Australia's National
Science Agency

CSIRO Digital Careers

Final Evaluation Report

Sarah Renals, Christopher Banks, Lisa Walker

February 2024

Citation

Renals S, Banks, C, Walker, L (2024) Digital Careers – Final Evaluation Report. CSIRO, Australia.

Contents

Figures

Tables

Acknowledgments

The authors would like to thank Digital Careers participants and stakeholders who have contributed to this evaluation by completing surveys, interviews and focus groups. Their time and effort has helped inform the insights discussed in this report.

The authors would also like to acknowledge the CSIRO Digital Careers program delivery team who have supported all evaluation activities.

The authors would like to acknowledge that Digital Careers program monitoring, evaluation and continuous learning was funded by the Australian Government Department of Industry, Science and Resources (DISR), through the Digital Careers grant, and Northrop Grumman Australia and the Australian Signals Directorate as funding partners for CyberTaipan.

Finally, the authors would like to acknowledge the additional industry partners that CSIRO have worked with to deliver the Digital Careers program: Bebras International Community, Microsoft, Air and Space Forces Association, and the Australian Department of Defence: Defence Science and Technology Group.

Executive summary

Digital Careers

In 2021 the Department of Industry, Science, Energy and Resources (DISR) issued a grant to CSIRO to deliver a renewed and extended Digital Careers program to be delivered between 2021 and 2023. The new Digital Careers program was intended to build on the foundations of CSIRO's existing Digital Careers program that had been established in 2011. Digital Careers 2021–2023 comprised eight related elements that were designed to support teachers and encourage students' understanding of digital technologies and build the foundational skills they require in an ever-changing workforce.

Program elements

1. Bebras – Twice annual computational thinking challenge with accompanying resources.
2. CyberTaipan – Annual multi-round cybersecurity competition, cyber-camps, and a careers tour.
3. FarmBeats – Agricultural focused AI, Big Data and IoT school-based projects with Microsoft.
4. Professional Learning – Seminars to support delivery of the Australian Curriculum: Technologies.
5. Web resources – Videos, worksheets and information focusing on digital careers and concepts.
6. CAT competition – Remote and very remote school engagement in a computational challenge.
7. Young ICT Explorers – Annual ICT project challenge.
8. Research – Research into the factors influencing young female students' participation in digital technologies education.

Program reach

Students	Teachers & Educators	Schools	Industry professionals
171,145	8,274	2,642	159

Caveat: Students, educators, schools and industry partners will be counted more than once in program totals if they participate on multiple occasions in a Digital Careers program. Bebras participants are counted per round with two rounds per annum, while CyberTaipan, CAT and YICTE participants are counted per year.

Program intended and actual outcomes

Increased the number of students considering the ICT industry as a career option. **75%** of students were more interested in working in computer science or cyber security (CyberTaipan Careers Tour)	**Improved student interest and capability in technology focused activities.** **94%** of students agreed that they were more interested in learning about cyber security (CyberTaipan CyberCamps)
Improved student capability in algorithmic and computational thinking skills. **98%** of educator survey respondents saw an increase in student capabilities (Bebras)	**Improved teacher capability and confidence in the delivery of the Australian Curriculum: Technologies.** **95%** of educator survey respondents agreed that they were more confident in teaching computational thinking (Bebras)
Increase interest and skills in cybersecurity, artificial intelligence, Internet of Things and Big Data *The more real it becomes the more excited the students get.* (FarmBeats)	

Digital Careers participant experience

Participant experience data was collected for a few elements of Digital Careers and includes:

- Students expressed high levels of satisfaction with CyberTaipan program element.
- Educators expressed high levels of satisfaction with: Bebras, CyberTaipan, and professional learning program elements.
- Industry professionals expressed high levels of satisfaction with CyberTaipan program element.

87% of students enjoyed their experience, and

89% of students would recommend (CyberTaipan)

95% of educators were very or extremely satisfied with their experience, and

89% would recommend (Professional Learning)

87% of industry professionals felt the program was well managed, and

78% of industry professionals would recommend (CyberTaipan)

Digital Careers impact

The most beneficial part about participating in the CyberTaipan competition was being able to work collaboratively with teammates through both success and struggle and to understand and utilise each other's strengths. (CyberTaipan Student Survey)

The more people we have in the country able to deal with cyber security, I think the better. I think that's another good thing about CyberTaipan and cyber awareness, that we're definitely shoring up the future knowledge in the country. (CyberTaipan Mentor Interview)

The Bebras Challenge is an excellent initiative that has provided valuable insights into my students' thought processes, problem-solving capabilities, and particularly their proficiency in computational and critical thinking. (Bebras Educator Survey)

I can in future now make my own computer's security much better. (CyberTaipan Student Survey)

Challenges & Opportunities

The Digital Careers program experienced a number of significant digital technology challenges in its delivery that impacted participant experience, and this was usually in relation to third party technology (CyberTaipan, Bebras, FarmBeats).

A national pandemic created significant challenges for families, educators, and industry professionals prior to and during program delivery. Whilst this increased the need for online program delivery, in some instances it reduced the availability of student supporters.

Evaluation design

This mixed methods evaluation used a number of different data sources and data collection methods, including operational program data, surveys (students, educators, industry professionals), a small number of interviews (educator and industry professional), and observational data. This evaluation did, however, experience challenges including limitations on how people could be invited to take part, low survey response rates, a reliance on self-reported outcome data, and a lack of ability to measure longer term program outcomes.

1 Digital Careers Overview

1.1 Background

Data-driven innovation and digital technologies represent key areas of economic growth globally, and for Australia, and require new knowledge, new technologies, and innovative thinking. As the Australian Government recognised in its 2021 Digital Economy Strategy, to capitalise on these opportunities and realise potential for innovation into the future, Australia needs to ensure that the workforce has the necessary skills and knowledge (Commonwealth of Australia, 2021). These goals are reinforced by the Australian Computer Society's annual snapshot of the Australian Technology Industry, which estimates that the number of workers in information and communications technology (ICT)-related industries will grow to 1.2 million by 2027 and represent an increasing share of the Australian workforce (from 6.7 per cent in 2022 to 8.5 per cent in 2027) (Australian Computer Society 2022). As a reflection of the importance of digital technologies to Australia's future, there has been a push by federal and state governments to increase and improve digital technology education in Australia.

The introduction of the Australian Curriculum: Digital Technologies in 2015 saw digital technologies, problem-solving and teaching students to operate in a knowledge-based society recognised as critical to the wellbeing and sustainability of the economy (Australian Curriculum Assessment and Reporting Authority (ACARA), 2022). The recent release of the Australian Curriculum: Digital Technologies v9.0 included updates to keep pace with changing needs of students and teachers, including sub-strands on privacy and security.

Across the broader science, technology, engineering and mathematics (STEM) field there was concern that Australian students at school and tertiary levels are not engaging in STEM. This is reflected both in overall numbers of students undertaking STEM studies and falling academic performance against international benchmarks (Australian Council for Educational Research (ACER), 2018).

In addition, minority groups are less represented and have fewer opportunities in STEM. This includes students who identify as Aboriginal and/or Torres Strait Islander, girls, and students from areas of low-socioeconomic advantage, and regional and remote communities. Research from the Department of Industry, Science, Energy and Resources (DISR) showed that women are not enrolling in STEM-related university courses at the same rate as men, with 42 per cent of men enrolled in a higher education course choosing a STEM-related course compared to 19 per cent of women (Department of Industry, Innovation and Science, 2020).

1.2 Digital Careers objectives and intended outcomes

The CSIRO Digital Careers Program ('Digital Careers') was first established in 2011 to help raise awareness of and interest in ICT careers to grow and diversify the pool of tertiary students preparing for a career in the ICT industry. In 2021 DISR issued a grant to CSIRO to deliver a renewed and extended Digital Careers program to be delivered between 2021 and 2023. The new Digital

Careers program was intended to build on the work conducted in the Digital Careers program from 2011 and comprised eight related elements that were designed to support teachers and encourage students' understanding of digital technologies and build the foundational skills they require in an ever-changing workforce.

The program objectives were to:

- Increase interest and participation amongst school students in computational thinking, artificial intelligence (AI), cyber security, big data and digital technologies, particularly among underrepresented groups in ICT.
- Increase awareness of career diversity, opportunities and benefits of ICT jobs and careers.
- Provide education and training material and professional development for educators delivering digital technology curriculum and activities (e.g. Bebras, YICTE, CyberTaipan).

The program's intended outcomes were to:

- Increase the number of students considering the ICT industry as a career option.
- Improve student capability in algorithmic and computational thinking skills.
- Increase interest and skills in cyber security, AI, Internet of Things (IoT) and Big Data.
- Improve student interest and capability in technology-focused activities.
- Improve teacher capability and confidence in the delivery of the Australian Curriculum: Technologies.

1.3 Program elements

The eight elements of the Digital Careers program are listed below.

1. Bebras Computational Thinking Challenge Australia (Bebras)
2. CyberTaipan Program (CyberTaipan)
3. Microsoft FarmBeats for Students Australia (FarmBeats)
4. Educator Professional Learning (Professional Learning)
5. Digital Careers Web Resources (Web resources)
6. Computational and Algorithmic Thinking Challenge (CAT)
7. Young ICT Explorers Program (YICTE)
8. Research: Girls' participation in DC Programs (Research)

Elements 1–3 (Bebras, CyberTaipan and FarmBeats) are independent program elements delivered by Digital Careers.

Elements 4–5 (Educator Professional Learning and Web resources) contribute to elements 1–3 in addition to the Digital Careers program as a whole.

Elements 6–7 (CAT and YICTE) are co-funded by CSIRO and delivered by a third party.

Element 8 (Research) is a CSIRO-commissioned research project funded by DISR and completed by the Australian Council for Educational Research (ACER) to inform future program delivery.

1.4 Impact pathways

Digital Careers and three program elements – Bebras, CyberTaipan and FarmBeats – have Impact Pathways (see Appendix A.1). These pathways, based on CSIRO's Impact Model, describe the logic and assumptions of each program, and articulate the expected outputs, outcomes, and longer term impacts. The Impact Pathways include both short-term and medium-term direct program outcomes and longer term, indirect impacts. The Educator Professional Learning program does not have a stand-alone Impact Statement but is integrated into the other Digital Careers programs.

1.5 Evaluation

The evaluation of the Digital Careers suite of programs used a mixed methods approach to synthesise quantitative and qualitative data to answer the following three key evaluation questions:

1. To what extent did the Digital Careers Program successfully engage students, teachers/educators, schools, and industry?
2. To what extent did the Digital Careers Program deliver intended benefits for students, teachers/educators, schools, and industry?
3. How significant is the Digital Careers Program in relation to being unique, efficient, valued, and sustainable?

The evaluation methodology is detailed in Appendix A.2 and discusses how data was collected, analysed and synthesised using an evaluation rubric designed specifically for the Digital Careers program evaluation. Appendix A.2 also includes a discussion of the strengths and limitations of the evaluation methodology.

2 Bebras

2.1 Bebras evaluation summary

Bebras has been a core element of the Digital Careers program that has gained traction from schools, community-based groups and homeschools between 2021 and 2023. Bebras has established participation rates of 164,895 students, 7,278 educators, and 2,728 education facilities of which schools accounted for 2,222 between 2021 and 2023[1]. Feedback from educators has indicated that Bebras is a valued and effective program for enhancing primary and secondary school students' computational thinking skills. Overall, there is evidence to suggest that Bebras has achieved measurable improvements in student participation, knowledge and skills in computational thinking, and has supported educators to gain capability and confidence in teaching computational thinking skills, although educator survey response rates are low.

The Bebras Impact Pathway (Appendix A.1.2) documents the intended outcome for the Bebras program. Table 1 provides an assessment of program outcomes and impacts using an impact scale[2] to indicate program progress and the strength and reliability of evidence.

Table 1 Bebras program outcomes and impacts

Target Group	Bebras Intended Outcomes	Program Progress	Evidence Rating
A. **Student** participation and engagement	Students participate in Bebras activities, finding them enjoyable and appropriately challenging.	Consolidating	Moderate-Low
B. **Student** awareness and interest	Students improve their understanding of computational thinking.	Consolidating	Moderate-Low
C. **Student** capability and confidence	Students develop knowledge and skills in computational thinking and problem-solving.	Consolidating	Moderate-Low
	Students (in group settings) develop skills in communication, leadership, and negotiation.	Developing	Moderate-Low
	Students utilise skills in computational thinking and problem-solving across educational contexts.	Developing	Low
D. **Teacher** capability and confidence	Teachers engage with and utilise Bebras resources and technical support, finding them easy to use and valued.	Consolidating	Moderate-Low
	Increased knowledge, skills, and confidence in facilitating computational thinking/problem-solving activities.	Consolidating	Moderate-Low
	Teachers use Bebras as a resource to facilitate improvement in student computational thinking.	Consolidating	Moderate-Low

[1] Participation rates caveat: Bebras participants are counted per round with two rounds per annum. Students, educators, and schools are counted more than once in program totals if they participate on multiple occasions in Bebras.

