Schools have increased cultural competency delivering Aboriginal and Torres Strait Islander contextualised inquiries in partnership with families and community	• Schools actively engage Aboriginal and/or Torres Strait Islander families and community members in developing and delivering a culturally competent curriculum	• Parents/carers, teachers, and students' self-reported perceptions of engagement of Aboriginal and/or Torres Strait Islander families and community members in culturally competent curriculum development
	• Local Aboriginal and Torres Strait Islander knowledges are included in science units	• Coordinators' general assessments of schools' cultural competency and use of local Aboriginal and Torres Strait Islander knowledges

[18] Due to the similarity between two outcomes (a. Increased community and parental engagement and b. Schools have increased cultural competency delivering Indigenous contextualised inquiries in partnership with families and community), they have been combined for the purposes of analyses.

Findings

Case study participants identified several challenges and barriers to increasing the engagement of community and parents/carers, and also partnering with community and parents/carers to deliver culturally competent science education. These challenges are discussed in more detail in the Challenges and barriers section. However, there was clear evidence for an appetite to increase engagement and partnerships, and several examples where this was already occurring. Table 12 provides a summary of participants' views of the outcome areas. The two main themes are discussed below (Increasing community and parental engagement, and partnering with community and parents/carers to deliver culturally competent science education).

Table 12. Outcome 4: Key qualitative findings

FINDINGS	FREQUENCY			
Teachers	UN	O	C	VC
Involvement of local community members would enhance teaching			■	
Recent efforts and improving strategies to engage community members and Elders		■		
Acknowledgement that community members should be paid for their time		■		
Scope for local community involvement in development of teaching units, not just in delivery		■		
Students	**UN**	**O**	**C**	**VC**
Schools viewed as welcoming to all parents/carers and Aboriginal and Torres Strait Islander community				■
Aboriginal and/or Torres Strait Islander community members (e.g. Elders) would be very well received and able to deliver knowledge and enrich I²S²			■	
Positive student experiences of focus on Aboriginal culture and engagement of community members			■	
Role played by Aboriginal and/or Torres Strait Islander teacher aides		■		
Students report discussing I²S² with their parents/carers, but often not in detail		■		
Parents/carers	**UN**	**O**	**C**	**VC**
I²S² activities incorporated into community engagement efforts		■		
Some existing capacity in some schools/areas to incorporate Aboriginal and Torres Strait Islander perspectives		■		
Perception that Aboriginal and Torres Strait Islander perspectives are taught well		■		

Note: Frequency was categorised as 'VC = very common', 'C = common', 'O = occasional', and 'UN = uncommon'.

Increased community and parental engagement

There were some examples among the case study schools of recent efforts and improved strategies to engage community members, Elders, and parents/carers in the school, and sometimes in the I²S² inquiries. One teacher explained:

We have actually just this year developed an Indigenous parent support group because the Elder is our CEC [Community Education Counsellor], *and he is making those connections and taking all staff out to community on the student-free days next year and going to make those connections so I am hoping that* [teachers] *feel more comfortable to contact… Elders through our parents* [and carers]…

Another teacher concurred that the school was *"… not standing up and saying we are experts here but we are asking* [parents/carers] *to come in and we also have to make them feel welcome and I think we are getting better at* [parents/carers] *feeling comfortable*". A recent trip to the bush with Elders and some parents/carers produced a big change for one school and its students, according to one teacher:

…last year was a big eye opener…going out to [bush] *and coming back with all these traditional foods and* [an Elder's] *gumby gumby and the kids making it in the classroom and sharing it with the other classes and* [Teacher] *and…that was a big step for some of the Indigenous kids as well.*

Teachers felt that the program created a more welcoming environment for Aboriginal and/or Torres Strait Islander families. Teachers felt that some of the inquiries got family members and Elders involved in the school. One teacher explained that: "*…some of those boys that had their grandparents there* [at a community event that included an I²S² activity] *as part of the Elder's group, you saw their pride in them being able to show their grandparent…*" However, overall, the feeling expressed was that it was difficult to achieve greater parental engagement due to the already limited involvement parents have with the school, with parents/carers having little or varied contact with the school across the year except for social events (i.e., concerts) or parent-teacher nights.

Most students felt that the schools were welcoming to all parents/carers and the Aboriginal and Torres Strait Islander communities, although the particular activities and ways this were expressed varied. Some students mentioned specific annual events: *"Generally during NAIDOC week…we had that weaving… and then we also had like the damper lunch, which was kind of fun".* Other students mentioned Elders getting involved in more day-to-day school activities:

We made damper and we did Indigenous art on the school, just places where they thought it was a bit plain. They had Elders come in and tell us stories about Dreamtime and just stuff like that, Indigenous history…they also taught us how to throw spears and techniques…

or art activities: *"We…painted some of the poles of our buildings with Aboriginal painting and we take a lot of notice of learning about their culture".*

Several students mentioned specific school programs for Aboriginal and/or Torres Strait Islander peoples, including I^2S^2 that they felt indicated a welcoming atmosphere: *"… there's many different programmes for Aboriginal and*[/ or] *Torres Strait Islander peoples, and programmes like this* [I^2S^2] *as well…I reckon we're a very welcoming school"* and *"They have a program called* [Program], *which allows all Aboriginal children to participate and learn their languages".*

Another student felt the school had a general level of respect: *"…the school appreciates…Aboriginal* [people] *because…they want to give them the same respect as everyone else…they want to welcome them and to feel comfortable".* The evaluation team feels that the responses to the question about how welcome Aboriginal and/or Torres Strait Islander peoples may have felt may have been prone to social desirability effects among non-Indigenous respondents.

Finally, one student recognised a shift in the school—from a low level of engagement to visible, higher levels of engagement:

I think it's really cool that this school is investing in it because…we have so many different things but there was nothing really ever for Aboriginal Torres Strait Islander students. And now our principal came in and…made [Aboriginal and Torres Strait Islander Program] *a thing and brought in…volunteers and…it was a really good thing for… Aboriginal and Torres Strait Islanders to do and they really enjoy it. I feel like, yeah, it made the school really good.*

Partnering with community and parents/carers to deliver culturally competent science education

Several case study participants felt that the program offered a number of opportunities to partner with local community organisations. Particularly, several teachers mentioned potentially partnering with their local Aboriginal Ranger programs, although this was still in the early stages. One teacher felt that:

…we were observing all the different trees and stuff [on a trip to the bush]. *We thought, how great would it be with all the kids, if we could get the community involved, the rangers…getting out into community and expanding to there.*

There was widespread agreement that involvement from community members and parents/carers would enhance teaching and the inquiry units, although examples of this involvement were not as prevalent. One teacher:

…was trying to bring the Elders in [to] *help…with the fire-starting methods and…making that link* [to Indigenous knowledges] - *I think it would be very valuable for teachers and the kids. And it also - bringing the parents in, it would be a very valuable link.*

Teachers were aware of multiple benefits of community involvement in delivering contextualised inquiries, including increased ownership of the curriculum:

If you're inviting [Elders] *to teach the kids…there… would be a lot more community involvement,* [and] *give them some ownership over* [the] *curriculum, what we're teaching the kids. I think that would be very powerful.*

Another teacher also realised that involving Elders would benefit teachers as well as students: "*Getting the Elders involved, and while they're educating the kids they're educating me as well; so, at the same time, it's like a 'two birds, one stone' scenario*". One teacher thought that partnering with Elders would increase engagement and interest among students:

I think [involving Elders] *could work. I think it'd be more interesting for the kids too because they're having an actual Elder to come in to talk to them and give them knowledge about how they've used it, or someone in their family has. And it shows them that there is someone who uses it.*

Other teachers wanted to involve Elders in developing and planning teaching units, not just in delivering them, explaining that: "*It would be good to have a heads-up as to…what's the possible inquiry that will be carried out…so that we can say this would be a good one* [to an Elder]… [and ask how]…*we could use it this way".* Among the many teachers that foresaw benefits from partnering with Elders, most agreed that community members needed to be paid for their time. One teacher emphasised the

importance of "*...giving your time and we're able to give a bit back to you. Payment for service...*" Another teacher felt that there were Elders out there and "*...you've just got to find the right person and they'll just come in and do it*".

Students were major advocates of building stronger links with community members. Many students felt Aboriginal and/or Torres Strait Islander peoples, including Elders, could deliver knowledges first-hand and enrich the I^2S^2 experience. Some examples of these views included:

[Elders] *actually know it personally, they've done it and then they can teach.*

[Elders]...*would have more knowledge than what the teachers do.*

Just because the teacher pretty much tells you the same thing every day, but if you have an Elder, it's someone new...

[Elders have] *good stuff to talk about, and they know it more than anyone.*

They know first-hand about the practical [units] *that we're doing whereas our teachers were just given it... to give to us...if...you had an Aboriginal Elder come in... and explain it, you might have...more knowledge or maybe something the science teachers missed out.*

I think everyone should learn about [Aboriginal and Torres Strait Islander scientific knowledges]. *It's good to learn about, and more people should hear about it and know about it.*

[It would be] *more interesting* [than] *our teacher telling us about it. No,* [I'd] *rather have the Elder than the teacher. Just because the teacher pretty much tells you the same thing every day, but if you have an Elder, it's someone new and* [it] *helps focus and you know it...*

Some students also, fortuitously, identified Aboriginal and/or Torres Strait Islander teacher aides as sources of knowledge and support. One student commented that:

They have a couple Indigenous teachers in our group, have them feel welcome and sometimes give them help like in our classroom [Teacher] *or* [Teacher] *comes over. She gets all the Indigenous kids and gets us help from her, to feel more comfortable with one of our own.*

Most students felt that their schools administered few activities to promote Aboriginal and Torres Strait Islander cultures and knowledge systems. The few activities that students mentioned were primarily small events with community members, displaying Aboriginal and Torres Strait Islander art on school grounds, and annual events such as NAIDOC week. Comments made by students identified a clear need for schools to include Aboriginal and Torres Strait Islander content in more meaningful ways in partnership with community, specifically the inclusion of these knowledge systems in the curriculum. Students explained that the curriculum rarely includes Aboriginal and Torres Strait Islander knowledges except for units explaining historical events or some cultural practices (i.e., cooking preparation, art lessons etc.). One student explained: "*I've learnt about a bit of it in history I'm pretty sure. Yeah, that's pretty much it".* While another student explained: *"We do a little bit in history...and* [in] *English a few years ago too...The Stolen Generations".* I^2S^2 was seen as a new and unique way to incorporate knowledges into the curriculum and encourage better links with community.

In relation to parents/carers, many students mentioned discussing I^2S^2 with their parents/carers or other family members, but not in detail. For example, different students said:

I think I briefly told my mum, but that was it.

I asked my dad a couple of questions about it, but my mum's not really into science so I couldn't.

I told my grandparents about it...[and] *they* [said] *I used to do that too, and they thought it was cool.*

Yeah, I told my family. They said, 'oh you get to learn something new for once'.

Yeah, she's like, 'Oh, that's good. Hopefully you do more work'.

When I went home and told them that [the inquiry activity] *didn't work straight up, my dad was like, 'You should have done this and you should have done that'.*

Yeah, I told my mum, after we did the experiment. And she said, and she was surprised what we were doing and that. And how it was linked to Aboriginal, and she thought it was great for us to do it.