[2] See Evaluation rubric and evidence rating scale Appendix 2.5.

It should be noted that the sample size of educators who have responded to the survey is small compared to those that participated and no other evidence is available to qualify these comments, hence a rating of 'moderate' has been provided against most intended outcomes.

2.2 Bebras aims and objectives

Bebras was first established by Lithuanian Professor Valentina Dagiene in 2004. Bebras is now an international network that seeks to build student interest in computer science while strengthening their logical and computational thinking skills. Bebras has now grown to over 60 countries with over 3.9 million students participating worldwide. According to one recently published Australian study, Bebras is one of the best known instruments for measuring the general computational thinking skills and knowledge of students (Boom et al. 2022). The increasing focus on computational thinking aligns with the Australian educational context, where computational thinking is listed as one of nine core concepts underpinning the Australian Curriculum: Technologies v9.0.

Computational thinking skills underpin the careers of the future. Creating opportunities for students to engage in activities that utilise their critical and creative thinking along with problem-solving skills is essential to further learning. The Bebras Challenge is an engaging way for students to learn and practise these skills.

In Australia, two Bebras Challenge rounds were offered each year taking place in May and August–September for students in school years 3–12. Each of the challenge rounds delivered a unique set of questions and challenges for students.

Students from CSIRO Young Indigenous Women's STEM Academy taking part in the Bebras Challenge

2.3 Bebras program delivery

The CSIRO Digital Careers team delivered the following Bebras elements in Australia between 2021 and 2023:

Bebras Challenge	An online event to engage students in problem-solving and computational thinking, held twice per year.
Bebras 365	Online and downloadable resources that use questions from past years of the Bebras Challenge.
Bebras Mini	Shorter versions of the Bebras Challenge available all year with a

Challenges	focus on one computational thinking skill.
Bebras unplugged	An offline, printable version of the Bebras Challenge for use at home or in the classroom.
Bebras solution guides	A downloadable guide that provides solutions to all of the questions and tasks from each Bebras Challenge Round with information relating to the age group, level of difficulty, country of origin of the question and key computational thinking skills.
Bebras webinars	'How to' guided sessions and post-competition review sessions to support educators and answer questions and queries.
Computational Thinking in Action activities	Downloadable worksheets designed to develop teamwork, critical and creative thinking, problem-solving, and computational thinking skills.

In addition, in 2023 a joint initiative was developed between Digital Careers and CSIRO STEM Professionals in Schools program. The initiative was called STEM Professionals in Bebras (SPiB). The intent of the initiative was to connect Bebras schools with a technology industry professional through CSIRO's STEM Professionals in Schools program to establish long-lasting, meaningful partnerships in the classroom.

Bebras will remain available for Australia students in 2024 (and beyond), delivered via the Australian Maths Trust (AMT). AMT offers diverse programs and competitions in maths, computational thinking, and STEM, benefitting over 250,000 participants annually. CSIRO Education is supporting this transition to AMT as part of the Digital Careers legacy – ensuring Bebras' continued impact into the future.

2.4 Bebras participation

Program participation data shown in Table 2, Table 3 and Table 4 show that Bebras has established participation rates between 2021 and 2023 of:

- 164,895 students
- 7,278 educators
- 2,728 education facilities (of which 2,222 were schools)
- 24 industry professionals

It is, however, important to note that Bebras participants are counted per round, with two rounds delivered per annum. If students, educators, and schools participate on multiple occasions in Bebras they are counted more than once in program totals.

Program participation data indicates that 23 per cent of students were male, 19 per cent of students were female, 58 per cent had no gender recorded and44 per cent were in grades 5–6.

Program participation data also indicates that 37 per cent of education facilities were government schools and 19 per cent were homeschools, with 30 per cent of education facilities located in New South Wales.

Table 2 Bebras participation by student demographics 2021–2023[3]

Student demographic data	2021		2022		2023		2021–2023	
	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Count	%
Student participant count	32,305	20,790	27,439	25,506	31,837	27,018	164,895	100%
Gender								
% Female	17%	21%	32%	25%	10%	13%	31,997	19%
% Male	17%	24%	38%	31%	14%	16%	37,776	23%
% Unknown	66%	55%	29%	44%	76%	70%	95,122	58%
School Grade								
Years 3 and 4	31%	35%	33%	37%	32%	38%	56,630	34%
Years 5 and 6	42%	43%	42%	45%	44%	47%	72,081	44%
Years 7 and 8	19%	16%	16%	13%	17%	12%	25,787	16%
Years 9 and 10	6%	6%	8%	5%	6%	3%	9,465	6%
Years 11 and 12	1%	<1%	1%	<1%	1%	<1%	932	<1%
Educators (Coordinators)	1,183	1,400	1,228	1,093	1303	1,071	7,278[4]	100%

Between 2021 and 2023, an annual average of 42 per cent of Bebras Challenge participants were from government schools (Table 3).

Table 3 Bebras participation by educational facility 2021–2023[5]

Education facility type	2021		2022		2023		2021–2023	
	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Count	%
Education facility count	416	422	498	442	532	418	2,728	100%
ACARA listed schools	416	318	390	318	419	361	2,222	81%
Education facility type								
Government schools	-	154	184	153	199	176	866	37%
Independent schools	-	84	99	84	132	113	514	22%
Catholic schools	-	81	106	81	85	74	427	18%
Homeschools	-	84	95	99	99	45	433	19%
Other	-	19	14	25	17	10	75	3%

[3] Source: Bebras program operational data

[4] Educators may have taken part over multiple years but are counted on each occasion they participated.

[5] Source: Bebras program operational data

Schools and other educational facilities from all states and territories participated in Bebras challenges (Table 4).

Table 4 Bebras participation by educational facility location 2021–2023[6]

Education facility location	2021		2022		2023		2021–2023 Count	2021–2023 Percent
	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2		
Education facilities:	416	422	498	442	532	418	2,728	100%
Education facility location								
Australian Capital Territory	8	9	6	5	5	5	38	1%
New South Wales	117	117	151	137	157	133	812	30%
Northern Territory	8	5	6	3	4	1	27	1%
Queensland	76	79	90	77	91	72	485	18%
South Australia	35	33	40	36	37	28	209	8%
Tasmania	32	28	34	21	31	17	163	6%
Victoria	78	84	90	82	112	85	531	19%
Western Australia	62	67	81	81	93	75	459	17%
Not stated	-	-	-	-	2	2	4	0%

STEM Professionals in Bebras (SPiB) Participation

As of November 2023, 25 SPiB partnerships had been established with 16 primary schools and nine secondary schools. These schools are located in six states (NSW = 6, VIC= 6, WA = 5, QLD = 3, SA = 3, TAS = 2), with 90 per cent (n = 20) based in major cities, 12 per cent (n = 3) in inner regional areas, and 8 per cent (n = 2) in outer regional areas. Just over half of schools were government schools (52 per cent, n = 13), and the remainder comprised catholic schools (28 per cent, n = 7) and independent schools (20 per cent, n = 5).

Almost two-thirds of the STEM professionals involved in SPiB have an information technology background (63%, n = 15). Other professionals involved are engineers (n = 3), economists (n = 3), an agricultural scientist, a geoscientist, and a statistician.

Organisations from which STEM professionals are sourced include universities (n = 6), state and commonwealth government departments (n = 6), private sector (n = 10), and two are retired STEM professionals.

[6] Source: Bebras program operational data

2.5 Bebras outcomes

The following section provides information about outcomes that Bebras created or contributed to as determined by feedback from educators in an annual survey.

Almost all educator survey respondents (2021–2023) observed improvement in their students computational thinking skills and application after taking part in Bebras activities (Figure 1).

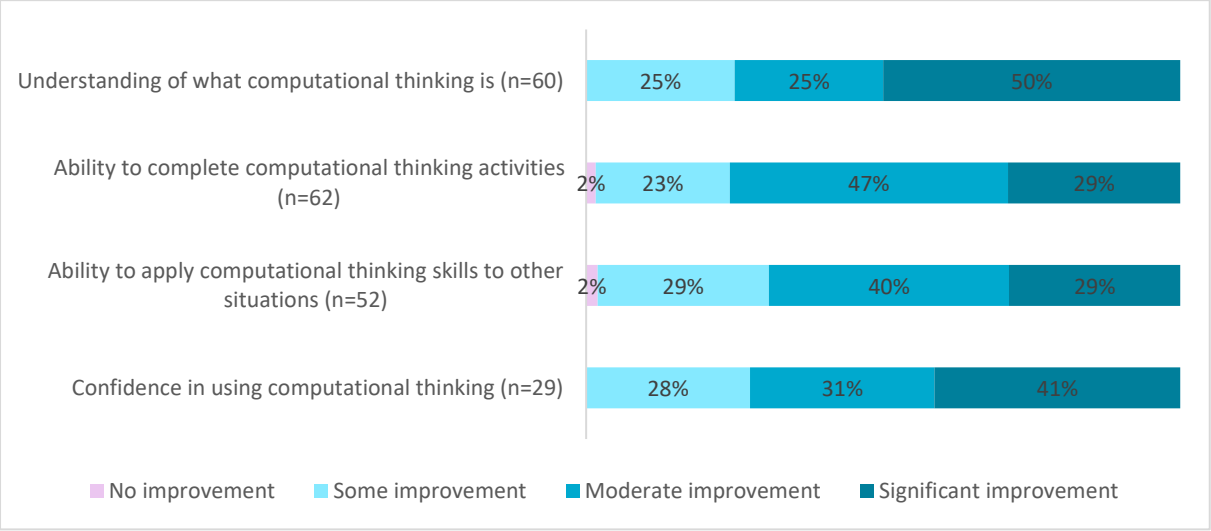


Figure 1 Extent to which educators have observed student improvement in student computational thinking skills as an outcome of using Bebras

More than three-quarters of educator survey respondents (2021–2023) observed improvement in their students' 21st-century skills, such as problem-solving, communication and collaboration skills, after taking part in Bebras activities (Figure 2).

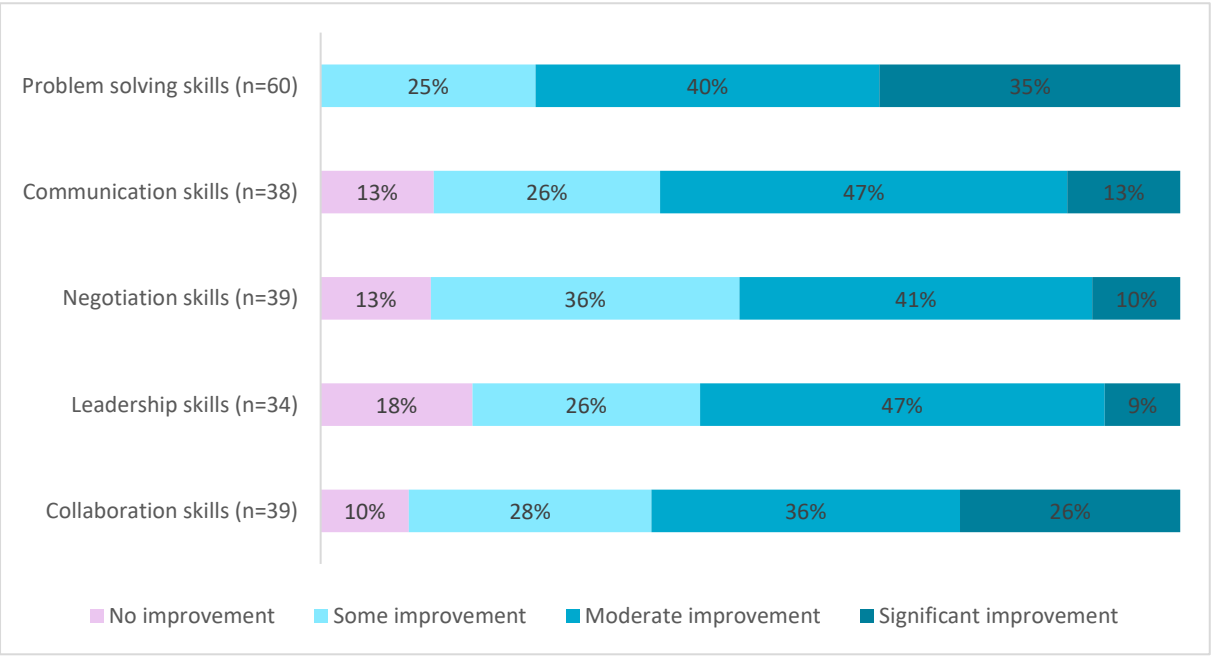


Figure 2 Extent to which educators have observed student improvement in 21st-century skills as an outcome of using Bebras

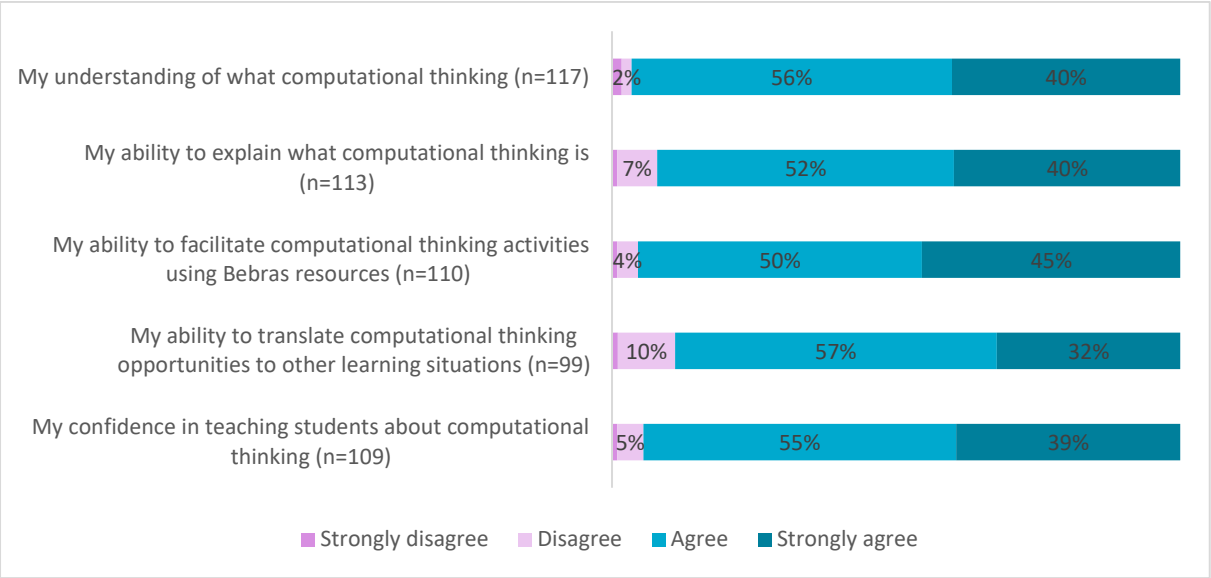


Figure 3 Extent to which educators agree/disagree that they have noticed improvements in their own skills[7].

Almost all educator survey respondents (2021–2023) reported improvement in their own understanding, skills and confidence to teach computational thinking skills to their students after taking part in Bebras activities (Figure 3).[8]

2.6 Bebras experience

Educator survey respondents (2021–2023) reported that Bebras events, activities and resources were considered highly useful.

100% of educators found Bebras Challenge useful of which 79% found very useful (n = 96/123).

100% of educators found Bebras Mini Challenges useful of which 63% found very useful (n = 41/65).

100% of educators found Bebras webinars useful of which 37% found very useful (n = 10/27).

99% of educators found Bebras unplugged useful of which 56% found very useful (n = 40/72).

[7] Source: Bebras educator survey 2021—2023

[8] To date no outcome data has been collected in relation to SPiB.

99% of educators found Bebras solution guides useful of which 72% found very useful (n = 50/69).

99% of educators found Bebras 365 useful of which 79% found very useful (n = 80/101).

94% found Bebras Computational Thinking in Action activities useful of which 50% found very useful (n = 18/36).

Satisfaction and willingness to recommend are two measures educators were asked to provide feedback on in relation to Bebras via the online educator survey.

In 2023, 100 per cent (n = 35) of respondents recorded that they would be likely or very likely to recommend Bebras to other educators. From 87 educator survey responses in 2021 and 2022, respondents rated the likelihood that they would recommend Bebras to other educators 9.1 out of a maximum 10 score rating (mode = 10).

In 2023, 97 per cent (n = 34/35) of educators who provided feedback rated their overall level of satisfaction with Bebras as satisfied or very satisfied, with 69 per cent rating 'very satisfied' (n = 24/35).

In 2021 and 2022 at least three-quarters of survey respondents stated they were satisfied or very satisfied with the following aspects of the Bebras program.

89% Accessing Bebras online resources (n = 87)

83% Requesting Bebras program support (n = 55)

83% Uploading students for Bebras (n = 54)

78% Following Bebras on social media (n = 70)

78% Accessing Bebras Challenge results and certificates (n = 84)

76% Registering yourself for Bebras (n = 49)

76% The Honour Roll changes for increased accessibility (n = 70)

75% Accessing Bebras Challenge review mode (n = 71)

2.7 Bebras impact and opportunities

Educators have highlighted the value and impact of Bebras to their students and their teaching practice and the following are examples of feedback received between 2021 and 2023.

> *The Bebras Challenge is an excellent initiative that has provided valuable insights into my students' thought processes, problem-solving capabilities, and particularly their proficiency in computational and critical thinking. It was a pleasant surprise to see three students attain Honour Roll status out of the 28 participants in the second round this year (year 3 & 4 students).*
>
> (Educator, 2023)

I love using the Bebras Challenge and resources to supplement teaching the Digital Technologies Curriculum. As there is a lack of formal data gathering opportunities in this area the Bebras Challenge allows me to collect data on my students computational thinking skills every year and demonstrate their areas of strength or areas that need improvement.

(Educator, 2023)

Excellent platform which my students have thoroughly enjoyed and gained in knowledge and understanding. I have found it very useful. WELL DONE.

(Educator, 2021)

Our students from Years 4–6 enjoy taking part in the Bebras Challenge and have used the resources and activities to transfer this into other areas of their learning.

(Educator, 2023)

It is such a fantastic and fun way to learn. Most of my students who participate love it.

(Educator, 2021)

The competition is a great program to find hidden talent.

(Educator, 2021)

Opportunities

Over the course of implementing the Bebras program, the program team have received feedback from educators via the educator survey. They have also received unsolicited feedback through emails and chat functions in live virtual sessions.

Key areas of feedback from educator surveys identifying opportunities to strengthen Bebras include:

- Consent process (n = 11): more streamlined and automated parental consent process if required at all; some educators offering solutions.
- Information on student performance (n = 10): greater granularity of information on student performance in the Bebras Challenge, easier access to results and the ability to track progress over time and across learning areas.
- Bebras website/platform (comments n = 10): more user-friendly website and platform, some have suggested more automation and audio/video questions.
- Question topic and resources (n = 7): easier to navigate question topics, ability to easily look for past examples and support resources.
- Certificates (n = 6): certificates linked with performance statistics and automated; educators have offered solutions.
- Marketing (n = 5): more marketing and publicity of Bebras.
- Pseudonym (n = 5): difficulty with using student pseudonyms.

- Curriculum links (n = 4): more explicit curriculum links across states, and with changing curriculum requirements.
- Eligibility (n = 4): the ability for younger students to participate and for parents who are not homeschooling their children to register their child.

Other areas have included details of Honour Roll participants, avoiding timing clashes with ICAS competition, clearer questions, and ability to re-take questions.

The Bebras program team have responded to a number of opportunities to strengthen program delivery.

Issues that in the most part have been addressed include:

- Overhauled the Terms and Conditions procedure to enable coordinators to more easily confirm that they had acquired consent from parents.
- Created a tagging system to tag questions based on the linked computational thinking skills, combined with sharing alignment in the solutions guides, which enabled educators to better navigate questions by topic.
- Created stronger links with the Australian Curriculum: Digital Technologies, and updated content for version 9. Individual state curriculums were not addressed due to the national nature of the program.
- Improved options for participating in high year levels.

Matters that have not been fully resolved due to limitations or ongoing challenges include the following:

- Due to privacy agreements necessitating the regular deletion of data from the delivery platform, the ability to track students over time was not possible on the platform itself. However, additional professional learning sessions for coordinators were developed to support them in analysing student results.
- While small tweaks to the platform could be made, there was limited ability to overhaul the platform. Additional prompts were included to support the usability of the platform.
- Consistent with the nature of Bebras as a challenge, not a competition, while certificates reflecting levels of participation were able to be generated by teachers, the primary focus was not on grading performance.
- While marketing and publicity was dramatically improved for 2023, staff turnover resulted in an inconsistent approach to marketing.
- The option to remove the pseudonym system was not possible for privacy reasons.
- Attempts have been made to create a K–2 challenge, but due to lack of resources and question availability this was not completed.

These learnings will be shared with AMT to inform their continuous improvement as they will be taking over the delivery of Bebras in 2024.

3 CyberTaipan

3.1 CyberTaipan evaluation summary

CyberTaipan has been a core element of the Digital Careers program, involving 1,904 students, 277 coaches, and 120 industry mentors between 2021 and 2023[9]. Despite some substantial technical challenges that negatively impacted program participation and experience, CyberTaipan has provided a valued education opportunity to increase student awareness, skills and interest in ICT and cybersecurity. Overall, there is sufficient evidence to suggest that CyberTaipan has achieved measurable improvements in ICT and cybersecurity-related student participation, awareness, interest, capability and confidence and educator capability and confidence.

The CyberTaipan Impact Pathway (Appendix A.1.3) documents the intended outcomes for the CyberTaipan program.

Table 5 provides an assessment of program outcomes and impacts using an impact scale[10] to indicate program progress and the strength and reliability of evidence.

Table 5 CyberTaipan program outcomes and impacts

Target Group	Cyber Taipan Intended Outcomes	Program Progress	Evidence Rating
Student participation and engagement	Increased number and diversity of CyberTaipan participants	Consolidating	Medium-High
	Increased opportunity for young people to participate in additional cybersecurity-related activities	Consolidating	High
Student awareness and interest	Increased knowledge of and interest in cybersecurity	Consolidating	Medium
	Increased number of students considering and/or pursuing education/career pathways in cybersecurity	Consolidating	Medium
Student capability and confidence	Increased skills in applying cybersecurity concepts	Consolidating	Medium-High
	Increased number of young people skilled in cybersecurity (or related fields)	[Beyond scope]	[Beyond scope]
Teacher capability and confidence	Increased knowledge and confidence in cybersecurity concepts	Consolidating	Medium
	Increased confidence advising young people of cybersecurity education and career opportunities	Consolidating	Medium
	Increased inclusion of cybersecurity concepts and activities in high schools (and clubs)	Developing	Medium

It should be noted that while the program commenced fully in 2020, four years of program delivery (2020–2023) is not long to observe evidence of some outcomes and impacts, particularly given the

[9] The total number of students, coaches, mentors and schools comprise the sum of each CyberTaipan competition year and will include repeat students and schools.

[10] See Evaluation rubric and evidence rating scale Appendix A.2.5.

interruptions caused by a global pandemic. In addition, post-event program data has been limited, and while it has been supplemented with a small number of interviews, it remains a limitation regarding strength of evidence.

3.2 CyberTaipan aims and objectives

CyberTaipan is an Australian cyber defence program for high-school-aged young people, consisting of a national competition and week-long holiday camps. The program is an adaptation of the United States Air Force Association's CyberPatriot program and is designed to educate, engage, and inspire young people to develop skills and pursue careers in cybersecurity and other STEM fields.

Building on the successful 2018–2019 CyberTaipan pilot program and the 2020 CyberTaipan Competition, CSIRO, Northrop Grumman Australia (Northrop Grumman), and the Australian Signals Directorate (ASD) entered into an agreement to deliver CyberTaipan Australian Youth Cyber Defence Competition from 2021 to 2023.

The CyberTaipan objectives from 2021 to 2023 were to:

- Scale the CyberTaipan Program nationally, including recruiting and supporting schools, cadets, youth and community groups and other organisations from all Australian states and territories
- Facilitate and manage the CyberTaipan Competition nationally, including two virtual rounds and a virtual or live national final event
- Schedule Cyber Camp programs hosted by schools, universities, cadets, youth and community groups and other approved organisations during agreed Australian periods.

3.3 CyberTaipan program delivery

The CyberTaipan program included engagement opportunities for Australian high-school-aged students, adult supporters (coaches and team assistants), industry experts (mentors) and the broader cybersecurity industry. While the CyberTaipan Competition provided the focus for annual events (Round 1, Round 2, a national final and an awards ceremony), this was supported in most years by educational and information opportunities for students and coaches, including on occasion Cyber Camps and in 2023 a Careers Tour.

CyberTaipan competition participants from Team Mensa

3.4 CyberTaipan participation

CyberTaipan has attracted increasing interest from Australian young people, schools, and community groups. CyberTaipan has been a core element of the Digital Careers program, and between 2021 and 2023, there have been 1,904 students, 277 coaches, and 120 industry mentors participating in CyberTaipan. These totals include some duplicate students, coaches and mentors who participated over multiple years[11]. Table 6 indicates that the five-year totals for participation were 2,447 students, 574 teams, and 436 coaches and mentors.