One school incorporated an I^2S^2 inquiry hands-on activity into a community event, which was welcomed and appreciated by some parents/carers: *"...the students were actually demonstrating the activity at NAIDOC as well. So, some of the students were doing the fire burning one there...and we had the plants if people wanted to look at them*". Parents/carers also recognised that some teachers had built a body of experience through working with Aboriginal and Torres Strait Islander communities that allowed them to confidently incorporate perspectives in the classroom:

You've got people at our school who have taught in the [Area] *community, who have taught in the Torres Straits, who have taught at Palm Island, who have taught in the Northern Territory. So, you've got staff here who have got that background and feel quite comfortable standing in front of our students and talking about culture and taking on those hard questions and providing an opportunity for a conversation.*

There was existing capacity in some schools to call on the expertise of community members to assist with I²S² and other projects. One teacher related that:

...there's lots of links out there. So, [a teacher is] *related to the local tribe. You've got* [another Aboriginal community member] *who is one of the workers* [in] *the primary school who you can always use...if you need something, and I've used him over the years when I was teaching many a time for different projects that I was doing. So, it just really depends on your connections and who you are.*

Connections within schools and with other I²S² schools

Although not strictly a 'community partnership' component, I²S² utilised a cluster model to promote partnerships among participating schools in local areas. These links aimed to create a community of practice among schools and provide an opportunity for schools to share resources and/or learnings. Two of the eight schools involved in the case study (one primary and one secondary school) had a partnership in place. For teachers, this partnership was useful as it allowed them to share resources; one teacher explained: *"We actually take the kids over to the* [high school] *science lab, so that was actually in-context science, so we did that for - there was a term when we all went in rotation. The kids loved that".* Other teachers felt that it would be beneficial to have more contact with surrounding schools as it would allow them to utilise local contacts (i.e., eternal organisations, experts, and Elders). One teacher explained:

Because if [school] *was doing it...we probably all share the same contacts, the same person...if you've got networks already out there, then you're linking with when that inquiry needs to happen then this is the support person. They can come in from a community or cultural perspective.*

Many students indicated that they would like to interact with and learn from other students. One student felt that the opportunity to partner with other schools *"sounds like a pretty cool field excursion".* Teachers echoed these sentiments, explaining that students responded positively to the idea, with one teacher stating that *"they definitely all seem keen about the idea".*

Some teachers felt that it was useful to have this collaboration with other teachers, including from other schools, as they did not specialise in STEM during their formal training. One teacher explained that: *"...because people obviously teach across different curriculum areas and different subject areas...*[we]*...chat to one another".* Many teachers explained that the program required them to collaborate with other teachers to better understand the inquiries and create solutions to any issues they encountered during the program. One teacher explained that *"We've got a lot of chance*[s] *to talk amongst ourselves and share similarities, differences, improvements that we know some of our classes that we're able to adapt that accordingly".* Another teacher said that it would be useful to collaborate with other teachers to understand: *"Have they made any of their own resources? Have they changed things or done anything different that we should be aware of? Just to moderate with what they found did or didn't".* For a few teachers it would be useful if they could develop better partnerships with other schools and teachers to collaborate on how to grade and assess their students. One teacher explained that it would be useful *"...to compare how the other schools also grade their inquiries would be great too. Sort of moderating".*

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Increased community and parental engagement	• Parents/carers and other community members feel more welcome at the school	Transformative	High
	• A wider range of community members are engaged with the school and students' education	Effective	Medium
	• Parents/carers have increased communication with teachers	Emerging	Low
Schools have increased cultural competency delivering Indigenous contextualised inquiries in partnership with families and community	• Schools actively engage Aboriginal and/or Torres Strait Islander families and community members in developing and delivering a culturally competent curriculum	Transformative	High
	• Local Aboriginal and Torres Strait Islander knowledges are included in science units	Effective	Medium
		Emerging	Low

Increased number[19] of Aboriginal and/or Torres Strait Islander (and non-Indigenous) students pursuing STEM pathways, including in Years 10 to 12, university, and alternatives (Outcome 5)

Key Message

There was evidence of interest in STEM subjects and careers (and some evidence of better than average uptake of STEM subjects in I²S² schools), although there was insufficient evidence to attribute this directly to I²S².

Definitions

Student aspiration is defined as a student's ability to be cognisant of their future educational and career goals (Lewthwaite, Osborne, Lloyd, Boon, & Llewellyn, 2015). Academic aspiration is reliant on the student's ability to focus their self-efficacy and academic ability to achieve their personal (intrinsic) and academic (extrinsic) goals. The education and career aspirations of many Aboriginal and/or Torres Strait Islander students directly reflect, promote, and validate their culture. For many Aboriginal and/or Torres Strait Islander students, it is important that the school or their learning environment foster opportunities to reflect on their social and cultural norms (e.g., group orientation and collaborative relationships) (Riley, 2015).

In the literature, a 'STEM career' is broadly defined as the undertaking of an occupation in STEM, including roles in engineering, mathematics, or natural and physical science (Office of the Chief Scientist, 2016). For this case study, STEM pathways are the educational and professional activities (or goals) that students must complete to successfully undertake a career in the STEM field. Specifically, educational goals include students pursuing university prerequisite subjects for STEM degrees or further studies, undertaking STEM activities outside their school environment, completing their high school studies, and achieving a university degree or actively pursuing further studies. For students wanting to pursue a STEM career, it is important to understand career options and the future demand for STEM skills. Students must have a clear understanding of the knowledge, skills, and qualifications that are necessary to progress through a STEM career pathway. For students in Years 10–12, the necessary skills include problem solving, creativity, critical analysis, teamwork initiative, digital literacy, and effective communication skills (Murphy, MacDonald, Danaia, & Wang, 2019; Prinsley & Baranyai, 2015). Students in Years 10 to 12 must consider core and elective subjects in mathematics, science, and technologies that are necessary for university (tertiary education) entry.

Indicators and measures

The indicators and measures used to assess Outcome 5 were:

AREA	INDICATORS	MEASURES
Increased number of students pursuing STEM pathways, including in Years 10 to 12, university, and alternatives	• Students show aspirations and interest in STEM subjects and pursing a STEM education and careers • Students select STEM subjects in high school	• Student self-reported increases in interest and aspiration in STEM subjects, education, and career • Increased numbers of students from I²S² schools take STEM subjects in high school (jurisdictional administrative data)

[19] 'Aspiration' to follow a STEM education or career pathway is covered in this outcome rather than in Outcome 2.

Findings

There was some evidence that I²S² contributed to increased interest and aspiration in STEM careers, including STEM subject selection (Table 13).

Table 13. Outcome 5: Key qualitative findings

FINDINGS	FREQUENCY			
Teachers	UN	O	C	VC
I²S² contributing to choosing STEM subjects				
Students	UN	O	C	VC
General expressions of interest in pursuing a STEM career				
Students generally unsure of their likely career pathway				
I²S² piques some interest in pursuing science as a career				
Parents/carers	UN	O	C	VC
Science seen as offering a good pathway				

Note: Frequency was categorised as 'VC = very common', 'C = common', 'O = occasional', and 'UN = uncommon'.

Student STEM subject selection

One jurisdiction provided data on STEM subject selection for schools involved in I²S² and for all other state schools in that jurisdiction. Table 14 outlines the proportion of students in Year 11 (second semester) who were enrolled in any STEM subject in 2018. There are several caveats related to these data. In many schools, not all classes in a year level participated in I²S². In addition, in 2018 only students who had participated in I²S² inquiries in 2016 (in Year 9) would be in Year 11, which could represent a relatively small proportion of all Year 11 students.
The data show that the proportion of students in the 17 I²S² schools taking STEM subjects (59.1 per cent) was lower than the proportion for all other government schools (71.5 per cent). However, when schools were compared using bands of ICSEA scores (in order to compare schools that have students with similar socio-educational backgrounds), the results were somewhat reversed. A total of 54.4 per cent of students in I²S² schools with ICSEA scores between 840 and 900 were enrolled in STEM subjects compared to 47.7 per cent across all state schools in that jurisdiction. These ICSEA scores indicate schools with students that had relatively lower levels of socio-educational backgrounds. The difference was most pronounced in schools with higher ICSEA scores (greater than 940): 87.7 per cent of Year 11 students in I²S² schools were enrolled in STEM subjects compared to 75.9 per cent of Year 11 students in all state schools. Because of the low sample size of I²S² schools, these results could be due to sampling errors; however, it is encouraging that I²S² schools compare favourably to jurisdiction-wide trends.

At the time of the case study, it was too soon for the majority of students who had participated in the program to be selecting subjects in high school. One teacher did note a trend at their school of increasing STEM subject selection, but it wasn't attributed directly or solely to I²S²:

We're seeing...[Year] *10* [and] *11 subject selection showed* [STEM interest] *very strongly. You've gone from a single class of biology, chemistry, and physics to two biology, a huge chemistry...probably two, physics almost at the stage where it no longer needs to be combined 11 and 12. And* [this is at] *the detriment of subjects like physical education...modern history, ancient history, kids are choosing the sciences.*

Table 14. STEM subject selection in Year 11: I²S² compared to all schools (2018)

ALL STUDENTS		PER CENT OF STUDENTS ENROLLED IN STEM SUBJECTS
I²S² schools (n = 17)		59.1
All schools		71.5
ICSEA 840-900	I²S² schools (n = 5)	54.4
	All schools	47.7
ICSEA 901-920	I²S² schools (n = 3)	51.4
	All schools	56.7
ICSEA 921-940	I²S² schools (n = 6)	65.3
	All schools	60.9
ICSEA >940	I²S² schools (n = 3)	87.7
	All schools	75.9

Note: The values in the table represent the per cent of students in 2018 in one jurisdiction who were enrolled in one or more STEM subjects (including Agricultural Science, Biology, Chemistry, ICT, Mathematics, Physics, and Technology Studies) in Semester 2 of Year 11.

Student STEM career aspirations

Many students who were interviewed felt somewhat unsure or only had generic ideas about their future education and career aspirations, which is not surprising given their ages (Years 5 to 9 or approximately 10 to 14 years old). Students felt that they had plenty of time to decide, considering their age and year level. However, several students indicated they had thought about the potential of a STEM career and the STEM subjects required to pursue those careers. Most of these students spoke about a career in medicine, engineering, or biology:

So, I probably have to continue with science, but with more technological stuff, because I'll be a technological engineer.

Yeah, that's why I might go to [university]*, they have a lot of robotics stuff there.*

I want to be orthopaedic or a neurosurgeon because my parents…both [have] *spinal issues. I want to help that…*[and take]*…biology, mathematics, physics and all those subjects in grade 10.*

…one of our sessions was biology and…I did…[well] *in the test so* [the teacher] *was talking about jobs that involve that. So, I want to be something in the medical field or a virologist.*

Science would be fun. I would love to learn more science because I want to become like, a forensic and do DNA and all that. So, it would be a lot more fun to learn more science.

I want to be a radiologist when I am older.

…especially in this generation, science is building so it's getting even more interesting, especially with the technology these days.

There was minimal evidence indicating why students had selected these potential careers. Some students felt that a STEM career would be interesting, while another student liked that STEM provided an opportunity to work in a team. Additionally, one student explained that a STEM career would provide them with a range of career options stating: "*Heaps of different things including science, that you get a variety*". A few students highlighted I²S² as generating increased interest in science as a career, with one student commenting: "*Yeah, it did make a difference* [in interest in pursuing science] *because…there's a base…a meaning of it, and you just understand that meaning more and more every time you have lessons".* Several parents/carers also expressed positive attitudes towards STEM careers for their children, including that STEM "*would be pretty good for her*" and that "*It's good knowing their maths and science*". One parent/carer said their child:

…knows that she wants to do science. Science and maths is her preferred area at this point in time, but science, we know that's the path, she'll go into… She just has to choose something that she'll actually be able to get a job in [and] *earn an income.*

Student aptitude for STEM and critical thinking skills development

I²S² also provided students valuable inquiry and critical thinking skills that could contribute to further STEM education and careers, or more broadly to STEM literacy that could be applied to any educational or career field. Students felt that revision, research, and practice meant they were confident to pursue the inquiry and test hypotheses. One student explained: *"...the more we researched it and the more we actually did it over and over again, we actually understood and figured out what we were doing and understood what was happening".* Most students could readily recall and explain the inquiry (or inquiries) they had participated in. When asked during the focus groups, several students recalled both the required steps to complete the inquiry and the scientific principles that were taught. Many teachers could recall instances where their students had spoken about what they had learnt during I²S² units. While another teacher explained that giving students the freedom to have that responsibility to learn allowed them to develop those critical thinking skills that are important for retention and skill development throughout a student's education: *"...with taking a lot of those restrictions off, a lot of them have a chance to flourish and take...their own thoughts and ways of developing on...".*

ASSESSMENT AGAINST INDICATORS

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Increased number of students pursuing STEM pathways, including in Years 10 to 12, university, and alternatives	• Students show an interest in STEM subjects and pursing a STEM education and careers • Students select STEM subjects in high school	Transformative	High
		Effective	Medium
		Emerging	Low

Identification of 'best practice' in high expectations science inquiry education and teacher professional learning, and adoption of this 'best practice' by states and territories (Outcome 6)

Key message

I^2S^2 has achieved recognition as a program of excellence and has seen a steady increase in uptake across Australia; however, jurisdictions have yet to adopt the program state- or territory-wide.

Definitions

High expectations for students are associated with a learning environment that fosters greater opportunities for students to participate in the classroom, alongside informative feedback from teachers (Riley & Pidgeon, 2019; Rubie-Davies & Peterson, 2016).

Science inquiry education programs are defined as programs that facilitate an investigative approach to learning science, which provides students with the opportunity to understand the inquiry process. Science Inquiry education programs provide students with the opportunity to name a scientific question for investigation, design an investigation to research their formulated questions, and interpret their findings of those investigations (Hackling, 2005; Oliver, McConney, & Woods-McConney, 2019; Sarra, Spillman, Jackson, & Davis, 2018).

Teacher professional learning is defined as training and activities that increase the teacher's skills and knowledge to improve their instruction or approach to pedagogy. Teacher professional learning should affect the teacher's attitude and beliefs about their approach to teaching. Teacher professional learning should always aim to increase learning by the students (Philipsen, Tondeur, Pareja Roblin, Vanslambrouck, & Zhu, 2019). For this outcome, the adoption of the program across jurisdictions involves the consistent administration of the program across time by participating schools and teachers.

Indicators and measures

The indicators and measures used to assess Outcome 6 were:

AREA	INDICATORS	MEASURES
Identification of 'best practice' in high expectations science inquiry education and teacher professional learning, and adoption of this 'best practice' by states and territories	• I^2S^2 identified as best practice and adopted	• Jurisdictions adopt the I^2S^2 program and training • Teachers and heads of department/curriculum self-identify I^2S^2 as best practice (in relation to professional learning and science inquiry education)

Findings

There was limited evidence for this outcome. Schools and individual educators were generally satisfied with the I²S² program, but it was often their first and only experience incorporating Aboriginal and Torres Strait Islander knowledges into the science curriculum. Therefore, it was difficult for educators to ascertain whether the program constituted 'best practice'. I²S² was implemented and operated during a period of increasing interest and activities related to inquiry and/or Indigenous knowledges in science, at the practice, program, and policy levels. For example, in October 2018, the Australian Curriculum, Assessment, and Reporting Authority released 95 elaborations to support teachers to incorporate Aboriginal and Torres Strait Islander Histories and Cultures into teaching the *Australian Curriculum: Science* at all year levels. In addition, the National Aboriginal and Torres Strait Islander Curricula Project was launched in 2019 that aimed to empower teachers to integrate Aboriginal and Torres Strait Islander perspectives into their classroom practice. The Stronger Smarter Institute also developed and delivered the Stronger Smarter Institute Knowledges in Science, Technology, Engineering and Mathematics Pathways, which offers strategies and processes for teachers to implement culturally responsive tools to teach STEM. This intersection of developments has placed I²S² in a newly rich space for teachers. However, educators did not mention any other developments during the focus groups and interviews, although this is likely due to the discussion being focused on I²S².

The Indigenous STEM Education Project, of which I²S² is a major component, has been recognised more broadly as best practice in several ways. For example, the Indigenous STEM Education Project won the Australian Museum Eureka Prize for STEM inclusion in 2020. The project also won the Aboriginal and Torres Strait Islander Engagement Impact Excellence Medal at the internal CSIRO Awards 2020. There has been significant media attention related to the project, including articles in the ABC, National Tribune, and Teacher Magazine. Finally, the Australian Government's Department of Education, Skills, and Employment showcased the project as a strategy that works in its National STEM Education Resources Toolkit (https://www.dese.gov.au/australian-curriculum/national-stem-education-resources-toolkit/introductory-material/aboriginal-and-torres-strait-islander-students).

To the best of the evaluation team's knowledge, no state, territory, or Catholic education system has incorporated I²S² into their state/territory-wide education plans; it remains an individual school-based program. However, engagement from individual teachers and schools was continuing to grow at the time of writing this report. As at August 2019, the cumulative total number of teachers engaged with the program was 655. In addition, there has been increasing interest from universities using I²S² expertise and resources to build the capacity of pre-service teachers. For example, the University of Canberra invited the I²S² to deliver training to pre-service teachers in late 2019.

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Identification of 'best practice' in high expectations science inquiry education and teacher professional learning, and adoption of this 'best practice' by states and territories	• I²S² identified as best practice and adopted	Transformative	High
		Effective	Medium
		Emerging	Low

Schools supporting other STEM programs (e.g., ASSETS, CREST Awards, PRIME Futures) (Outcome 7)

Key message

The schools involved in the case study were involved in several STEM programs, although this involvement was not directly attributable to I²S² but rather an overall commitment to STEM learning. I²S² was the only STEM program to feature Aboriginal and Torres Strait Islander knowledges in all schools.

Definitions

STEM is broadly understood as the approach to learning and development that integrates the four disciplines of science, technology, engineering, and mathematics. STEM programs take an interdisciplinary approach to teaching and learning that is cohesive and includes the principles of each discipline as opposed to delivering each subject independently. STEM programs engage students with hands-on, real-life examples that see students working in an integrative way (Timms, Moyle, Weldon, Mitchell, & Australian Council for Educational Research, 2018). STEM programs promote lessons or curriculum units that challenge students to find a solution to a problem and often revolves around working on a learning project. School support in the context of this outcome is defined as the inclusion and promotion of STEM programs and initiatives in a school or the wider school community.

Findings

The eight schools that comprised the case study were involved in a range of STEM programs,[20] including a trade training centre (including engineering); a numeracy project, the construction of a specialist STEM facility, a virtual STEM academy, a STEM excellence project, a STEM girls leadership day, bespoke STEM programs, STEM 4 Schoolkids, state government student science grants, STEM industry partnership programs, and several girls STEM programs. In addition, some schools had in place STEM/project-based learning approaches that pervaded the entire school. Although it was not likely that I²S² directly led to the additional take-up and ongoing promotion and implementation of other STEM programs, it was clear that the Aboriginal and Torres Strait Islander knowledges that comprised a central feature of I²S² resources was a unique element of the program that complemented the focuses of other STEM programs (e.g., female participation, exposure to industry professionals, and employment pathways).

There was anecdotal evidence that some students engaged in I²S² were involved in other STEM programs. For example, one Coordinator noted: "The kids who are in ASSETS, some of them have...done I²S² and sometimes that's where their passion stems from, that they even apply for ASSETS". Another Coordinator observed that a student who won an Indigenous Science Award *"was involved with I²S² ...*[the] *previous year...that's not why she won the award but* [it was] *a part of it"*.

Indicators and measures

The indicators and measures used to assess Outcome 7 were:

AREA	INDICATORS	MEASURES
Schools support other STEM programs	• Take-up and ongoing promotion and implementation of STEM programs	• Teachers, students, parents/carers, Coordinators and heads of department/curriculum self-report school promotion and involvement in STEM programs (besides I²S²)

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
Schools support other STEM programs	• Take-up and ongoing promotion and implementation of STEM programs	Transformative	High
		Effective[21]	Medium
		Emerging	Low

[20] Specific names have been removed to ensure schools are not identifiable.

[21] Not directly attributable to I²S².

School culture of high expectations – also benefitting other subject areas (Outcome 8)

Key message

Students, teachers, and parents/carers reported that their school had a culture of high expectation, focused primarily on effort. There was anecdotal evidence that I^2S^2 contributed indirectly to this culture.

Definitions

School culture is broadly defined as the basic beliefs, values, and practices that are shared amongst school members, teachers, staff, and the wider school community. A culture of high expectations in the school environment is described as a learning environment that supports the success of the student. A high expectation learning environment includes learning strategies t involving content that is relevant to students with examples of real-world applications (Sarra, 2011; Stronger Smarter Institute, 2017).

Indicators and measures

The indicators and measures used to assess Outcome 8 were:

AREA	INDICATORS	MEASURES
School culture of high expectations	• Teachers, heads of curriculum/ department and parents/carers have high expectations for students in science, particularly Aboriginal and/or Torres Strait Islander students	• Teacher/heads of departments/curriculum, student and parent/carer self-reported school culture of high expectations in science
High expectations in science and other subject areas	• Teachers, Heads of Curriculum/ Department and parents/ carers have high expectations for students in other subjects, particularly Aboriginal and/or Torres Strait Islander students	• Teacher/heads of departments/curriculum, student and parent/carer self-reported school culture of high expectations in other subjects

Findings

Almost all educators that were interviewed felt that their school fostered a culture of high expectation. When teachers were asked if they had high expectations for their students, they responded that they did, both personally and from a school perspective, with one teacher saying: "*We've got high expectations for our children".* Many students echoed these sentiments, explaining that teachers encouraged them and provided them with the resources and assistance to achieve. Students explained that teachers encourage them to "*get good grades", "Grow, try and succeed",* and "*try* [y] *our best".* Generally, students felt that teachers expected them to achieve good grades; however, several students said teachers placed greater emphasis on their effort, as opposed to grades. Students explained that teachers always encouraged students to improve and to take the initiative to challenge themselves. One student said:

They don't really mind about – well they probably do mind about your grades, but if you put the effort to try and get good grades, and if you get like a D or an E they'll help you to achieve higher instead of just going, oh well you should have done this better.

Another student explained: "*It's more about the effort than wanting us to get – they like they want us to get good grades, but they want us to try our best in order to get them, not try just because of that reason".* Many students felt that students who are proactive about their educational outcomes received active assistance from teachers. One student observed: "*Yeah. And I guess the school encourages - if you feel the need to get the really good grades for yourself, then they'll help you along with that in whatever way they can".* Teachers felt reticent to attribute their expectations of students directly or indito the I^2S^2 program, which is not surprising.

One teacher explained that they: "*...think most teachers have very high expectations. But we're also steeped in reality. We know what happens or doesn't happen outside the school environment".* Teachers acknowledged that it is unrealistic to expect 70-minute units to affect their overall expectations of their students' abilities.

Students felt that teachers encouraged them to be challenged during the inquiries. Teachers explained that creating unrealistic goals for students would only deter them from achieving the more advanced tasks and inquiry activities. One teacher felt that the I^2S^2 units provided teachers with an opportunity to "*...lift expectations in terms of what students can achieve".* An underutilised aspect of I^2S^2 that could raise expectations was the challenge tasks and additional activities. Few teachers mentioned these as being employed for high achieving students.

In terms of spillover effects into other subject areas, there was limited evidence that the high expectations originated in science and spread to other subjects. One teacher noted that English, maths, and science teachers often compared notes, and questioned why some students would do well in science, but not in the other subjects: "*You've shown me you can do it in science. You've shown me you can write in science. What's happening there for you? Why aren't you showing it there, but you're showing it to me?"* This does demonstrate that high achievement in science was spreading expectations to other areas to a limited degree. Another teacher felt that I^2S^2 built self-confidence in Aboriginal and/or Torres Strait Islander students, which may not necessarily lead to better academic achievement across subjects, but did contribute to better outcomes for students overall, which was a "*good thing*" according to the teacher.