Table 6 CyberTaipan participation 2018–2023[12]

	Students	Teams	Coaches & Mentors
CyberTaipan Competition 2023	683	163	121
CyberTaipan Competition 2022	675	146	115
CyberTaipan Competition 2021	546	125	82
CyberTaipan Competition 2020	413	112	78
CyberTaipan Pilot 2018–19	130	28	40
Total	**2,447**	**574**	**436**

CyberTaipan has successfully engaged students from across all Australian states and territories. Teams based in New South Wales have typically made up approximately a quarter of participating teams between 2021 and 2023. Changes in participation of other locations has however been notable as can be seen in Table 7.

Table 7 Location of participating teams 2021–2023[13]

Location	2021	2022	2023
National	NA	6%	23%
New South Wales	23%	27%	25%
Victoria	13%	14%	21%
Western Australia	13%	16%	13%
Queensland	23%	21%	8%
South Australia	6%	5%	4%
Australian Capital Territory	17%	14%	2%
Tasmania	3%	3%	2%
Northern Territory	1%	1%	1%

[11] The total number of students, coaches, mentors and schools comprise the sum of each CyberTaipan competition year and will include repeat students and schools.

[12] Source: CyberTaipan operational data.

[13] Source: CyberTaipan operational data 2021–2023

Table 8 provides an overview of female participation in CyberTaipan from 2021 to 2023. Increasing the diversity of young people interested in cybersecurity has been a focus of CyberTaipan, but it has been a challenge to increase engagement for some previously underrepresented cohorts. As identified in Australia's Cyber Security Sector Competitiveness Plan 2020, females make up around 27 per cent of Australia's cybersecurity workforce. Increasing the diversity of the cybersecurity workforce is a key focus for the Australian cybersecurity industry.

Table 8 Female participation in CyberTaipan 2021–2023[14]

Female participation	2021	2022	2023
Female students	18%	20%	18%
Female coaches	34%	32%	35%
Female mentors	25%	17%	15%

Around one-fifth of students participating in the CyberTaipan Competition have been female; however, this has not translated into female student participation in the CyberTaipan National Final, which was 2 per cent (n = 1) in 2023, down from 9 per cent (n = 5) in 2022. Around one-third of coaches have been female, with 2023 seeing 35 per cent participation rates (n = 26). Female mentors participating in 2023 made up 15 per cent (n = 7) of all mentors, and this figure was lower than 2022 (17 per cent) and 2021 (25 per cent).

The program successfully engaged and inspired 16 young women in a four-day CyberTaipan Young Women's Career Tour in late January – early February 2023. These young women were exposed to a range of cybersecurity-related areas and roles with the inclusion of many women in senior roles talking about their career pathways.

Participation of students who identify as Aboriginal and/or Torres Strait Islander in the CyberTaipan Competition has fluctuated. Participation has ranged between 5 per cent in 2022 to 1 per cent in 2023. The participation of teams from CSIRO's Young Indigenous Women's STEM Academy bolstered numbers in 2022; however, a number of teams withdrew in 2023.

CSIRO CyberTaipan Young Women's Career Tour 2023, participants, staff and supporters

[14] Source: CyberTaipan operational data 2021–2023

Further outreach to Aboriginal and/or Torres Strait Islander organisations and education groups would have been needed to further improve participation rates.

The CyberTaipan Competition has engaged 135 government, independent and catholic schools between 2021 and 2023 and an increasing percentage of community groups, as can be seen Table 9.

Table 9 Distribution of CyberTaipan participation 2021–2023[15]

Location	2021	2022	2023
Independent schools	33%	34%	22%
Government schools	31%	24%	28%
Catholic schools	14%	8%	6%
Community (including ADF Cadets, homeschools)	22%	33%	45%

The Australian Defence Force Cadets (ADF Cadets) have made up a significant number of the community-based teams in the CyberTaipan Competition, as can be seen in Table 10. In 2023, 53 Cadet teams participated in CyberTaipan, making up 33 per cent of all teams. CyberTaipan has provided an increasingly important education opportunity for ADF Cadets over recent years. Case studies that explore the contribution of CyberTaipan to ADF Cadets are presented in Appendix 3.

Table 10 Australian Defence Force Cadet Teams 2021–2023[16]

Cadet teams	2021	2022	2023
Australian Army Cadets	14	25	20
Australian Air Force Cadets	4	26	31
Australian Navy Cadets	-	-	2
TOTAL	**18**	**51**	**53**

The CyberTaipan Competition has retained interest from many schools and community groups over multiple years and seen a number of teams return each year to compete in the National Final. In 2023, 35 per cent of coaches had previously participated, as well as 31 per cent of mentors and 17 per cent of students. This has seen many coaches and students build upon their knowledge and experience from previous years. CyberTaipan has played an important role in the learning calendar of schools as part of school-based clubs, with 34 per cent recorded in 2023 and 15 per cent as a classroom-based activity.

'The Kernel Krushers' team from The King's School, New South Wales, has placed in the top three for the last three years and took first place in 2023 (Table 11). The Kernel Krushers were also the national champions in the pilot year of CyberTaipan. Team Mensa, a nationally

[15] Source: CyberTaipan operational data 2021–2023

[16] Source: CyberTaipan operational data 2021–2023

distributed community team, had previously succeeded in topping the finalists table in 2021 and 2022.

Table 11 CyberTaipan National Final top three placed teams 2021–2023[17]

Finalists	2021	2022	2023
1st	Team Mensa National community-based team	Team Mensa National community-based team	The Kernel Krushers The King's School, NSW
2nd	The Kernel Krushers The King's School, NSW	The Kernel Krushers The King's School, NSW	Tks Forgo The King's School, NSW
3rd	CGS Alpha Canberra Grammar School, ACT	PID 1337, Community group, NT	High Security 3 Australian Army Cadets, NSW

Of note, of the six schools participating in the 2023 finals, all could be considered schools with students of relatively high community socio-educational advantage, having ICSEA scores[18] over 1100 (with 1000 being the median for Australia). However, community-based teams that have also participated in the finals can involve students from areas of different socioeconomical advantage, including regional and remote areas.

3.5 CyberTaipan outcomes

Measuring program outcomes through participant post-competition surveys has been challenging due primarily to the way the surveys could be administered to align to jurisdictional research committee requirements. However, following the completion of each year's competition (2021–2023), outcome and satisfaction data has been collected from students, coaches and mentors via an online survey. Program registration and participation data has also been analysed. In addition, in 2023, a small number of coaches and mentors were interviewed online to provide feedback about their experience, and survey and observational data were collected during a cyber camp.

The number of completed post-competition surveys each year has remained small, which is likely due to a combination of factors including invitation timing and administrative challenges (students were required to receive their survey link via their team coach rather than directly from CSIRO to align with the approved ethics protocol).

While overall survey response rates for 2023 and previous years were lower than expected and limit the ability to generalise results across all participants, the results do provide useful information on how this sample of students, coaches and mentors felt about the program.

[17] Source: CyberTaipan operational data 2021–2023

[18] ACARA.2026 Guide to understanding ICSEA.

Student outcomes

Student survey feedback indicates that CyberTaipan has made a notable positive impact on increasing student understanding and skills in cybersecurity-related topics. CyberTaipan has also increased students' self-reported intention to study and work in computer-science-related areas, including cybersecurity.

Upwards facing arrows in Table 12 indicate the overall percentage increase amongst students who rated their understanding of cybersecurity-related concepts as moderate or higher after taking part in CyberTaipan compared to before taking part in CyberTaipan[19]. Linux operating system knowledge, ICT networking and scripting, and command line operations has generally seen the biggest self-reported increase in understanding.

Table 12 Change in student understanding of cyber security related topics 2021–2023[20]

Student: Change in understanding	2021 (n = 11)	2022 (n = 22)	2023 (n = 9)
Windows operating systems	31%↑	27%↑	45%↑
Linux operating systems	61%↑	86%↑	33%↑
ICT Networking	39%↑	50%↑	55%↑
Scripting & command line operations	54%↑	64%↑	45%↑
Real-world applications of cybersecurity	38%↑	27%↑	10%↑

Upwards facing arrows in Table 13 indicate the overall percentage increase amongst students who rated their skills in cybersecurity-related concepts as moderate or higher after taking part in CyberTaipan compared to before taking part in CyberTaipan[21]. Linux operating system knowledge, ICT networking and scripting, and command line operations has generally seen the biggest self-reported increase in understanding.

Table 13 Change in student self-reported skills relating to cyber security concepts 2021–2023[22]

Students: Change in skills	2021 (n = 11)	2022 (n = 22)	2023 (n = 9)
Windows operating systems	17%↑	24%↑	23%↑
Linux operating systems	67%↑	80%↑	56%↑
ICT Networking	50%↑	56%↑	33%↑
Scripting & command line operations	50%↑	65%↑	45%↑
Analysing problems with team members	9%↑	33%↑	20%↑
Communicating with team members	0%↑	19%↑	9%↑

[19] Retrospective pre-post survey questions were used to determine percentage change to moderate or higher.

[20] Source: CyberTaipan student survey 2021–2023

[21] Retrospective pre-post survey questions were used to determine percentage change to moderate or higher.

[22] Source: CyberTaipan student survey 2021–2023

In addition, 91 per cent of students agreed that they were more confident identifying cybersecurity risks.

CyberTaipan and cybersecurity competitions more broadly served to raise awareness of the varied cybersecurity career pathways and diverse industries that employ cybersecurity professionals. While student survey numbers from 2021–2023 are small, they do reflect that participating in CyberTaipan has had a notable positive impact on their self-reported study and careers interests and intentions in relation to computer science and/or cybersecurity.

After taking part in CyberTaipan:

- 87 per cent said that participating in CyberTaipan had impacted their career goals.
- 86 per cent agreed that they were more interested in learning about cybersecurity.
- 70 per cent agreed that they were more likely to study technology in years 11 and 12.

CyberTaipan also contributed to improvement in awareness of study and career options, with room for further support from their educators.

- 76 per cent agreed that they knew more about cybersecurity education options.
- 68 per cent agreed that they knew more about potential cybersecurity jobs they could work in.

In line with student self-reported outcomes, of the coaches who responded to the post-competition survey in 2023 (n = 12), 92 per cent thought their students had improved skills in using Linux operating systems, 91 per cent using scripting and command line operations, and 83 per cent using ICT networking (all of which were an increase on coach perceptions in 2022). Additionally, 100 per cent of coaches agreed that their students were more aware of cybersecurity-related careers and 88 per cent agreed that their students were more interested in pursuing a career in cybersecurity-related areas.

Coach outcomes

Feedback from coaches indicates that CyberTaipan has made a notable positive impact on increasing coach understanding and skills in cybersecurity-related topics, in addition to coach confidence to teach and advise students on cybersecurity-related topics[23].

Table 14 indicates by the upwards facing arrows that there is an observable positive trend 2021–2023 in improved coach understanding across the seven cybersecurity-related topic areas.

Table 14 Coach change in understanding of cyber security related topics 2021–2023[24]

Coach: change in understanding	**2021 (n = 10)**	**2022 (n = 9)**	2023 (n = 12)
Windows operating systems	10%↑	–1%↓	25%↑
Linux operating systems	30%↑	22%↑	56%↑
ICT Networking	20%↑	22%↑	58%↑
Scripting & command line operations	30%↑	22%↑	33%↑
Real-world applications of cybersecurity	40%↑	44%↑	0%→
Options for students to study cybersecurity	30%↑	44%↑	22%↑
Options for students to work in cybersecurity	20%↑	33%↑	33%↑

Table 15 indicates by the upwards facing arrows that there is an observable positive trend 2021–2023 in improved coach knowledge in teaching cybersecurity-related subjects and confidence in advising students about further/higher education and career opportunities in cybersecurity.

Table 15 Coach change in confidence teaching and advising students in cyber security related topics 2021 –2023[25]

Coach: Change in confidence	**2021 (n = 10)**	**2022 (n = 9)**	**2023 (n = 12)**
Teaching students about cybersecurity-related subjects	20%↑	45%↑	24%↑
Advising students about further/higher education in cybersecurity-related subjects	20%↑	22%↑	15%↑
Advising students about careers in cybersecurity-related areas	30%↑	23%↑	14%↑

[23] Due to the small survey response rates findings cannot be generalised to all coach participants.

[24] Source: CyberTaipan coach survey 2021–2023

[25] Source: CyberTaipan coach survey 2021–2023

3.6 CyberTaipan experience

CyberTaipan post-competition feedback indicates overall high levels of satisfaction, particularly in 2023. Students, coaches and mentors were provided the opportunity via an online survey to provide feedback on their experience and level of satisfaction regarding various operational aspects of CyberTaipan. Indicators of positive participant experience that recorded 75 per cent or higher levels of agreement (agree or strongly agree)[26] from respondents have been highlighted light blue in Table 16, Table 17 and Table 18 and indicate overall high levels of satisfaction[27].

Table 16 Student CyberTaipan experience 2021–2023[28]

Student experience	2021 (n = 11)	2022 (n = 22)	2023 (n = 9)
CyberTaipan was fun/enjoyable	82%	95%	89%
CyberTaipan was a rewarding experience	73%	64%	100%
CyberTaipan was a good use of my time	86%	95%	100%
I would take part in CyberTaipan again	88%	90%	78%
I would recommend CyberTaipan to others	82%	95%	89%

Table 17 Coach CyberTaipan experience 2021–2023[29]

Coach experience	2021 (n = 10)	2022 (n = 9)	2023 (n = 12)
The CyberTaipan registration process was straightforward	78%	88%	75%
The CyberTaipan Competition instructions were easy to follow	90%	67%	83%
The CyberTaipan website has informative resources	88%	78%	75%
I felt sufficiently prepared to take part in CyberTaipan	50%	56%	75%
The delivery of CyberTaipan was well managed	50%	67%	75%
Likelihood to recommend (likely /extremely likely)	88%	89%	83%

Table 18 Mentor CyberTaipan experience 2021–2023[30]

Mentor experience	2021 (n = 6)	2022 (n = 6)	2023 (n = 3)
The CyberTaipan registration process was straightforward	83%	100%	100%
The CyberTaipan Competition instructions were easy to follow	80%	100%	100%
The CyberTaipan website has informative resources	60%	100%	100%
I felt sufficiently prepared to take part in CyberTaipan	75%	100%	100%
The delivery of CyberTaipan was well managed	100%	100%	66%
Likelihood to recommend (likely /extremely likely)	83%	50%	100%

[26] Response options: Strongly disagree, Disagree, Neither agree or disagree, Agree, Strongly agree.

[27] Due to the low survey response rate across the three cohorts and three groups, caution should be taken when referring to these findings.

[28] Source: CyberTaipan student survey 2021–2023

[29] Source: CyberTaipan coach survey 2021–2023

[30] Source: CyberTaipan mentor survey 2021–2023

3.7 CyberTaipan impact and opportunities

As part of the evaluation of CyberTaipan, five impact case studies were developed through an interview process with mentor representatives from the Australian Air Force Cadets, the Australian Army Cadets, Australian Mensa, CSIRO Young Indigenous Women's STEM Academy, and the Islamic College Brisbane. The five impact case studies have been approved for circulation by the participants and are provided in Appendix 3. Key findings from the case studies are presented below.

CyberTaipan coaches and mentors are drawn to support students in CyberTaipan because they can see a critical gap in student education regarding cybersecurity, AI and team-based ICT problem-solving that CyberTaipan meets. It provides a space for students with different abilities and backgrounds to compete in a national competition.

> *The fact that it's an intellectual team sport is, I think, a really precious opportunity. There's not enough of that combination. So that's central to what draws me to invest in in this project.*
>
> (Australian Mensa Mentor)

The online nature of CyberTaipan has provided access for students across different regions and states to work together as a team.

> *I had a team in New South Wales that was from five different units across NSW. So that was the benefit that they were able to work with other like-minded teams and like-minded individuals who nominated themselves and that helps with the motivation perspective.*
>
> (Australian Army Cadet Mentor)

CyberTaipan has provided coaches, who are often schools teachers and community group leaders, with knowledge and skills in cybersecurity and awareness of cybersecurity-related careers that they would otherwise not have access to. In some instances, this has inspired coaches to become mentors.

> *I think that it was really great receiving mentorship from the CSIRO…I think that everyone's made friends. Everyone's met new role models and been inspired. I didn't really know very much about it [cybersecurity] actually, and since I've done it, I've been improving every year.*
>
> (Young Indigenous Women's STEM Academy Mentor)

Mentors expressed delight in seeing their students expand their knowledge and skills in ICT and importantly in 21st-century skills, such as group problem-solving, communication and negotiation.

> *It really is a very, very good opportunity for kids to learn teamwork and to learn all the soft skills. And in the world of cyber careers, these are people who are going to be the biggest salary earners in future, the people who are entrusted with the biggest secrets, and these are people you want to have these soft skills.*
>
> (Islamic College Brisbane Mentor)

Some mentors saw their students take the next step in cybersecurity-related careers as a direct result of taking part in CyberTaipan.

> *I got an email from a cadet who participated in last year's competition (2022). And they said 'Mam just so you know, I wasn't really too sure what I wanted to do for uni or a career. But based on experience last year I now want to focus on cyber and I'm putting in an application at a couple of places. Would you mind being*

my referee?' And I was like, 'Certainly! I'd be more than happy to be referee'.

(Australian Air Force Cadets Mentor)

Mentors also saw CyberTaipan offering Australia a means to ensure the next generation of Australians had awareness, interest and skills in cyber awareness and cybersecurity, which they felt was critical to Australia's future.

The more people we have in the country able to deal with cybersecurity, I think the better. I think that's another good thing about CyberTaipan and cyber awareness, that we're definitely shoring up the future knowledge in the country.

(Australian Air Force Cadets Mentor)

Opportunities

Over the course of implementing the CyberTaipan program, the program team identified several opportunities to strengthen program delivery.

Issues that have been largely addressed include:

- Implementation of a more automated and digitally enabled registration and participant management system has been developed and enhanced from 2022.
- Transition from one competition host platform to another eased financial and most technical issues in 2023; however, technical issues were still experienced by some teams that had preferred a web-hosted competition.
- Multi-modal and high-impact support material for coaches to ease their experience of technical challenges faced in CyberTaipan.

Matters that have not been fully resolved due to limitations or ongoing challenges include:

- A highly technical barrier to program entry due to several operational issues.
- Windows license key issue has limited the competition to Linux OS-only images, further exacerbating technical barriers to entry, as most people are familiar with Windows OS.
- Timing of important deadlines often clashed with school holidays, affecting communication with coaches. Involvement of international delivery partners meant these dates/competition rounds were not flexible. Also, Australian state and territory school holidays do not align with each other, which extended communication blackout periods to upwards of three weeks.

4 FarmBeats

4.1 FarmBeats evaluation summary

FarmBeats was piloted with 18 schools and 397 students across six jurisdictions in 2021. Overall, there is some evidence to suggest that FarmBeats has developed strategies to engage students in applying AI, IoT, big data and machine learning to real-world settings, particularly its application in agriculture. There is some evidence that teachers gained knowledge and skills to support their students' learning; however, technical problems using the equipment supplied did have a negative impact on the educational experience.

The FarmBeats Impact Pathway (Appendix A.1.4) documents the intended outcomes for the FarmBeats program.

Table 19 provides an assessment of program outcomes and impacts using an impact scale[31] to indicate program progress and the strength and reliability of evidence.

Table 19 FarmBeats Pilot outcomes 2021

Target Group	FarmBeats Intended Outcomes	Program Progress	Evidence Rating
Student participation and engagement	Students gain experience and feel engaged in in applying AI, IoT, big data and machine learning and their practical applications in agricultural contexts.	Developing	Low
	Students feel engaged and gain an increased understanding of agriculture, land management, environmental monitoring and management, and sustainability that is relevant to them.	Developing	Low
Student awareness and interest	Students have an increased awareness of AI, IoT, big data and machine learning.	Emerging	Low
	Students gain an increased understanding of agriculture, land management, environmental monitoring and management, and sustainability.	Emerging	Low
Student capability and confidence	Students gain skills and confidence in practical application of AI, IoT, big data and machine learning concepts.	Emerging	Low
	Students (in group settings) develop skills in communication, leadership and negotiation.	Emerging	Low
	Students increase their digital literacy and interest in STEM-based study (and careers).	Emerging	Low
Teacher capability and confidence	Teachers feel engaged as partners in the FarmBeats for students program, helping to shape local adaptation and implementation.	Emerging	Low
	Teachers gain skills and confidence in effectively engaging students in practical application of AI, IoT, big data and machine learning concepts.	Emerging	Low

[31] See Evaluation rubric and evidence rating scale Appendix A.2.5.

It should be noted that while evidence from participating educators indicates that FarmBeats has created and contributed to intended outcomes for students, the sample of educators that were involved in interviews is small and, with no other evidence available to qualify these comments, an evidence rating of 'low' has been provided against intended outcomes.

4.2 FarmBeats aims and objectives

In 2021, CSIRO partnered with Microsoft to pilot FarmBeats. The program sought to increase student skills and teacher confidence in key information technology areas, including AI, Internet of Things (IoT), big data, and machine learning. In addition to these intended outcomes, the program also sought to demonstrate the feasibility of the FarmBeats program and provide a platform for future expansion.

4.3 FarmBeats program delivery

Each participating teacher was given a set of 'Microsoft FarmBeats for Students kits' to deliver the program with their class. Kits included a Raspberry Pi and sensors for soil moisture, light, ambient temperature, and humidity.

Teachers were provided with training in the leadup to their delivery of the pilot, during which they were walked through the construction of the kits and the lesson activities. Teachers were connected through a Microsoft Teams space and invited to share their experiences as they progressed through the program. Teachers were also offered a weekly opportunity for live technical support through this virtual Teams space.

An educator looking at data collected from the Microsoft FarmBeats program

4.4 FarmBeats participation

In 2021, 397 students from years 8–10 who attended one of 18 schools across six jurisdictions in Australia took part in FarmBeats (NSW = 5, QLD = 5, WA = 4, SA = 2, TAS = 1, VIC = 1). Of the 18 schools that participated, 89 per cent (n = 16) were situated in regional Australia, and 50 per cent were government schools. Amongst the participating schools, 55 per cent (n = 10) had an ICSEA value below the Australian median of 1000 (median = 973, range 839–1180), which is an indicator of community social and economic advantage (Table 20 and Table 21).

Table 20 FarmBeats school participation 2021[32]

Schools (n = 18)	NSW	QLD	SA	TAS	VIC	WA	Per cent
Location	5	5	2	1	1	4	-
Regionality							
– Inner regional	5	3	-	-	1	2	61%
– Outer regional	-	2	2	1	-	-	28%
– Major cities	-	-	-	-	-	2	11%
School Type							
– Government	3	1	1	1	-	3	50%
– Independent	2	2	-	-	1	1	33%
– Catholic	-	2	1	-	-	-	17%

Table 21 FarmBeats student participation 2021[33]

Students (n = 397)	NSW	QLD	SA	TAS	VIC	WA	Per cent
Gender							
– Male n = 251	89	82	10	6	2	57	63%
– Female n = 145	38	62	10	9	2	27	37%
– Not stated n = 1	-	-	-	-	-	-	0.3%

4.5 FarmBeats outcomes

Evaluation data indicates that the first iteration of the FarmBeats program, run as a small-scale pilot in 2021, provided an innovative addition to traditional digital technology classrooms and successfully engaged students in hands-on, real-world inquiry-based activities.

All teachers who were interviewed spoke positively about FarmBeats, highlighting the uniqueness of the program's content, particularly its connection to agriculture, and the positive nature of student engagement. Interviewees also outlined technological challenges they faced with the FarmBeats equipment.

Key insights from semi-structured interviews undertaken with educators in four participating schools included the following:

[32] Source: FarmBeats operational data 2021

[33] Source: FarmBeats operational data 2021

FarmBeats was well received by the teachers interviewed and their students. The lesson resources were helpful, easy to use, and prompted thoughtful classroom discussions. For example, one teacher commented:

> *On the whole, the materials were very well composed and had a good, logical progression to them and really got students to stop and think about some of the stuff that's going on rather than just following instructions.*
>
> (FarmBeats Teacher interview participant)

The practical nature of the program, its connection to agriculture, and AI elements of the program were particularly engaging for students of those interviewed. For example, as one teacher noted:

> *The more real it becomes the more excited the students get. It's not often when we're in a digital technology classroom that we get to go and touch and smell them. I mean, as much as I love computers, it can be quite abstract … to be able to get out into the sun, get vitamin D and watch something grow and know that you've done that, it's pretty cool. It's pretty satisfying, and I think all the students got to experience that in the same way I did.*
>
> (FarmBeats Teacher interview participant)

4.6 FarmBeats experience and opportunities

All teachers interviewed encountered challenges connecting the provided hardware and software, which impacted their delivery of the course to varying extents. Despite these challenges, teachers were keen to be involved in further iterations of the program and offered useful suggestions for improvement. All teachers interviewed agreed they would recommend the program to other schools and teachers.

Based on feedback via these interviews and discussions with the program team, the Impact and Evaluation team identified five areas where the program could be enhanced if it were to be delivered in the future:

- Consider alternative technology arrangements or program delivery methods.
- Provide additional resources and/or support to accompany the AI activities.
- Encourage and support teachers to engage with local industry and universities.
- Provide additional information to support the outdoor setup of FarmBeats hardware/garden.
- Provide additional guidance and/or training to teachers on how to collaborate on Microsoft teams.

5 Professional Learning

5.1 Professional learning evaluation summary

Educator professional learning sessions have been a core component of Digital Careers since its inception. The Digital Careers educator professional learning program provided 40 professional learning sessions to 461 educators during 2022 and 2023. With 95 per cent of educator survey respondents (n = 70) expressing they were very or extremely satisfied, and 89 per cent (n = 66) stating that they would recommend the program, it can be determined that Digital Careers professional learning program was a valued resource for educators implementing the digital technologies curriculum.