Assessment against indicators

AREA	INDICATORS	ACHIEVED	LEVEL OF EVIDENCE
School culture of high expectations	• Teachers, heads of curriculum/department, and parents/carers have high expectations for students in science, particularly Aboriginal and/or Torres Strait Islander students	Transformative	High
		Effective*	Medium
		Emerging	Low
High expectations in science and other subject areas	• Teachers, heads of curriculum/department, and parents/carers have high expectations for students in other subjects, particularly Aboriginal and/or Torres Strait Islander students	Transformative	High
		Effective*	Medium
		Emerging	Low

* Not directly attributable to the program

Challenges and barriers

In addition to evidence of the achievement of outcomes, an analysis was also conducted to understand some of the factors that affected the attainment of the outcomes. The findings have been arranged into two broad categories: Challenges and barriers and success factors. The challenges and success factors are summarised at a relatively high level to provide a general overview of these factors because the emphasis of this evaluation has been on evidence associated with achieving the intended outcomes.

In terms of program implementation and operational challenges and barriers, teachers, teaching assistants, Aboriginal and Torres Strait Islander education workers, and heads of curriculum and department identified several areas that presented barriers to the successful implementation and operation of I^2S^2. Coordinators have been included as sources for identifying challenges.

Logistical barriers

- Sourcing equipment and materials[22], and obtaining physical spaces to undertake inquiries
- New safety considerations not encountered before (e.g., projectiles in the Throw it Far unit)
- Some inquiries not working as planned or causing some discomfort (e.g., repetitive motion)

Inquiries and lesson delivery

- Pacing and varying engagement levels of different inquiries for different student preferences (e.g., immediate results of some inquiries compared to slow progress of other inquires)
- Organising inquiries with multiple stages or that were relatively complex
- Students finding it difficult to record and understand data
- Making connections between science concepts and the Aboriginal and Torres Strait Islander contexts, particularly when the content/ theoretical and inquiry/practical components were separated by substantial periods
- Teachers balancing the amount of time spent on inquiries (which take more planning) with other curriculum requirements
- Some Aboriginal and/or Torres Strait Islander students did not want to be associated with the inquiries (i.e., they preferred not to share their cultural knowledge with others, and some students even felt shame expressing that they knew something – 'tall poppy syndrome') Shifting from an explicit teaching pedagogy to an inquiry approach was challenging for teachers and students; the new concept required a conscious shift in approach (e.g., student led)
- Ensuring continuity of teachers within a class over the year, as some classes had multiple teachers, which led to the repetition of some components of the inquiries

Moving to an online model

- Apprehension about online models of professional learning (e.g., less engaging)
- Feeling less confident about delivering I^2S^2 initially without face-to-face support
- Feeling that an online model would not allow teachers to ask and explore questions and draw out the experience of individual Coordinators
- Feeling that an online model would not allow teachers to clarify their understanding in real time
- Concern that an online model would not cater for different communities compared to the knowledge of a local Coordinator
- Concern that schools in rural and regional areas would miss out on face-to-face support

Training and professional learning

- Schools weighing the cost versus benefit of releasing staff to attend the I^2S^2 training
- Designing and delivering professional learning that was suited to a range of levels of teaching experience, including:
  - Balancing theory versus practical components in the training materials
  - Balancing the amount of material presented during teacher professional learning sessions, with some teachers feeling it was too much and others too little
  - Ensuring the training and materials are not overly prescriptive
  - Ensuring enough foundational content (e.g., scientific concepts) is included in the training prior to the conduct of an inquiry
- Relying heavily on someone within the school to lead and champion the program's implementation, such as a head of curriculum or department

[22] Some teachers felt that the delivery of inquiry resources from CSIRO was at times inconsistent (prior to the end of 2018), as at times there were delays and issues in sourcing resources for the inquiries. This meant that units were sometimes delivered inconsistently across the teaching year or not at all for certain cohorts. After the end of 2018, teachers sourced their own resources.

- Ensuring sufficient guidance in the materials in relation to multi-modal assessments to remove literacy as a barrier to assessing science understanding
- Teachers not having sufficient time to prepare and practice delivering I^2S^2 units
- Having sufficient program resources for Coordinators to meet regularly with teachers (particularly new teachers)

Aboriginal and Torres Strait Islander content delivery

- Lack of confidence among non-Indigenous teachers to sensitively and appropriately deliver Aboriginal and Torres Strait Islander knowledges or speak to Elders in the community (e.g., fear of saying something wrong or over-generalising)
- Providing sufficiently detailed and practical information and guidance to teachers on how to embed knowledges, particularly when they are not from the local area and may be unaware of context, history, and sensitivities
- Ensuring general cultural competency levels are sufficient to inform the specific capability and confidence to employ scientific knowledges
- Organising authentic, engaging experiences delivered by Elders inside and outside the classroom, and understanding the processes and protocols for finding and contacting Elders
- Facilitating local people transferring local knowledge to teachers to ensure students feel confident that teachers are speaking from a place of awareness
- Schools/teachers understanding the importance of engaging with Elders

School recruitment

- Barriers to recruiting schools to the program, including schools already having an inquiry-based program, not having many Aboriginal and/or Torres Strait Islander students, not enough time/space to fit another program in, and simply not interested
- Overcoming perception among schools and teachers that the program would require too much extra time and effort to implement
- Once a school was recruited into the program, issues with obtaining enough face time with schools because school budgets only allowed for finite levels of off-class time and, more generally, some schools were not always 'open' to visitors
- Program design and operation
- Catering for students at different achievement levels; specifically, making it relevant to high achievers as well as those with lower literacy levels
- Accommodating for the differences between primary and secondary schools
- Difficulties establishing and maintaining inter-school collaborations, due to a lack of time and resources

Parental/CARER engagement

- Transportation and time barriers to participating in school activities
- Providing information directly to parents/carers
- Engaging parents/carers meaningfully in school activities (rather than just observing), such as catering to different parental interests
- Sustainability and program fidelity
- Sustainability of the program within a school, given the inevitable turnover of trained teaching staff
- Engaging with communities so they connected strongly to schools and eventually provided support to deliver the cultural components of the program in an ongoing way
- I^2S^2 Coordinator continuity; when the Coordinator changed, the program tended to lose momentum and had lower engagement levls with schools in that area
- Program fidelity, including differences in how individual Coordinators operated the program in different schools, for example, in terms of the frequency and type of in-person school visits, modelling instruction, and sourcing and providing inquiry materials, among other factors

Success factors

The evaluation team identified a set of general success factors that assisted in achieving the outcomes of I^2S^2. Some success factors were identified from individual cases (i.e., teachers, classes, or schools) and although generalising to all situations and contexts should be undertaken with caution, these cases were clear examples of success factors that should prompt further consideration for wider implementation and continuous improvement.

School factors

- Strong head of curriculum/department champion within the school, who drives the program and maintains momentum
- Explicit and ongoing support from the principal, giving teachers the confidence to invest time and effort into delivering the program and permission to include the units in the curriculum
- All relevant year levels and classes participating in the program, creating a broader 'community of practice' where learnings can be shared among educators, and which increases the likelihood that the program will be sustainable

- Whole-of-school/multi-year planning, which facilitates more effective planning across years and can build on student's knowledges and experiences more proactively
- Internal peer support, practice sharing, and/or reflective opportunities in place for teachers to deliver inquiry-based science units
- Collaboration and sharing with other schools to build an inter-school community of practice (I^2S^2 can provide the reason to liaise with other schools), where teachers can share approaches and opinions and compare practice
- Incentives and/or recognition in place for teachers to deliver I^2S[23]

Teacher factors

- High confidence and capacity to deliver:
  - science/inquiry components
  - cultural components
  - hands-on components
  - multi-modal assessments
- Content connected to students' everyday life (real-world application), and aspects of real-world science are incorporated (e.g., accumulating evidence)
- Teachers create a safe space for students to voluntarily share cultural knowledge where appropriate (e.g., lead groups, share family stories)

Community and Cultural Factors

- Authentic partnerships in place with Elders, Traditional Owners, and/or knowledge custodians
- School Aboriginal education worker(s)/Community education officer(s) actively engaged with program, including in-classroom work (teachers must reach out and create a safe space)
- Local Aboriginal and Torres Strait Islander knowledges and/or languages used in inquiries
- Parent/carer/family engagement encouraged

Program Support Factors

- Consistent Coordinator (i.e., low turnover) to ensure continuity of support and relationship
- Frequent face-to-face visits (or as needed), including modelling instruction and coaching at the team level
- Open line of communication with Coordinators, as it meant teachers were confident to deliver the units
- Coordinators respond to questions in a timely manner, for example immediately before a unit was being delivered
- Materials made available in a timely manner (or readily available locally)
- Including general cultural competency training in addition to specific training related to embedding Aboriginal and Torres Strait Islander knowledges
- Including data collection requirements as part of the program to encourage teachers/schools to reflect and aim for continuous improvement
- Leveraging reputation of CSIRO as a national science organisation with an education unit

Curriculum

- Inquiries tailored to different classes and student levels (e.g., challenges used for high achieving students), and introduces inquiry-focused learning at an early age (which can be built on throughout school years and beyond)
- Ensuring program meets curriculum requirements and can be included in science classes with minimal disruption (i.e., embedding within the curriculum, rather than having a separate program)
- A scaffolded approach with accompanying teaching resources
- Resources developed with substantial input from Aboriginal and/or Torres Strait Islander education experts
- An approach that is highly adaptable to suit local contexts, student cohorts, individual teaching styles, and primary vs secondary school, and that allows teachers to find new ways of teaching
- Content that acknowledges and creates understanding of Aboriginal and/or Torres Strait Islander peoples, and provides a way to learn about cultural and scientific contributions positively
- An approach that works equally well for Aboriginal and/or Torres Strait Islander and non-Indigenous students

[23] No case study schools had a formal incentive or recognition program in place; however, some schools had informal acknowledgements.

Discussion

I²S² helped teachers create environments were students, particularly low-achieving students, could engage more actively in science and Aboriginal and Torres Strait Islander contexts; increases in academic achievement were also observed. The hands-on, inquiry-based activities were especially engaging, and the for many Aboriginal and/or Torres Strait Islander students, there was a greater feeling of pride, sense of value, and belonging. Schools' stronger connections with community was universally supported but was mostly in the early planning stages. There was some evidence of longer-term outcomes being achieved, including greater interest in STEM subjects and careers, and a culture of high expectations of students.

Student engagement and academic results

I²S² provides, for Years 5 to 9 science students, a more inclusive pedagogy (i.e., using Aboriginal and Torres Strait Islander knowledge systems as a context), greater teacher capacity (i.e., cultural competency and inquiry), multi-modal teaching techniques and, to some extent, greater student agency in the classroom through inquiry-based, hands-on activities. Together, these program elements have led to increased student engagement and achievement, particularly among lower achieving students and in schools with lower ICSEA scores. Student engagement has a significant influence on the educational and social outcomes for Aboriginal and/or Torres Strait Islander people (Mooney, Seaton, Kaur, Marsh, & Yeung, 2016); therefore, this has been an important achievement.

The social, cultural, and environmental factors surrounding students directly influence students and their beliefs around achievement (i.e., personal, family, and community) (Prodonovich, Perry, & Taggart, 2014). Historically, the Australian education system has favoured western knowledge systems and corresponding teaching frameworks. However, over the past several decades, there has been a consistent call and dialogue around Indigenous knowledge systems and how best to incorporate these knowledge systems into the curriculum, both in Australia and internationally (Friesen & Ezeife, 2009). Students from the non-dominant culture often have to adjust their own behaviour, ways of learning, and language to effectively learn in the classroom (Parsons & Carlone, 2013). Providing an inclusive curriculum such as I²S² creates a learning environment that places value on and recognises the student's culture, histories, and life practices (Sarra, 2011). Although significant progress has been made in developing programs and elaborations (see Appendix 3 for examples of initiatives and programs in Australia), there is little evidence of their effectiveness. The evidence from interviews, focus groups, and jurisdictional and other data shows that improvements in achievement and engagement are possible, despite the significant challenges and barriers. Compared to other Indigenous STEM Education Project programs, I²S² has had the highest level of difficulty in achieving its aims. That is, it has involved the most students, the most schools, across the most jurisdictions, and their varying educational systems and policies, and in metropolitan and regional areas. To have demonstrated tangible successes in student achievement and engagement is a testament to the program's investment in culturally appropriate program design and delivery.

Student sense of value and school belonging

There was evidence for increases in the sense of value and school belonging (aspiration is covered in Outcome 5). I²S² created a new, positive way to highlight Aboriginal and Torres Strait Islander knowledges, and in so doing allowed many Aboriginal and/or Torres Strait Islander students to feel pride in their knowledge and heritage, and that the school was valuing this. In many schools, prior to I²S², culture was only engaged through one-off events (e.g., NAIDOC week) or history, where the content was focused on facts and not something to the deepen understanding of Aboriginal and Torres Strait Islander knowledges and how they were applied.

A sense of value and belonging at school can have significant impacts on wellbeing. The school environment creates opportunities for students to engage with other students, build their networks, and make significant contributions to the school's culture and extended community (Allen & Bowles, 2012). I²S² provided an avenue that largely did not exist before, and created a space that, when effectively managed by capable and confident teachers, encouraged many Aboriginal and/or Torres Strait Islander students to share and feel confident to lead in new ways. Non-Indigenous students also nearly unanimously felt that the knowledges used as context for the I²S² inquiries were interesting and valuable, contributing to the overall sense of belonging

felt by Aboriginal and/or Torres Strait Islander students. A person's self-belief in their achievement does not end with school; therefore, schools are responsible for preparing students to become self-assured individuals capable of pursuing their own goals and ambitions (Pajares & Schunk, 2001). At least for some of the students involved with the case study, this process of increased belonging and sense of value was enhanced by I²S².

Teacher capacity

I²S² provided professional learning, face-to-face support, and a set of resources that assisted most teachers to increase their capacity in delivering inquiry-based learning and using Aboriginal and Torres Strait Islander knowledges as context for science units. Overcoming teachers' low confidence and fear of 'making a mistake' in the area of cultural competency was not and will not be easy. The success of I²S² depends almost entirely on the confidence and capacity of teachers to deliver the program. The Australian Institute for Teaching and School Leadership & Innovation Unit (2018) notes that teachers share the responsibility to cultivate and nurture the self-efficacy and confidence of their students. In doing so, teachers provide the circumstances necessary for students to effectively engage with the curriculum content, build their competence, improve their decision-making skills, and increase their motivation (McInerney, 2005; Pajares & Schunk, 2001; Riley, 2015). Evidence from the interviews and focus groups indicates that teachers that were confident and capable in inquiry-based content and pedagogy could work at multiple levels, teaching effectively within a class, planning inquiry activities across multiples classes, and using Aboriginal and/or Torres Strait Islander knowledges to enrich science understanding and build student motivation. In addition, I²S² was an important contributor to the Australian Professional Standards for Teachers focus areas 1.4 (strategies for teaching Aboriginal and/or Torres Strait Islander students) and 2.4 (understand and respect Aboriginal and Torres Strait Islander people to promote reconciliation between Indigenous and non-Indigenous Australians).

Most Australian teachers work within the dominant western framework of teaching. Bodkin-Andrews and Carlson (2016) suggest that educators must move beyond western knowledge systems and embrace the validity and value of other worldviews and knowledge systems. For many teachers, I²S² was the first in-depth exposure to Aboriginal and Torres Strait Islander knowledges (many teachers reported an absence of cultural capability training as pre-service teachers) and it often proved challenging; however, many educators rose to the challenge and, using the support of Coordinators and their peers, commenced on a pathway to increased cultural competency overall.

Although identifying and understanding general practices that strongly engage students is of critical importance, teaching should also ensure that practices culturally reinforcing for students from varying social and cultural backgrounds, particularly for First Nations students, are prioritised (Bodkin-Andrews & Carlson, 2016; Preston & Claypool, 2013; Walter & Butler, 2013). I²S² provided the vehicle for many teachers to help reinforce the value and importance of Aboriginal and Torres Strait Islander knowledges, thereby sending a strong message to students, the school, and the community more generally.

Engagement and partnerships

For students, the influence of community, family, and culture can significantly affect the educational and career pathways that are taken (Best, MacGregor, & Price, 2017; McInerney, Smyth, & Down, 2011). For Aboriginal and/ or Torres Strait Islander young people, positive adult connections in education and a focus on community relationships can either promote wellbeing or protect against risk factors associated with disengagement (Andersen, Edwards, & Wolfe, 2017). Most students reported minimal engagement of parents/carers in their schooling or I²S² more specifically; however, because I²S² was unique (combining hands-on inquiry with Aboriginal and Torres Strait Islander knowledges), students relayed their experiences more frequently to their parent(s) than other subjects. The case study evaluation could not discern any longer-term impacts this sharing of information may have led to, but the increased level of engagement of students in I²S² sets the circumstances for increased parental awareness, and possibly greater engagement in the future.

Effective and positive engagement by parents/carers and Aboriginal and/or Torres Strait Islander and non-Indigenous members of the community in schools should be characterised by authenticity, respect of others' worldviews, accessibility, and purposeful connection to a real-world career and education opportunities (Broadbent & Cacciattolo, 2013; Donovan, 2018; Pridham & Deed, 2012). However, parental engagement needs to consider the diversity of capacities and resources that families possess (Blackmore & Hutchison, 2010) and the perception of shared values across education and the home (Bissett, 2013). For most schools, community and parental engagement in students and the schools overall was relatively low; which doesn't necessarily have negative consequences as parents may feel their children do not need or want more engagement. However, there were a few examples of I²S² prompting interest among parents/ carers, although this was not a deep engagement. One school did have strong links to the community, and I²S² inquiries and knowledges featured in this engagement, demonstrating the potential for other schools to engage more deeply and sustainably with the community.

Enthusiasm levels among educators for achieving more engagement with Elders and Traditional Owners were high; however, engaging with parents/carers was not seen as high a priority (with the acknowledgement that the groups are not mutually exclusive).

Education models that value engagement and partnerships among students, parents/carers, and the broader community benefit from the often-relational nature of Aboriginal and Torres Strait Islander cultures and can draw on the shared ways of knowing, practices, and language of some communities (Donovan, 2015). Authentic engagement between Aboriginal and/or Torres Strait Islander people and educators can also positively influence professional knowledge and develop pedagogical practices that are culturally responsive (Lowe, 2017). Education models that support increased family and community involvement in the education of Aboriginal and/or Torres Strait Islander students include family- and community-based events, encouraging representation at all education levels, forming community partnership programs, and involving community members in learning events and activities (such as 'on-country' two-way science and inviting influential cultural leaders to participate in or lead culturally inclusive activities) (Allen, Vella-Brodrick, & Waters, 2016; Douglas, 2011; Pridham & Deed, 2012). I²S² has provided examples of some of these models, including community-based events; however, there are many opportunities to expand and enhance these opportunities.

Student STEM pathways

There was some evidence that I²S² led to increased interest in and engagement with STEM among students, although it was relatively early to make conclusions about the longer-term education and career pathways that may result due to this increase. Decreasing enrolments and participation in STEM disciplines is a significant issue because building capacity in the STEM fields is pivotal to maintaining and increasing productivity and international competitiveness (Marginson, Tytler, Freeman & Roberts, 2013; Office of the Chief Scientist, 2013, 2020). Because the Australian education system does not often reflect the diverse cultural views of 'aspiration' that students may have, including the many aspirations held by Aboriginal and/or Torres Strait Islander students, I²S² can play a pivotal role in creating interest in and commitment to STEM, particularly pre-high school (Years 5 to 6). The dual focuses of I²S² to increase engagement and improve education outcomes is relatively rare among pedagogical approaches (Burgess et al., 2019). This combination bodes well for achieving longer-term outcomes among student participants; however, there will be significant challenges maintaining gains beyond Year 9, the last year the program is available.

Best practice and adoption by jurisdictions

Historically, Indigenous knowledges (including scientific knowledges) have often been depicted as inferior to western knowledge, dismissed altogether, or misappropriated and oversimplified (Ewing, 2014; Martin, Nakata, Nakata, & Day, 2017). Underlying the relationship between the mainstream education system and Aboriginal and/or Torres Strait Islander people is a colonial history of exclusion and systemic disadvantage (Lowe, 2017). Therefore, a diverse workforce or the capability of educators to be culturally responsive is important to change this view and increase engagement with Aboriginal and/or Torres Strait Islander families and community members in education (Ewing, 2014; Shay & Wickes, 2017). I²S² has provided schools with an inquiry-based learning program that privileges Aboriginal and Torres Strait Islander knowledges. Several teachers commented that I²S² is the "spearhead" that has positively introduced these knowledges. The teacher professional learning, and particularly the subsequent face-to-face, individualised support provided by Coordinators, was effective but faced several barriers, given the sheer diversity of schools and teacher competency levels involved. Although no jurisdictions had adopted I²S² as a state-wide program (likely unrealistic, as I²S² is primarily targeted at schools with higher enrolments of Aboriginal and/or Torres Strait Islander students), the introduction of an online training I²S² professional learning component has seen increased interest and uptake across the country. A different approach identified in the literature is 'curriculum reconciliation' (Kennedy et al., 2019), which may be a concept for I²S² to investigate in the future. This approach 'adheres to Aboriginal methods for conducting business and maintaining knowledge integrity, rather than embedding predefined packages of Indigenous Knowledges and pedagogies into curricula' (p. 148).

Schools supporting other STEM programs

There was ample evidence that the eight schools involved in the case study supported a diverse range of STEM programs, including school-wide initiatives. Involvement in I²S² was likely part of wider interest and support for STEM, rather than I²S² causally leading to this involvement. Feedback from Coordinators also indicates a relatively high amount of cross-pollination between CSIRO programs.

High expectations

I²S² was widely viewed by students, educators, and community members as a positive, effective STEM education program that contributed overall to a culture of high expectations in schools. Almost all students provided feedback that their teachers and school generally wanted them to do well academically; however, the overall focus was on effort. There was limited evidence that I²S² led directly to increases in expectation, but there was substantial feedback that I²S² provided important components that were not in place beforehand.

Recommendations

The following recommendations for the I²S² program are based on the evaluation findings conducted in 2018 and 2019, that is, before the program moved to a primarily online delivery model in 2020.

Celebrating and sharing student success

1. Further explore opportunities to recognise student completion of I²S² inquiries, particularly challenge level activities, for example by additional collaboration with CSIRO's Creativity in Research, Engineering, Science and Technology Award (CREST) program or a separate recognition program.

2. Explore opportunities for students who have completed I²S² inquiries to share their findings at science events, potentially virtually. Facilitating events that allow students to interact with other students from across the country and take control of the learning process would likely further increase engagement. More generally, the program could explore how to increase interactions among students participating in the program from different schools.

Community, school, and parental connections

3. There are opportunities for more schools to connect more closely with local Elders, Traditional Owners, community members, and Indigenous organisations. The I²S² program could provide more resources, support, and guidance (for example, who to approach and how to appropriately compensate knowledge custodians) regarding how schools can build stronger relationships with local stakeholders, including how to engage these stakeholders in science inquiry, and contextualising Aboriginal and Torres Strait Islander knowledges and the school more generally. Involving knowledge custodians would provide more authentic and engaging experiences for students.