It should be noted that the educator professional learning element of Digital Careers does not have an impact pathway against which it is evaluated.

5.2 Professional learning aims and objectives

Beginning in 2022, the professional learning program was formalised into a stand-alone Digital Careers stream, with dedicated staff overseeing the program. This saw program-specific professional learning sessions augmented with sessions targeting elements of the Digital Technologies curriculum in line with recommendations from the Australian Computer Society, encouraging schools and education departments to support the upskilling of teachers in the Digital Technologies curriculum through systematic professional learning programs (Zagami, J. 2022).

5.3 Professional learning delivery and participation

Professional learning sessions were offered as live webinars, with participants able to make comments and ask questions throughout the session. Recordings were also made available to all registered individuals. The Digital Careers educator professional learning program provided 40 professional learning sessions to 461 educators between 2022 and 2023 as can be seen in Table 22.

Teacher engaging students in digital technologies from Holy Spirit School, Queensland

Table 22 Professional Learning delivery 2022–2023[34]

Session Topic	Audience	Number of sessions	Attendances[35]
Planning Your Year with Digital Careers	General	7	47
Authentic Learning with engaging data	General	5	65
Bringing AI and ML into the classroom	General	10	180
Classroom resources	General	1	8
Cybersecurity 101	General	3	21
Educators guide to cyber security	General	4	66
CONASTA – presentation	General	1	25
How to Bebras	Bebras	1	25
Bebras – Round 1 Review	Bebras	2	44
Bebras – Round 2 Review	Bebras	2	17
How to CyberTaipan	CyberTaipan	2	19
CyberTaipan coach information session	CyberTaipan	2	10
Total		40	461

In 2022–2023 professional learning sessions attracted 1,564 registrations, which translates into 461 attendances, indicating that just under three-quarters (71 per cent) of registrants were unable to attend events. Given the demands placed on teachers throughout their school day, the ability to view recordings is seen as an important component of the professional learning program. While the program team implemented strategies to try to increase the conversion rate of registration to participation among educators, this continued to be a considerable challenge. Therefore, as the majority of professional learning sessions were recorded for later viewing for those registered, it enabled a further 475 views of the recorded professional learning sessions listed in Table 22.

In 2023 the Digital Careers program delivered four pre-recorded sessions that were not offered as live sessions. The sessions were considered critical information for Digital Careers' two main programs, Bebras and CyberTaipan, and attracted a combined total of 799 views.

5.4 Professional learning outcomes

The educator professional learning program does not have specific outcomes against which this evaluation can measure its success; rather, the professional learning program supports and contributes to the outcomes for Bebras, CyberTaipan and FarmBeats. Notwithstanding, following

34 Source: Educator Professional Learning operational data
35 Caveat: Educators are counted each time they participated in professional learning.

each professional learning webinar, those attending were invited to complete a voluntary, online survey to provide their feedback on the session and offer suggestions for improvement.

When asked provide feedback regarding what had been valuable, examples of responses included:

The links to the Bebras computational thinking information and activities. I can see this being very useful for assessing these skills in my role as a technology specialist, then targeting the areas for improvement.

(Attendee – Planning Your Year with Digital Careers, 2022)

Careers in Dig tech and cyber security – types of roles, where those roles can be found in a range of govt and non-govt organisations, salaries etc.

(Attendee – Cybersecurity 101, 2022)

Looking at the questions and example strategies.

(Attendee – Bebras Round 2 Review, 2023)

In addition, respondents provided feedback regarding how they found the delivery of the sessions.

Targeted, to the point, informative, and great examples of visualisation techniques.

(Attendee – Authentic learning with engaging data, 2022)

Engaging session with a great balance of audience interaction and information.

(Attendee – Cybersecurity 101, 2022)

I had several teachers sit in on this and it gave them an insight into Bebras… I enjoyed and found the webinar insightful.

(Attendee – Bebras Round 2 Review, 2023)

5.5 Professional learning experience and opportunities

Feedback from educator professional learning post-event surveys for 2022–2023 indicates that respondents have found the professional learning sessions engaging and valuable and would recommend them to others:

- 95 per cent of respondents were ‘extremely satisfied’ or ‘very satisfied’ with the professional learning session attended (n = 70).
- 89 per cent of respondents were very likely or extremely likely to recommend the educator professional learning session to another educator or colleague (n = 66).

Opportunities

The program team reflected on learnings and opportunities that could benefit other professional learning programs in the future, which include:

- Broaden professional learning on emerging technologies, following the successful inclusion of AI and machine learning into the program.
- Offer professional learning sessions and joining instructions to better suit educators across different time zones.
- Increase use of social media such as Facebook to advertise events as this positively impacted registration and attendance.
- Offer a more predictable and standardised calendar of educator professional learning activities so that educators can expect sessions to occur at set intervals.
- Refine the wording of program consent forms in order that educators that sign up for one program can be sent invitations to others.

6 Web Resources

6.1 Web resources evaluation summary

The Digital Careers program has provided in excess of 50 resources for educators, students and parents. Views of the program website have exceeded 1 million, with over three-quarters of a million downloads. Developed resources include competition guides, computational thinking activities, videos and worksheets exploring different digital career options, and focuses on future digital technologies. This evaluation cannot measure the value of these resources for those who have already accessed them, but the evaluation can determine that these resources provide a high-quality unique resource for Australia and a lasting legacy of the Digital Careers program.

6.2 Web resource aims and objectives

The Digital Careers website was intended to be 'a one-stop shop' for information about digital careers in Australia, including resources to address emerging careers, career and technology spotlights, further study options and careers matching. The website aimed to attract 150,000 visitors between 2021 and 2023 with new resources delivered in 2021 and 2022.

6.3 Web resource delivery

The following is a list of more than 50 video, worksheet and web content resources that have been developed by the Digital Careers team in collaboration with a range of industry professionals.

Bebras resources

- Bebras 365
- Bebras mini challenges
- Bebras unplugged
- Bebras question creation
- Bebras solutions guides
- Bebras Australia FAQ
- Bebras Handbook and poster
- How to Bebras videos
- Bebras Partnership guide
- Bebras Handbook and poster

CyberTaipan resources

- CyberTaipan Rulebook
- Modules and resources
- Demonstration images

My Digital Career resources

- Careers of the future worksheet
- Rhett Loban: Game designer – video
- Rae Johnston: STEM journalist and broadcaster – video
- Sue Kay: AI & Robotics – video & worksheet
- Kate Patterson: Visual Science Communications – video & worksheet

- Katie Lowe: Civil Engineer & Urban Design – video & worksheet
- Paulo de Souza: Micro sensors and space – video & worksheet
- Michael Seo: Nanotechnology – video & worksheet
- Sam Bartels: Vertical Harvesting – web content
- Clair Naughtin: Senior Research Consultant – web content
- Cybersecurity professionals
- Emerging technologies

My Digital Career professional - Katrina (Katie) Lowe

ICT Innovators resources

- Decoding with binary – Grace Hopper
- Designing dream apps and peripherals – Douglas Engelbart
- Think like George Boole – Logic problems
- Algorithmic thinking
- Turing and cyphers
- Search engine comparison
- Broken Difference Engine
- RGB colouring – Mark Dean

Computational Thinking in Action Resources

- Computational thinking definitions PDF
- Metacognition activity PDF
- Thinking about Computational Thinking PDF
- Computational Thinking in Action: Rubbish robots activity PDF
- Computational Thinking in Action: Smart cities activity PDF
- Computational Thinking in Action: Michael Seo touch screen activity PDF
- Computational Thinking in Action: Vertical harvesting activity PDF
- Computational Thinking in Action: Secure network activity PDF
- Computational Thinking in Action: Drone delivery activity PDF
- Computational Thinking in Action: Facial recognition activity PDF
- Computational Thinking in Action: Sorting algorithm activity PDF
- Computational Thinking in Action: Kate Patterson cell representation activity PDF

6.4 Web resource participation

Annual Digital Careers data was not available for the specific snapshot between 2021 and 2023; however, between March 2019 and December 2023, the Digital Careers website recorded:

- 1,171,000 views from 798,000 users
- 114,000 downloads from 87,000 users.

7 Computational and Algorithmic Thinking (CAT) Challenge

7.1 CAT evaluation summary

CSIRO's sponsorship of $300,000 supported AMT to engage schools and students from remote and very remote areas in computational and algorithmic thinking (CAT) challenges. School participation over three years was 44 (26 schools participated once, six schools participated twice, and three schools participated three times). Participating schools had a median ICSEA value of 928, indicating that CAT managed to engage schools from areas considered less socially and economically advantaged.

Across the three years 1,458 primary and secondary school students participated in CAT. Participation of students was highest in grades 5–10 and there is equal participation from boys and girls based on the available data.

As participation data is the only source of evaluation data for CAT[36], based on the available data from AMT, it can be determined that CAT was successful in engaging primary and high school students in computational and algorithmic thinking from remote and very remote communities across Australia.

7.2 CAT aims and objectives

The Computational and Algorithmic Thinking (CAT) competition gives students the opportunity to develop their problem-solving skills through algorithmic thinking. The competition incorporates unique three-stage tasks that encourage students to develop informal algorithms and apply them to test data of increasing size or complexity. CAT competition topics include applying rules, logic and case analysis, analysing algorithms, and developing algorithms.

7.3 CAT program delivery

CSIRO has provided $300,000 (GST exclusive) in total to the AMT over the 2021–2023 period[37] to support the engagement and participation of students that attend remote and very remote schools in CAT.

[36] As per grant agreement only participation data was required for reporting purposes.

[37] Funds contributed per year towards CAT: 2021 A$100,000.00, 2022 A$100,000 and 2023 A$100,000.

7.4 CAT participation

As can be seen from Table 23, AMT has engaged 1,485 students in CAT. Gender distribution when known indicated that 43 per cent of students were female and 42 per cent male. Students tended to be equally distributed across grades 5–6, 7–8 and 9–10.

Table 23 CAT student demographics 2021 –2023[38]

	2021		2022		**2023**		**2021-2023**	
Students	507		500		451		**1,458**	
Gender	Count	%	Count	%	Count	%	**Count**	**%**
Male	235	46%	167	33%	214	47%	**616**	**42%**
Female	249	49%	161	32%	220	49%	**630**	**43%**
Unknown	23	5%	172	34%	17	4%	**212**	**15%**
Grade								
3–4	5	1%	-	-	-	-	5	0.3%
5–6	154	30%	142	28%	82	18%	378	26%
7–8	170	34%	170	34%	169	37%	509	35%
9–10	155	31%	156	31%	147	33%	458	31%
11–12	23	5%	32	6%	53	12%	108	7%

Table 24 and Table 25 indicate that CSIRO funding helped to engage 44 schools over three years (26 schools participated once, six schools participated twice, and three schools participated three times). The majority were government schools in either remote or very remote areas of the Northern Territory, Queensland, South Australia, Tasmania and Western Australia. Most participating schools have an ICSEA value of below 1000 (median 928, range 734–1028), which is the national median value used as an indicator of community socioeconomic and educational advantage.

[38] Source: CAT Statistics Reports provided by AMT.

Table 24 CAT school type and ICSEA 2021–2023[39]

	2021	2022	2023	2021–2023
Schools	17	13[40]	14	**44**
School Type	Gov = 82% Non-Gov = 18%	Gov = 77% Non-Gov = 23%	Gov = 64% Non-Gov = 36%	**Gov = 74%** **Non-Gov = 26%**
ICSEA[41]	Median = 925 Range = 741–1028	Median = 923 Range = 745–1028	Median = 928 Range = 734–1018	**Median = 928** **Range = 734–1028**

The total sum of school participation is 44, made up 35 individual schools (26 schools participated once, six schools participated twice, and three schools participated three times).

Table 25 CAT school location 2021–2023[42]

	2021		2022		2023		2021–2023	
Location	Count	%	Count	%	Count	%	**Count**	**%**
NT	1	6%	3	25%	3	21%	**7**	**16%**
QLD	2	12%	1	8%	-	-	**3**	**7%**
SA	1	6%	2	17%	3	21%	**6**	**14%**
TAS	4	24%	1	8%	1	7%	**6**	**14%**
WA	9	53%	5	42%	7	50%	**21**	**49%**
Regionality								
Remote	13	76%	11	92%	9	64%	**33**	**77%**
Very remote	4	24%	1	8%	5	36%	**10**	**13%**

The data presented in the tables was sourced from CAT Reports provided by AMT. Collection of individual student-level or school-level outcome data was not a requirement of the grant agreement and therefore no outcome data is available to report for CAT.

[39] Source: CAT Statistics Reports provided by AMT.

[40] One school was an AMT school.

[41] ACARA.2026 Guide to understanding ICSEA.