4. Coordinators felt that school leadership and their support of the program was essential to the program's success. Currently, the relationships with the I²S² program are with individual teachers and/or heads of curriculum/department. It is recommended that further investigations be undertaken on how to create more successful relationships between school leadership and the I²S² program, which would result in more engagement from the entire school and sustainability over time.

5. Explore what resources or support the program could provide teachers to encourage parents/carers to attend I²S² science inquiry units. Specifically, teachers would appreciate more assistance from the I²S² program to create meaningful relationships and partnerships with Aboriginal and/or Torres Strait Islander families and organisations. It is acknowledged that teachers and schools are exceptionally busy, but with some additional support, potentially in conjunction with other Reconciliation Action Plan work, schools could make connections with a few families per year.

Professional learning

6. Investigate bolstering the teacher professional learning concerning the inquiry process to ensure teachers are confident and knowledgeable in its delivery. The inclusion of more practical skill modules (potentially voluntary modules) and modelling examples (for example, videos of teachers) would be useful, particularly for new teachers.

7. Investigate whether a 'train-the-trainer' model, similar to that used in the PRIME Futures program, would increase the sustainability and scalability of the program. A dedicated 'head I²S² teacher' with a formal certification from CSIRO may increase the school's ownership of the program, although the issue of teacher turnover would remain.

8. Further explore opportunities to obtain formal accreditation for I²S² teacher professional learning in all jurisdictions.

Lesson planning and inquiries

9. Investigate whether teachers should be recommended to deliver theoretical and practical aspects of I²S² inquiries in closer succession. Some students reported difficulties when conceptual and hands-on activities were spread across several weeks.

10. Continue to update and improve existing inquiries, and implement additional inquiries covering other areas of the science curriculum and year levels, particularly earlier year levels (Prep to Year 4).

11. Investigate how to more effectively use local Indigenous languages and other community-based cultural knowledge to further contextualise the inquiries (which are based on more universal Aboriginal and/or Torres Strait Islander knowledges) to increase connections to community and place. In particular, increasing the confidence and skills of teachers to adapt the generic resources to their classroom and local contexts would be beneficial.

12. Investigate whether teachers are providing students with sufficient context to the inquiries, so learners understand the aim of each inquiry and the knowledge intended to be gained.

13. Investigate interactive, online IT platforms for students to record data and undertake other aspects of the inquiry, for example, links to more information about Indigenous knowledges.

Assessment and resources

14. Examine whether more information needs to be provided to teachers regarding how to assess and grade inquiry-based science, for example, multi-modal assessment techniques.

15. Provide teachers with more information about where they can locate resources and how best to include them in the classroom (i.e., Coordinators modelling lesson plans). The potential for a centralised, web-based store could be explored.

Consistency in Coordinators, communication, and program resources

16. Due to substantial variations in how individual Coordinators implemented and operated the program (beyond adapting to local needs), efforts should be made to ensure minimum standards for program fidelity are met and that a core set of communications, interactions, and support from Coordinators are consistently applied across schools and jurisdictions. For example, there should be a minimum response time set for answering queries from teachers, particularly as many teachers ask for help the day before an I^2S^2 inquiry unit is due to be delivered in the classroom.

17. Work more closely with Indigenous education Coordinators (or similar) at the state and territory level to promote and champion the program. These Coordinators often have more continuity than teachers.

Cultural competency for teachers and communities of practice

18. Explore how the I^2S^2 program could inform broader practice in delivering cultural competency training to teachers, for example, through university courses for pre-service teachers or providing refresh/intermittent training modules. The I^2S^2 cultural competency training was deemed useful and valuable to participants; however, many teachers felt a more comprehensive and ongoing professional learning related to cultural competency would be helpful.

19. Further develop an online community of practice to facilitate teachers sharing and learning from each other, including meaningful collaborations to, for example, undertake lesson planning and how to 'do things differently'. A 'buddy system' pairing more experienced teachers with less experienced teachers could also be explored. In addition, more information should be provided about 'cluster schools' and how schools can make connections.

Online learning platform

The following recommendations are provided in the context of the case study being conducted before I^2S^2 was shifted to primarily online delivery.

20. Ensure the online platform is as engaging as possible, as face-to-face contact was the preferred mode of contact for the majority of teachers (at the time of the case study).

21. Ensure the personal knowledges of Coordinators can continue to be accessed and shared in an online environment. Explore options for integrating the expertise of Coordinators into the learning experience.

22. Explore options for recreating a hands-on experience in a virtual context, as learning 'hands-on' with a program Coordinator was a valuable component of the face-to-face professional learning.

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Appendix 1: Impact pathway

Impact Pathway Statement Inquiry for Indigenous Science Students

Participation

CSIRO, BHPB

I2S2 Team, Technical Experts

INPUTS
What we invest

- $5.90m
- 30 year relationship between CSIRO and BHPB in science education
- CSIRO experience in science inquiry education – especially CREST
- Indigenous leadership

ACTIVITIES
What we do

- **Recruitment of schools** to participate in program and building community relationships

- Recruit and train team to develop and implement:
- Hands on scientific inquiries with indigenous context linked to Australian curriculum
- Teachers support resources – e.g. multimodal delivery and assessment, wiki space, scaffolding
- Teacher Professional Development (TPD) package – science inquiry skills and Indigenous context

- Development of program monitoring processes

Assumptions

- Indigenous leadership is critical to program success including development of Indigenous inquiry. Indigenous assistant teachers know the cultural context so are important partners. They may need capacity building in western science context.
- Using multi-modal ways to demonstrate and improve success in science will encourage students to improve their literacy and encourage schools and teachers to raise their expectations.
- To improve pathways to university we need to work through middle school and into year 10.
- Both VET and university pathways should be supported, tailored to individual student skills and aspirations. Inquiry pedagogy is consistent with Indigenous pedagogy.

External factors

- The Aboriginal and Torres Strait Islander cross curriculum priority is an important support for the program's focus on Indigenous context.
- The level of non-Indigenous parental support for Indigenous content in schools is untested. There is a lack of curriculum demonstrating Indigenous scientific inquiry skills.
- Most teachers of Indigenous students are non-Indigenous so role modelling of high expectation STEM programs by non-Indigenous teachers is important.
- Family support for education achievement varies.
- There are systemic pressures that channel Indigenous students to VET.
- Policy imperatives with literacy and numeracy can result in science pedagogy having lower priority.

I2S2 team, Dept Officials, Principals, Teachers	I2S2 coordinators, Teachers, Students, Elders, Family, Community	Universities, Community Jurisdictions, Schools

OUTPUTS Our deliverables	OUTCOMES The uptake, adoption or consumption of or work		IMPACTS Benefits to economy, environment and society
Development of agreements with schools and partnerships with community orgs	Increased student engagement, attendance and results	Increased number of Indigenous (and non-Indigenous) students pursuing STEM pathways – Yr 10-12, university and alternatives	Indigenous knowledge and culture valued: complementarily to western science demonstrated
Year 5-9 Indigenous contextualised inquiry and support resources developed	Increased student aspiration, sense of value and school belonging	Schools are culturally competent in delivering Indigenous contextualised inquiries in partnership with families and communities	Greater under-standing and care of environment
TPD package delivered to participating teachers	Increased teacher capacity in both inquiry and indigenous context	Best practice in high expectation science inquiry education programs and TPD identified; jurisdictions adopt	Social cohesion/ reconciliation
Delivery of inquiries	Increased community, parental engagement	Schools supporting other STEM programs (e.g. ASSETS, Crest and Awards, PRIME Futures)	More, higher quality and greater workforce diversity of STEM professionals
Ongoing TPD		School culture of high expectation – also benefitting other subject areas	Increased innovation and workplace productivity
Monitoring data			

Appendix 2: I²S² inquiry topics

Year 5

What's Cooking?

Investigate food preparation and cooking techniques with Aboriginal and/or Torres Strait Islander knowledge of chemical science.

Keeping Cool

Experiment with shelter construction and the impacts of light and heat on physical structures and surfaces with Aboriginal and/or Torres Strait Islander knowledge of physical sciences.

Year 6

Let's Stick it Together

Explore the use of resins and gums as adhesive tools with Aboriginal and/or Torres Strait Islander knowledge of chemical sciences.

Grow and Survive

Investigate ecological processes with Aboriginal and/or Torres Strait Islander knowledge of chemical sciences.

Year 7

Throw it Far

Experience and explore the design and construction of spears and spear throwers with Aboriginal and/or Torres Strait Islander knowledge and physics.

In the Mix

Experiment with separation techniques and how to separate mixtures for a variety of purposes with Aboriginal and/or Torres Strait Islander knowledge of chemical sciences.

Year 8

Fire: A Burning Question

Investigate kinetic and heat energy through traditional fire-starting methods with Aboriginal and/or Torres Strait Islander knowledge of energy.

Rock On

Explore rock tools and their diverse uses with Aboriginal and/or Torres Strait Islander knowledge of earth sciences.

Year 9

Burn and Grow

Explore fire ecology principles used to landscape and manage the environment with Aboriginal and/or Torres Strait Islander knowledge of abiotic factors and energy.

Perfect Pitch

Explore the manipulation of sound waves with Aboriginal and/or Torres Strait Islander knowledge of physical sciences and sound production.

Appendix 3: Inquiry-based and Indigenous STEM Programs

Aboriginal and Torres Strait Islander Histories and Cultures, Australian Curriculum Assessment and Reporting Authority Teaching Elaborations

In 2018, the Australian Curriculum Assessment and Reporting Authority released 95 teaching elaborations that sought to assist educators and communities in incorporating Aboriginal and Torres Strait Islander Histories and Cultures across the curriculum, specifically in Science units (Australian Curriculum Assessment and Reporting Authority, 2018). The elaborations aim to provide teachers and students with an opportunity to recognise and value the historical and cultural significance of Aboriginal and Torres Strait Islander knowledge and practices. In addition to teacher background information resources and illustrations of practice, the elaborations aim to endorse a more culturally responsive curriculum experience for Aboriginal and Torres Strait Islander students. The elaborations provide practical examples and content across all three strands of the science curriculum for all year levels. The elaborations across Years 5 through 10 included teacher background information explaining how the content aligns with the science curriculum. The background information provided to teachers includes a list of consulted works readily accessed online.

Primary Connections: Linking science with literacy

Primary Connections: Linking science with literacy is a program developed by the Australian Academy of Science that aims to link the teaching of science and literacy in primary schools across Australia (Primary Connections, 2021). The program focuses on strengthening students' skills and understanding of science and literacy through inquiry-based teaching methods. The program is delivered to Foundation through to Year 6 students. In 2004, Primary Connections developed and trialled eight curriculum units and a Professional Learning Program.

The program provides teachers and students with a suite of classroom units alongside learning resources that align with Australian Curriculum requirements for science. Specifically, the program covers three strands of science: Science as Human Endeavour, Science Understanding, and Science Inquiry Skills. Primary Connections also covers other content that forms part of the Australian Curriculum, for example, mathematics and English.

The professional development component of the program aims to improve students' science and literacy outcomes and develop teacher confidence. The professional development component explains the pedagogy of the program, the goals of the program, and its delivery. Teachers are given the opportunity to attend workshops that develop their pedagogical content knowledge. The workshops provide teachers with an opportunity to explore how they could administer, extend, or adapt the curriculum units for their students across their own lesson planner.

Science by Doing

Science by Doing is an online evidence-based program for students in Years 7 through to Year 10 (Science by Doing, 2021). The program was developed by the Australian Academy of Science and funded by the Australian Government Department of Education. The program aims to improve student science outcomes by increasing student engagement through an inquiry-based learning approach. Additionally, the program aims to provide teachers with quality resources that are relevant and utilise innovative technology.

The program aligns with Australian Curriculum standards for science. The program offers introduction courses called '*Introduction to Science by Doing' and 'Doing Science Investigations'* in addition to 16 units for students in Year 7 through to Year 10. Each curriculum unit comprises three delivery components, comprising the Student Guide, Student Digital, and Teacher Guide. The Student Guide provides students with instructions for each unit activity, questions, and additional resources. The Student Digital is an online resource that students can access through the Student Guide that provides supplementary videos, audio clips, and interactive activities. The Teacher Guide includes additional teacher notes and information to assist them with lesson delivery.

re(Solve), Maths by Inquiry

re(Solve) Mathematics by Inquiry seeks to provide students in Foundation through to Year 10 with high-quality, engaging mathematics content and lessons (re(Solve): Maths by Inquiry, 2021). The re(Solve) program promotes inquiry-based lesson delivery and aims to develop and administer a suite of relevant units and resources for students and teachers that incorporate contemporary mathematics pedagogies. re(Solve) is managed by the Australian Academy of Science alongside the Australian Associated of Mathematics and funded by the Australian Government Department of Education.

The re(Solve) program includes an inquiry protocol that informs classroom delivery of the program. The protocol includes three focal points, including the program's emphasis on mathematics being purposeful, the program tasks remaining inclusive and challenging, and classrooms having a knowledge building culture. Teaching resources are available to teachers for each year level that include lesson descriptions, lesson plans, a Teacher Guide, and content references. Each unit, alongside the related resources, align with the Australian Curriculum: Mathematics. The program also offers teachers the opportunity to engage with professional learning modules that aim to promote the development of teachers and school engagement. Professional learning modules include information around the underlying principles of teaching mathematics utilising inquiry projects, the inclusion of all students, examples of challenging student tasks, and consolidating student learning.

SSiSTEMIK Pathways

SSiSTEMIK Pathways is a program delivered by the Stronger Smarter Institute that aims to encourage increased use of and engagement with Aboriginal and Torres Strait Islander knowledge in STEM (Stronger Smarter Institute, 2021). The program places great importance on increasing the understanding (or deeper understanding) students have of STEM. The program offers teachers and community members an opportunity to focus on Indigenous knowledge in STEM and develop culturally responsive activities and resources. The SSiSTEMIK Pathways program offers program participants three masterclasses that they can choose to attend. Each masterclass varies in duration, both the SSiSTEMIK Maths Masterclass and the SSiSTEMIK Science Masterclass are delivered across 4 days, whereas the Digital Technologies class is delivered across 2 days. There is an interim of 5 to 6 weeks between each masterclass, the institute allows participants to take this time to consolidate their understanding of the content, in addition to designing the research as part of the challenge.

Each masterclass requires participants to design a research challenge to take back to their workplace. The research challenge allows the participant to explore Indigenous research methodologies and develop their ability to create resources to bring back into the science classroom. Through the implementation and designing phases of the research challenge, participants are supported by an Indigenous knowledge expert and the Stronger Smarter Institute. The SSiSTEMIK masterclass strategies and processes have been recommended by Indigenous knowledge experts and educators that are based on a wide body of research.

The Digital Technologies Masterclass aims to strengthen the ability of the participants to deliver a curriculum that explores Indigenous knowledges through a digital technology lens. The masterclass also delivers effective strategies to deliver a culturally responsive curriculum. The SSiSTEMIK Masterclass: Science focuses on how best to design research that includes Indigenous knowledge systems and developing the research challenge of the participants. The SSiSTEMIK Masterclass: Mathematics focuses on creating connections between the mathematics curriculum, STEM thinking, and Indigenous knowledges.

National Aboriginal and Torres Strait Islander Curricula Project

The National Aboriginal and Torres Strait Islander Curricula Project aims to increase the integration of Aboriginal and Torres Strait Islander perspectives in the classroom (Australian Government, 2021). The program provides teachers with a framework to implement Indigenous perspectives in the classroom as part of the Australian Curriculum. The project promotes an inquiry-based learning model and focuses on eight key learning areas: English, Mathematics, Science, The Arts, Technologies, Humanities, Social Sciences, and Health and Physical Education.

The project includes a resource package designed to empower teachers to focus on and include Aboriginal and Torres Strait Islander knowledge into the classroom, especially knowledge about astronomy, fire, and water. The package includes effective and practical examples of how to incorporate Aboriginal and Torres Strait Islander content into the classroom, with each topic (learning area) including an introduction summary and suggested classroom activities. The examples provided as part of the project are designed to be administered to students at Year 5 through to Year 8 levels. The project promotes the Aboriginal and Torres Strait Islander knowledge as transferrable across all year levels from Foundation through to Year 10.

The National Aboriginal and Torres Strait Islander Curricula Project recognises the significance of language as part of Aboriginal and Torres Strait Islander culture. Although the resources do not explicitly utilise Aboriginal and Torres Strait Islander languages, schools and teachers are encouraged to engage with their local community and the Framework for Aboriginal Languages and Torres Strait Islander Languages.

Appendix 4: Interview and focus group questions

TEACHERS

How long have you taught at this school?

Student questions

1. Do the students find the I²S² inquiries engaging? (Hints: relevant to their everyday lives).

a. Does this contrast with the regular science curriculum?

b. Are there differences in how Indigenous and non-Indigenous students engage with the inquiries?

2. How do you measure student success?

3. Do you provide personalised student support? (Hint: What does this look like?)

Individual (teacher) questions

4. Are you confident in delivering:

a. inquiry?

b. the Indigenous context of the inquiry?

5.Was the Teacher Professional Learning important in assisting you with:

a. inquiry delivery?

b. exploring Indigenous contexts?

6. How important has the role of the I²S² Coordinator been to you?

School questions

7. Does the program integrate well with your school's approach to curriculum and pedagogy?

8. Does your school have a culture of high expectations for all students? What does this look like?

a. Does this apply to teachers? What does it look like?

9. Are you supported in your professional learning to enact new programs and ideas such as I²S²?

10. Do you feel you belong to a community of practice with this (or other) programs?

Family/Community questions

11. Does your school have strong relationships with Indigenous families?

a. Has the I²S² program helped in building relationships with families; other community members/ organisations?

STUDENTS

Student questions

1. Can you tell me a bit about the I²S² inquiries/units that you've done?

2. Did you like them? Find them interesting/ fun? Why/why not?

a. Do you think the I²S² units are different to your other science classes? If 'Yes', How?

3. Do you enjoy learning about the science used by Aboriginal and/or Torres Strait Islander peoples? Why?

4. How did what you learnt make you feel? (Hint: proud to be Aboriginal & Torres Strait Islander? /not proud, uncomfortable, disgusted?)

Teacher questions

5. Do you ask for help when you don't understand something? Do you feel comfortable asking for help?

6. Is your teacher able to help you? (Hint: Do they have time? Resources?)

7. Does your teacher show you how science can explain things you do/use every day?

8. Can you tell me what you've learnt?

9. Do you find the I²S² units easy or hard?

School questions

9. Do you think that your school expects you to get good grades? Or do more/further study after school?

10. How do you feel about Indigenous culture being taught in your school?

Family/Community questions

11. Do you think your school respects and values Aboriginal and Torres Strait Islander cultures? *[NB: be clear here that we aren't making value judgements]*

12. Do you feel like your family is welcome at your school?

13. Has this program helped get your community/your family to be more involved with your school? (e.g.) Have you had an aunty or uncle come in to talk to your school as a result of I²S²?

FAMILY/COMMUNITY

Student questions

1. Does your child/children find the science curriculum engaging? (Hints: relevant to their everyday lives).

a. Does this contrast with the regular science curriculum?

Individual (teacher) questions

2. Do you feel that the school teaches Indigenous perspectives well?

3. Are they getting help from Aboriginal and/or Torres Strait Islander parents/carers, organisations, Elders?

School questions

4. Does your school expect your kids to succeed and what does this look like?

5. Does this apply to both students and teachers?

6. Does the school have a good relationship with Aboriginal and/or Torres Strait Islander parents/carers? With the Aboriginal or Torre Strait Islander community?

Family/Community questions

7. Has I²S² helped in building relationships between the school and Indigenous families? With local Aboriginal organisations?

Appendix 5: Example inquiry rubric (year 6: let's stick it together)

STRAND	SUBSTRAND	A	B	C	D	E
Science Understanding	Chemical sciences	Applies science knowledge to evaluate the consequences of variation to usual reversible change.	Explains the difference between reversible and irreversible changes and gives an example.	Classifies changes as reversible and irreversible.	Identifies a change.	Names a type of change.
Science as a Human Endeavour	Use and influence of science	Explains how Indigenous knowledge of resins has contributed to science understanding.	Describes ways knowledge of resin could be applied today.	Identifies how knowledge of resin could be applied today.	Identifies different purposes for which resin is used.	Names a use of resin.
Science Inquiry Skills	Questioning and predicting	Develops an investigable question and makes a reasoned prediction linking detailed science knowledge to cause and effect.	Develops an investigable question and makes a plausible prediction with scientific understanding.	Develops an investigable question and makes a prediction about what might happen with a reason.	Identifies what can be investigated and makes a prediction.	Uses a given investigation question.
	Planning and conducting	Plans a detailed method that includes safety considerations and explicit variable control. Records and organises accurate data.	Identifies variables to be measured, changed and controlled. Identifies safety considerations and ways to reduce risk. Plans and follows a clear method. Records and organises comprehensive data.	Identifies variables that need to be changed and measured. Identifies safety risk. Plans and follows a method. Records and organises relevant data.	Identifies possible steps for a method and a variable to be measured. Uses equipment safely. Records observations.	Uses given investigation method and equipment safely. Records information.
	Processing and analysing data and information	Explains trends within the data. Presents a well-reasoned, evidence-based conclusion.	Presents data using appropriate representations. Identifies trends. Compares results with prediction using data in explanation.	Presents data using appropriate representations. Refers to data when reporting findings.	Suggests a finding.	Makes a statement about the investigation.
	Evaluating	Justifies how change will improve the investigation.	Suggest a change that will improve the method.	Suggest a change to the method.	Identifies a difficulty/ problem.	Identifies if the test was fair or unfair.
	Communicating	Coherent use of relevant scientific language when communicating ideas and findings.	Uses appropriate every day and scientific language to communicate ideas and findings.	Uses appropriate everyday language to communicate ideas and findings.	Uses everyday language.	Fragmented use of language.