[42] Source: CAT Statistics Reports provided by AMT.

8 Young Information Communication Technology Explorers (YICTE)

8.1 YICTE evaluation summary

CSIRO's sponsorship of $270,000 supported SAP Australia Pty Ltd. (SAP) to engage 2,481 school students, in 996 ICT projects by funding state and national finals between 2021 and 2023. Across the three years 223 primary and secondary schools participated, almost half of students were female and all but one Australian jurisdiction was represented. As participation data is the only source of evaluation data for Young Information Communication Technology Explorers (YICTE) as per grant agreement based on the available data from the SAP, it can be determined that YICTE was successful in encouraging primary and high school students in Australia to showcase their passions using technology to solve real-world problems.

8.2 YICTE aims and objectives

YICTE is a non-profit competition, created by SAP, supported by CSIRO Digital Careers and The Smith Family and with the help of industry and university partners across Australia, to encourage primary and high school students in years 3–12 in Australia to solve real-world problems or showcase their passions using technology.

8.3 YICTE program delivery

CSIRO has contributed $270,000 (GST exclusive) in total to SAP YICTE 2021–2023[43] to assist in funding state, territory and national finals.

Projects are marked on four main criteria:

- Creativity and Innovation
- Project Difficulty
- Quality and Completeness and
- Presentation and Documentation.

Projects are reviewed by a panel of judges for each state and territory in two age-group rounds:

- Senior Years (grades 7–8, 9–10, 11–12), August–September
- Junior Years (grades 3–4, 5–6), September–October.

[43] Funds contributed per year towards YICTE finals: 2021 A$70,000.00, 2022 A$100,000 and 2023 A$100,000.

8.4 YICTE participation

Between 2021 and 2023, in total 2,481 students were engaged in 996 YICTE projects from 223 schools across Australia (208 projects in 2021, 357 projects in 2022, and 359 projects in 2023)[44]. As can be seen in Table 26, distribution of students across states was on the whole representative of the population distribution of Australia; however, Tasmania – a less populated state – made up 20 per cent overall of students. Also of note, there were no students participating from the Northern Territory, which the program team understand was due to SAP not having established contacts there.

Table 26 YICTE Student participation 2021–2023[45]

Students	2021		2022		2023		Totals	
Location	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent
ACT	7	1%	18	2%	26	4%	51	2%
NSW	117	18%	221	24%	214	30%	552	22%
QLD	128	19%	112	12%	203	21%	443	18%
SA	63	9%	55	6%	48	7%	166	7%
TAS	129	19%	210	23%	160	5%	499	20%
VIC	98	15%	136	15%	132	20%	366	15%
WA	121	18%	169	18%	114	13%	404	16%
NZ	1	0.2%	-	-	-	-	1	0.2%
Totals	664	100%	921	100%	897	100%	2481	100%

Table 27 indicates that 47 per cent of students were female (n = 1,157), with 2023 seeing the highest percentage of female participation at 51 per cent (n = 453).

[44] One project was submitted from New Zealand in 2021.

[45] Source: YICTE data provided by SAP

Table 27 YICTE student gender 2021–2023[46]

	2021		2022		2023		Totals	
Gender	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent
Girls	303	46%	401	44%	453	51%	1,157	47%
Boys	356	54%	520	56%	444	49%	1,320	53%
TOTAL	659	100%	921	100%	897	100%	2,477	100%

The distribution of participating schools shown in Table 28 reflects student participation shown in Table 26 apart from Tasmania, which made up 4 per cent of participating schools but 20 per cent of students, indicating high student engagement from a small number of schools (n = 8).

An analysis of school ICSEA values, an indicator of community socioeconomic and educational advantage, indicates that participating schools had a median ICSEA of 1038, and a range of 767–1201, indicating participating schools came from areas above and below the national median of 1000[47].

Table 28 YICTE school participation 2021–2023[48]

Schools	2021		2022		2023		Totals	
Location	Count	Per cent	Count	Per cent	Count	Per cent	Count	Per cent
ACT	2	3%	2	3%	3	4%	7	3%
NSW	19	25%	23	32%	23	30%	65	29%
QLD	18	24%	17	24%	16	21%	51	23%
SA	10	13%	6	8%	5	7%	21	9%
TAS	2	3%	2	3%	4	5%	8	4%
VIC	11	14%	11	15%	15	20%	37	17%
WA	13	17%	11	15%	10	13%	34	15%
NZ	1	1%	-	-	-	-	1	<1%
Totals	76	100%	72	100%	76	100%	223	100%

The data presented in the tables was sourced from YICTE statistical reports provided by SAP. Collection of individual student-level or school-level outcome data was not a requirement of the grant agreement and therefore no outcome data is available to report for YICTE.

[46] Source: YICTE data provided by SAP

[47] ACARA.2026 Guide to understanding ICSEA.

[48] Source: YICTE data provided by SAP

9 Research

9.1 Research summary

In 2022 and 2023, The Australian Council for Educational Research (ACER) was commissioned by CSIRO to undertake research into the factors influencing young female students' participation in digital technologies education. The research was funded by the Australian Government Department of Industry, Science and Resources (DISR)under the Digital Careers program. The research was conducted in two phases: (1) literature review, policy review, and program review; and (2) primary research with students, teachers, and tertiary stakeholders. The research is summarised in a recent article in *Teacher* magazine[49], and the two reports are available on the CSIRO website[50].

9.2 Research aims and methodology

The aims of the research were to highlight the enablers and barriers to young female students engaging with digital technology. By addressing this function, the research was intended to aid CSIRO to increase the participation of young female students in the digital technology programs offered by CSIRO Education and Outreach (CEdO).

The Phase 1 methodologies comprised:

- A brief literature review with a focus on understanding the key enablers and barriers to young female students' engaging with STEM and digital technology.
- A review of relevant policy aimed at increasing engagement in digital technology and STEM.
- A review of alternative digital education programs that are designed to engage female students in digital technology and/or STEM.
- A brief review of CSIRO's programs (CyberTaipan, FarmBeats and Bebras), comparing the design of the programs with key findings in the research literature and the Australian Curriculum. The review also considered the extent to which the materials reflect any diverse contexts for different parts of Australia, such as recognition of the experiences of First Nation peoples in Australia.

[49] Banks, C., Buckley, S. & Osborne, K. (2023). Factors facilitating greater engagement of young women in digital technologies education. Teacher Magazine, August 2023. Retrieved from https://www.teachermagazine.com/au_en/articles/factors-facilitating-greater-engagement-of-young-women-in-digital-technologies-education

[50] Buckley, S., Ahmed, S.K., Osborne, K., McNeilly, C., Sniedze-Gregory, S.& Felgate, R. (2022). Engaging young female students in digital technology programs: Part One. CSIRO, Australia. Retrieved from https://www.csiro.au/-/media/Education-media/Files/Impact-and-Evaluation/ACER_CSIRO-Report_PartOne_25062023_annotated.pdf

Osborne, K., Felgate, R. & Buckley, S. (2023). Engaging young female students in digital technology programs: Part Two. CSIRO, Australia. Retrieved from https://www.csiro.au/-/media/Education-media/Files/Impact-and-Evaluation/ACER_CSIRO-Report_PartTwo_25062023_annotated.pdf

The Phase 2 methodologies comprised:

- An online survey of Australian teachers (n = 129)
- A focus group with a sample of students aged 14–16 years (n = 14)
- Interviews with a small sample of STEM educators in tertiary institutions (n = 5).

9.3 Research findings

Across both phases of the research, the key findings included:

- The importance of female students being exposed to positive, female role models in digital technologies.
- The issue of representation in the way that digital technologies curriculum was implemented and taught in secondary education.
- The impact of mothers, fathers, and other carers on students' attitudes towards digital technology.
- The existence of active cultural biases and stereotypes around females and digital technologies (e.g. girls and gaming/female tertiary students and robotics) and their negative impact on female students' engagement with the subject area.

9.4 Research relevance

The research contributes to the wider evidence base on increasing the under-representation of women in STEM. This research highlighted some practical and more systemic factors that have been considered by CEdO in its program design and implementation, and could be considered by educators, parents/carers, and program deliverers more broadly. As outlined in the *Teacher* article (2023), the key factors for increasing engagement among young women include:

- Increasing the confidence and awareness of educators.
- Relating digital technologies to real-world, inclusive contexts.
- Addressing the confidence imbalance among students.
- Cultivating interest in STEM/digital technologies from a young age.
- Challenging the stereotypical portrayal of digital technologies.
- Equipping parents with more information and resources.
- Clarifying that gaming/coding are only one aspect of digital technologies.
- A greater focus on encouraging young women to take digital technologies subjects and degrees.

The research project subsequently led to a collaborative project between CSIRO and ACER to develop and deliver a free webinar series for primary and secondary teachers on best practice for engaging young women in digital technology education. The project is funded by the auDA Foundation and will be completed by the end of 2024.

10 Summary of Findings

This final evaluation report has focused on measuring the level of engagement, outcomes and impacts of the Digital Careers program between 2021 and 2023. The following section summarises key findings under these headings and against the Digital Careers evaluation rubric.

10.1 Digital Careers participation

Program participation data (Table 29) indicates that Digital Careers has established participation rates of over 170,000 students, over 8,200 educators, over 2,600 schools and over 150 industry professionals in the program between 2021 and 2023.

Table 29 Digital Careers participation rates 2021–2023

Direct	Students	Teachers & educators	Schools	Industry professionals
TOTAL	**171,145**	**8,274**	**2,642**	**159**
Bebras	164,895	7,278	2,222	24
CyberTaipan	1,904	277	135	120
FarmBeats	397	>18[51]	18	-
Professional Learning[52]	-	>300	-	-
Web resources	-	-	-	>15
Indirect				
CAT	1,458	>44[53]	44[54]	-
YICTE	2,477	>223[55]	223	-
Research	14	134	-	-

Caveat: Students, educators, schools and industry partners will be counted more than once in program totals if they participate on multiple occasions in a Digital Careers program. Bebras participants are counted per round, with two rounds per annum, while CyberTaipan, CAT and YICTE participants counted per year.

[51] >18 FarmBeats educators is calculated as an assumption that a minimum of one educator per school were engaged for the pilot.

[52] Professional learning – count of educators in live events, this does not include educators who downloaded recorded sessions if they could not attend the live event.

[53] >44 CAT educators is calculated as an assumption that a minimum of one educator per school were engaged per year.

[54] 44 YICTE schools is the sum across three years – 35 schools participated in YICTE of which 26 schools participated once, six schools participated twice, and three schools participated three times

[55] >223 YICTE educators is calculated as an assumption that a minimum of one educator per school were engaged per year.

Web-based resources have further extended Digital Careers reach to students, educators and family members, with 1,171,000 views from 798,000 users, and 114,000 downloads from 87,000 users[56].

10.2 Digital Careers outcomes and impact

This final section of the Digital Careers evaluation report considers the impact of the Digital Careers program between 2021 and 2023. Table 30 provides a key to the impact rating that has been used to assess the impact of the Digital Careers program.

Table 30 Digital Careers impact rating scale

Program outcome	Emerged – developed strategies	Developed-implemented strategies	Consolidated measurable increase in domain of interest	Lead – substantial measurable increase in domain of interest
Strength of evidence	Not available or out of scope	Low – one source of evidence with moderate reliability	Medium – one or a few sources of evidence with moderate reliability	High – multiple sources of reliable evidence

Notwithstanding the caveats mentioned in the methodology section of this report (Appendix A.2.6 **Evaluation limitations**), this evaluation has assessed outcomes and impacts of the Digital Careers program 2021–2023. Table 31 provides a summary of evidence against the Digital Careers objectives and ranked against the progress made and the strength of evidence available.