Appendix 6: Jurisdictional data analysis

	Year 5			Year 6			Year 7			Year 8		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Science grade												
I²S²schools: All students	3.15	0.90	1,724	3.19	0.93	1,608	3.36	0.86	3,698	3.25	0.94	3,548
Comparison schools: All students	3.39	0.89	47,688	3.46	0.91	46,592	3.52	0.91	41,058	3.46	0.97	39,104
t-value / p value / Cohen's d	11.22	0.00	0.28	11.45	0.00	0.30	10.71	0.00	0.18	12.50	0.00	0.21
I²S² schools: Aboriginal and/or Torres Strait Islander students	2.73	0.85	457	2.76	0.85	396	2.97	0.85	713	2.81	0.90	711
Comparison schools: Aboriginal and/or Torres Strait Islander students	2.89	0.86	4,823	2.89	0.86	4,823	3.00	0.89	4,032	2.87	0.94	3,798
t-value / p value / Cohen's d	3.89	0.00	0.19	2.95	0.00	0.15	0.97	0.33	0.04	1.66	0.10	0.07
I²S²: Non-Indigenous students	3.30	0.88	1,267	3.33	0.92	1,212	3.46	0.84	2,985	3.36	0.92	2,837
Comparison schools: Non-Indigenous students	3.45	0.87	42,863	3.51	0.90	41,981	3.58	0.89	37,021	3.52	0.95	35,305
t-value / p value / Cohen's d	6.19	0.00	0.18	6.99	0.00	0.21	7.59	0.00	0.14	8.85	0.00	0.17
ICSEA score												
I²S² schools: <901	2.95	0.89	615	3.00	0.91	599	3.30	0.90	766	3.08	1.02	743
Comparison schools: <901	2.94	0.92	3,546	3.05	0.93	3,440	3.07	1.00	2,412	2.94	1.03	2,311
t-value / p value / Cohen's d	0.44	0.66	0.02	1.11	0.27	0.05	5.99	0.00	0.24	3.11	0.00	0.13
I²S² schools: 901-920	3.00	0.91	499	3.24	0.91	470	3.25	0.83	399	3.19	0.94	434
Comparison schools: 901-920	3.08	0.90	2,441	3.23	0.93	2,529	3.37	0.88	1,971	3.17	0.98	2,029
t-value / p value / Cohen's d	1.88	0.06	0.09	0.080	0.94	0.00	2.50	0.01	0.13	0.44	0.66	0.02
I²S² schools: 921-940	3.32	0.80	213	3.13	0.87	171	3.34	0.82	1,829	3.26	0.91	1,701
Comparison schools: 921-940	3.20	0.91	3,888	3.25	0.90	3,625	3.38	0.89	5,560	3.23	0.92	5,247
t-value / p value / Cohen's d	-2.16	0.03	0.14	1.64	0.10	0.12	1.90	0.06	0.05	-0.97	0.33	0.03
I²S² schools: >940	3.54	0.83	397	3.44	0.96	368	3.55	0.91	704	3.47	0.87	670
Comparison schools: >940	3.48	0.86	37,422	3.53	0.89	36,644	3.60	0.89	30,869	3.56	0.94	29,253
t-value / p value / Cohen's d	-1.34	0.18	0.07	1.77	0.08	-0.10	1.26	0.21	-0.05	2.54	0.01	0.09

Note: SD = Standard deviation; n = number of students in sample; cells shaded in blue indicate comparison schools had significantly higher mean grade ($p < 0.05$); green shaded cells indicate I²S² schools had a significantly higher mean grade ($p < 0.05$); white shaded cells indicate no significant difference.

	Year 5			Year 6			Year 7			Year 8		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Per cent Indigenous students												
I^2S^2 schools: 0-11 per cent	3.36	0.84	397	3.41	0.87	393	3.44	0.83	966	3.34	0.89	774
Comparison schools: 0-11 per cent	3.47	0.87	34,624	3.53	0.89	33,707	3.58	0.89	30,540	3.54	0.95	28,864
t-value / p value / Cohen's d	2.60	0.01	0.13	2.75	0.01	0.14	5.37	0.00	0.16	6.07	0.00	0.21
I^2S^2 schools: 12-16 per cent	3.17	0.91	368	3.30	0.92	322	3.33	0.88	1,145	3.21	0.87	1,166
Comparison schools: 12-16 per cent	3.31	0.86	5,279	3.38	0.89	5,374	3.40	0.94	6,108	3.29	0.96	5,946
t-value / p value / Cohen's d	2.90	0.00	0.16	1.45	0.15	-0.09	2.54	0.01	0.08	2.59	0.01	0.08
I^2S^2 schools: 17-33 per cent	3.20	0.94	296	3.09	0.98	255	3.38	0.85	1,091	3.38	0.97	1,132
Comparison schools: 17-33 per cent	3.18	0.89	5,382	3.26	0.92	5,170	3.42	0.88	3,062	3.30	0.98	3,006
t-value / p value / Cohen's d	-0.36	0.72	0.02	2.77	0.01	0.19	1.03	0.30	0.04	-2.27	0.02	0.08
I^2S^2 schools: 34-100 per cent	2.98	0.90	663	3.03	0.92	638	3.26	0.91	496	2.89	0.99	476
Comparison schools: 34-100 per cent	2.92	0.95	2,403	3.03	0.96	2,341	2.96	1.01	1,348	2.83	1.02	1,288
t-value / p value / Cohen's d	-1.33	0.18	0.06	0.08	0.94	0.00	-5.96	0.00	0.30	-1.15	0.25	0.06
Remoteness												
I^2S^2 schools: Major cities	2.97	0.90	451	3.22	0.90	430	3.29	0.82	1,407	3.15	0.87	1,270
Comparison schools: Major cities	3.44	0.89	29,303	3.50	0.91	28,669	3.59	0.89	25,085	3.55	0.95	23,764
t-value / p value / Cohen's d	11.12	0.00	0.53	6.58	0.00	0.32	13.11	0.00	-0.33	15.63	0.00	0.42
I^2S^2 schools: Inner regional	3.47	0.85	462	3.33	0.95	385	3.37	0.95	550	3.31	0.90	553
Comparison schools: Inner regional	3.35	0.85	9,992	3.38	0.88	9,809	3.43	0.91	8,625	3.31	0.95	8,184
t-value / p value / Cohen's d	-2.95	0.00	0.14	1.00	0.32	0.06	1.56	0.12	0.07	0.05	0.96	0.00
I^2S^2 schools: Outer regional	3.06	0.89	811	3.10	0.93	793	3.42	0.87	1,741	3.31	0.99	1,725
Comparison schools: Outer regional	3.32	0.89	6,986	3.40	0.92	6,771	3.47	0.92	6,419	3.39	0.99	6,271
t-value / p value / Cohen's d	7.86	0.00	0.29	8.76	0.00	0.33	1.92	0.05	0.05	3.02	0.00	0.08

	Year 9			Primary (Years 5-6)			Secondary (Years 7-9)			All Years		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Science grade												
I²S²schools: All students	3.29	0.94	3,066	3.17	0.92	3,332	3.30	0.91	10,312	3.27	0.92	13,644
Comparison schools: All students	3.44	0.99	38,767	3.43	0.90	94,280	3.47	0.96	118,929	3.45	0.93	213,209
t-value / p value / Cohen's d	8.58	0.00	0.15	16.07	0.00	0.29	18.25	0.00	0.18	22.66	0.00	0.20
I²S² schools: Indigenous students	2.79	0.92	557	2.74	0.85	853	2.86	0.89	1,981	2.83	0.88	2,834
Comparison schools: Indigenous students	2.85	0.97	3,476	2.92	0.87	9,423	2.91	0.94	11,306	2.91	0.91	20,729
t-value / p value / Cohen's d	1.47	0.14	0.06	5.78	0.00	0.20	2.32	0.02	0.05	5.02	0.00	0.10
I²S²: Non-Indigenous students	3.40	0.91	2,509	3.31	0.90	2,479	3.41	0.89	8,331	3.39	0.89	10,810
Comparison schools: Non-Indigenous students	3.50	0.97	35,284	3.48	0.89	84,844	3.53	0.94	107,610	3.51	0.92	192,454
t-value / p value / Cohen's d	5.29	0.00	0.10	9.34	0.00	0.19	12.44	0.00	0.13	14.22	0.00	0.14
ICSEA score												
I²S² schools: <901	3.13	1.07	709	2.98	0.90	1,214	3.17	1.00	2,218	3.10	0.97	3,432
Comparison schools: <901	3.00	1.06	2,321	2.99	0.93	6,986	3.01	1.03	7,044	3.00	0.98	14,030
t-value / p value / Cohen's d	2.783	0.01	0.12	0.48	0.63	0.01	6.72	0.00	0.16	5.617	0.00	0.11
I²S² schools: 901-920	3.31	0.90	395	3.11	0.92	969	3.25	0.89	1,228	3.19	0.91	2,197
Comparison schools: 901-920	3.24	0.98	1,967	3.16	0.91	4,970	3.26	0.95	5,967	3.21	0.94	10,937
t-value / p value / Cohen's d	1.0220	0.31	0.07	1.40	0.16	0.05	0.37	0.71	0.01	1.14	0.25	0.03
I²S² schools: 921-940	3.27	0.88	1,364	3.24	0.84	384	3.29	0.87	4,894	3.29	0.87	5,278
Comparison schools: 921-940	3.26	0.92	4,959	3.22	0.91	7,513	3.30	0.91	15,766	3.27	0.91	23,279
t-value / p value / Cohen's d	-0.28	0.78	0.01	-0.38	0.70	0.02	0.22	0.82	0.00	-1.22	0.22	0.02
I²S² schools: >940	3.50	0.91	598	3.49	0.90	765	3.51	0.89	1,972	3.50	0.90	2,737
Comparison schools: >940	3.52	0.98	29,257	3.51	0.88	74,066	3.56	0.94	89,379	3.53	0.91	163,445
t-value / p value / Cohen's d	0.47	0.64	0.02	0.44	0.66	0.02	2.39	0.02	0.05	1.74	0.08	0.03

	Year 9			Primary (Years 5-6)			Secondary (Years 7-9)			All Years		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Per cent Indigenous students												
I^2S^2 schools: 0-11 per cent	3.42	0.88	740	3.38	0.85	790	3.40	0.87	2,480	3.40	0.86	3,270
Comparison schools: 0-11 per cent	3.51	0.98	29,074	3.50	0.88	68,331	3.54	0.94	88,478	3.52	0.92	156,809
t-value / p value / Cohen's d	2.71	0.01	0.09	3.78	0.00	0.13	8.04	0.00	0.15	8.33	0.00	0.14
I^2S^2 schools: 12-16 per cent	3.25	0.87	802	3.23	0.92	690	3.27	0.87	3,113	3.26	0.88	3,803
Comparison schools: 12-16 per cent	3.27	0.98	5,461	3.35	0.88	10,653	3.32	0.96	17,515	3.33	0.93	28,168
t-value / p value / Cohen's d	0.49	0.62	0.02	3.17	0.00	0.13	3.19	0.00	0.06	4.59	0.00	0.08
I^2S^2 schools: 17-33 per cent	3.36	0.95	1,103	3.15	0.96	551	3.38	0.93	3,326	3.34	0.93	3,877
Comparison schools: 17-33 per cent	3.32	0.98	2,988	3.22	0.91	10,552	3.35	0.95	9,056	3.28	0.93	19,608
t-value / p value / Cohen's d	-1.18	0.24	0.04	1.72	0.09	-0.08	-1.50	0.13	0.03	-3.90	0.00	0.07
I^2S^2 schools: 34-100 per cent	2.93	1.04	421	3.00	0.91	1,301	3.03	0.99	1,393	3.02	0.95	2,694
Comparison schools: 34-100 per cent	2.85	1.05	1,244	2.98	0.96	4,744	2.88	1.03	3,880	2.94	0.99	8,624
t-value / p value / Cohen's d	-1.37	0.17	0.08	-0.87	0.39	0.03	-4.82	0.00	0.15	-3.94	0.00	0.09
Remoteness												
I^2S^2 schools: Major cities	3.22	0.85	944	3.09	0.91	881	3.23	0.84	3,621	3.20	0.86	4,502
Comparison schools: Major cities	3.51	0.98	23,486	3.47	0.90	57,972	3.55	0.94	72,335	3.52	0.92	130,307
t-value / p value / Cohen's d	10.15	0.00	0.29	12.45	0.00	0.43	22.35	0.00	0.34	24.22	0.00	0.34
I^2S^2 schools: Inner regional	3.15	0.95	526	3.40	0.90	847	3.27	0.94	1,629	3.32	0.93	2,476
Comparison schools: Inner regional	3.34	0.98	8,296	3.36	0.87	19,801	3.36	0.95	25,105	3.36	0.91	44,906
t-value / p value / Cohen's d	4.53	0.00	0.20	-1.32	0.19	0.05	3.59	0.00	0.09	2.24	0.02	0.05
I^2S^2 schools: Outer regional	3.37	0.98	1,596	3.08	0.91	1,604	3.37	0.95	5,062	3.30	0.95	6,666
Comparison schools: Outer regional	3.36	0.99	6,108	3.36	0.91	13,757	3.41	0.97	18,798	3.39	0.94	32,555
t-value / p value / Cohen's d	-0.21	0.83	0.01	11.75	0.00	0.31	2.73	0.01	0.04	7.16	0.00	0.10

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Contact us
1300 363 400
+61 3 9545 2176
csiro.au/contact
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