Table 31 Digital Careers impact 2021–2023

Program aims	Program objectives	Evidence Consolidating	Program outcome	Evidence rating
Student participation and engagement	Increased participation in computational thinking, digital technologies, including historically underrepresented students	The program implemented strategies that effectively saw measurable increases in student participation, in particular female students and students from regional and remote areas. There was some evidence that students from lower ICSEA schools had increased participation, but there was less evidence that Aboriginal and Torres Strait Islander students had increased participation; however, cultural identity demographic information was not readily available for most programs.	Consolidated	High
Student awareness and interest	Increased awareness and interest amongst school students in computational thinking,	The program successfully developed and implemented strategies to increase student awareness in computational thinking, digital technologies, ICT and STEM careers and saw	Consolidated	Moderate

[56] Digital Careers website data is from March 2019 to December 2023.

	digital technologies, ICT and STEM careers	measurable increases in these objective areas.		
Student capability and confidence	Improved student capability and confidence in computational thinking, design and systems thinking skills, cybersecurity, AI, IoT and big data	The program developed and implemented strategies to improve student capability and confidence with measurable increases in student capability and confidence in computational thinking, design and systems thinking skills, and cybersecurity and AI. There was less evidence of a measurable increase in student skills in IoT and big data, partially due to the short timeframe of the FarmBeats pilot and limited outcome data collection.	Consolidated	Moderate
Teacher capability and confidence	Improved teacher capability and confidence in delivery of the Australian Curriculum: Technologies	The program developed and implemented strategies that created a measurable increase in teacher capability and confidence in delivery of the Australian Curriculum: Technologies. In some areas the program extended teacher capabilities beyond curriculum requirements.	Consolidated	Moderate
Program significance	The program can be described as unique, efficient, valued and sustainable	The program has been described as valuable and unique. Evidence relating to the efficiency and sustainability of the program is, however, limited.	Developed	Low

Appendices

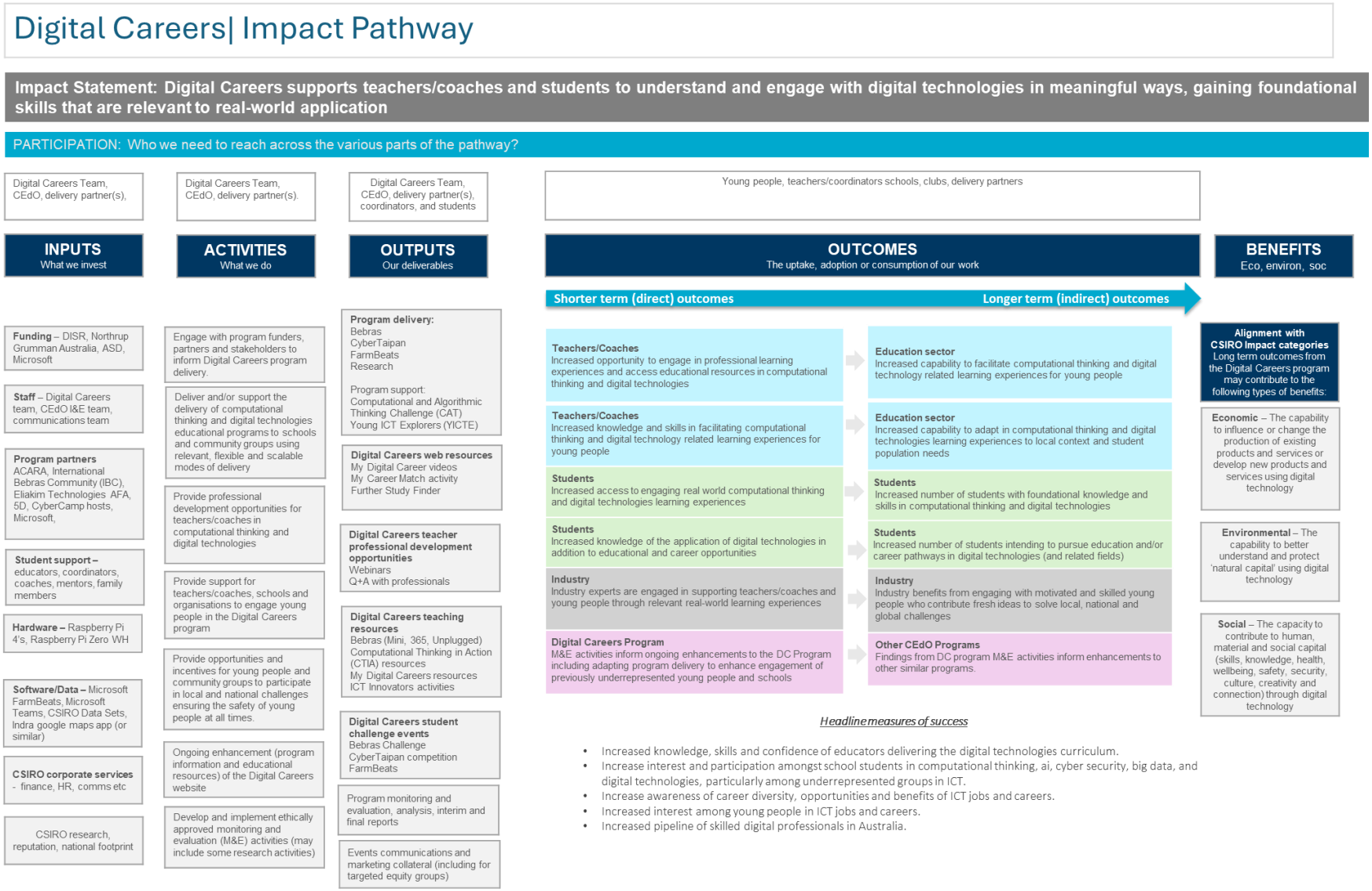
A.1 Impact Pathways

On the following pages impact pathways are presented for three elements of Digital Careers and one overarching impact pathway for all elements of Digital Careers.

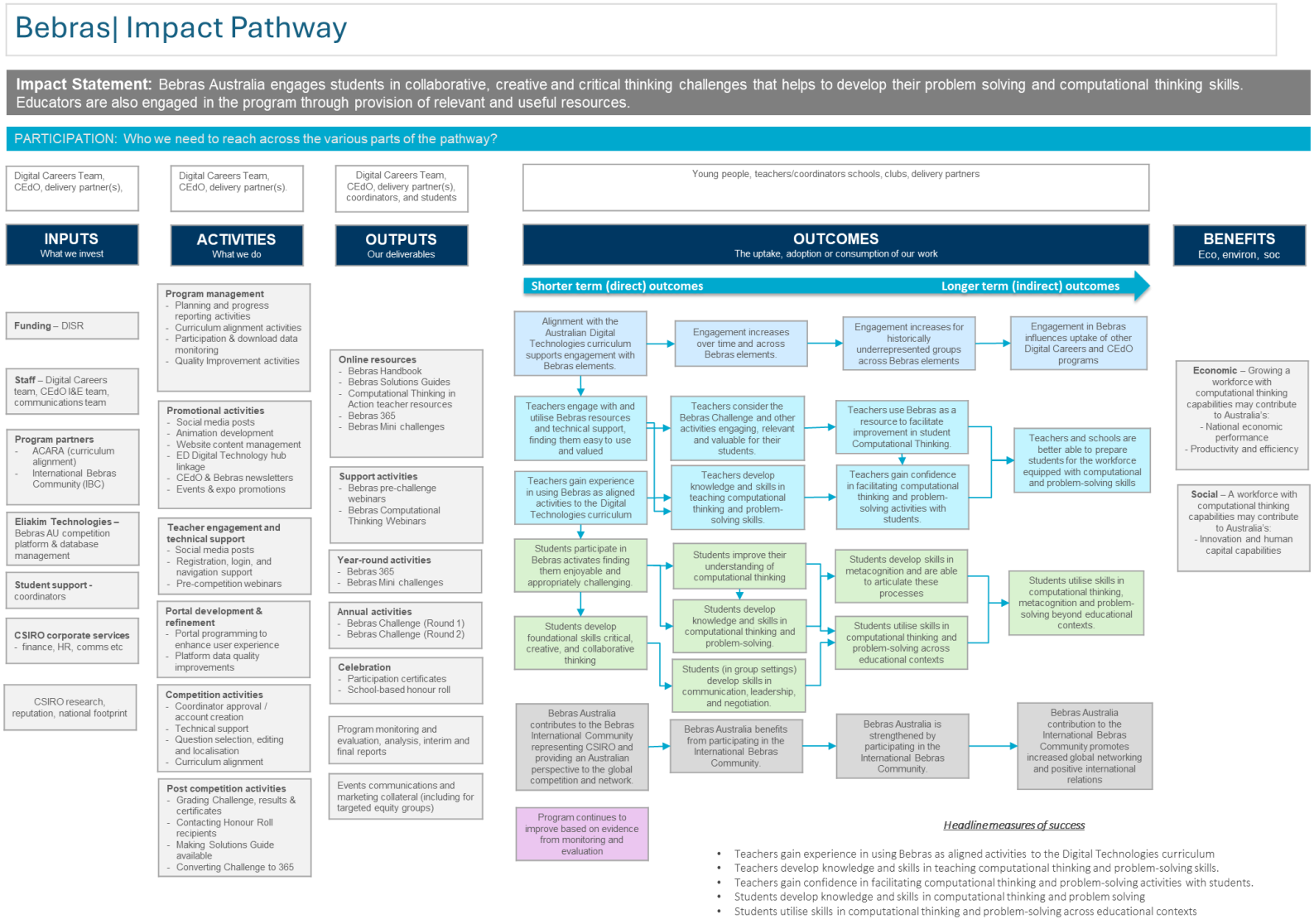
- Digital Careers Impact Pathway
- Bebras Impact Pathway
- CyberTaipan Impact Pathway
- FarmBeats Impact Pathway

These impact pathways were developed in 2021 with minor adjustments made in 2022. Impact pathways are intended to provide a high-level overview of Digital Careers and three program elements – Bebras, CyberTaipan and FarmBeats — have Impact Pathways. The pathways, based on CSIRO's Impact Model, describe the logic and assumptions of each program, and articulate the expected outputs, outcomes, and longer term impacts.

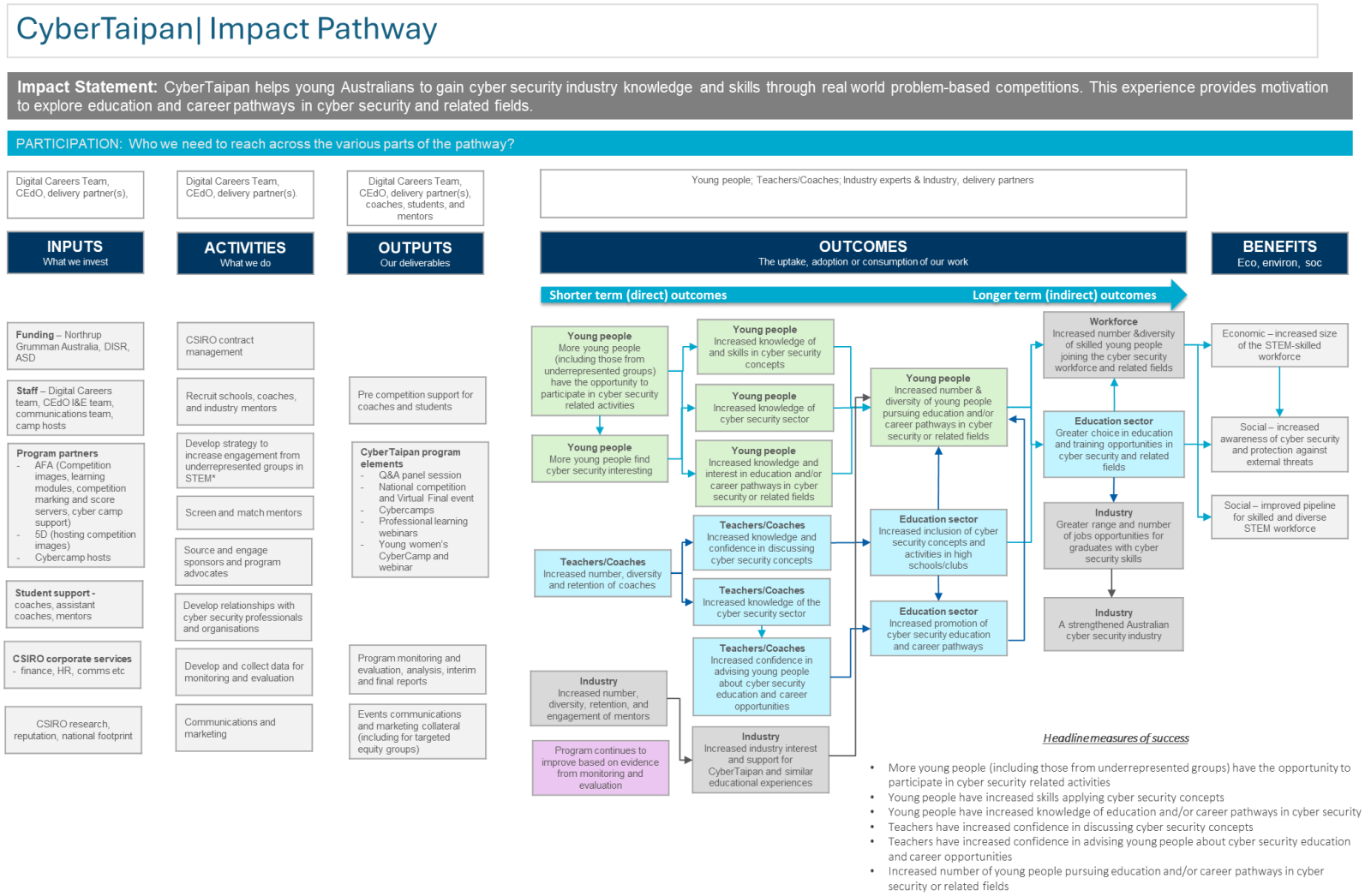
A.1.1 Digital Careers Impact Pathway



A.1.2 Bebras Impact Pathway

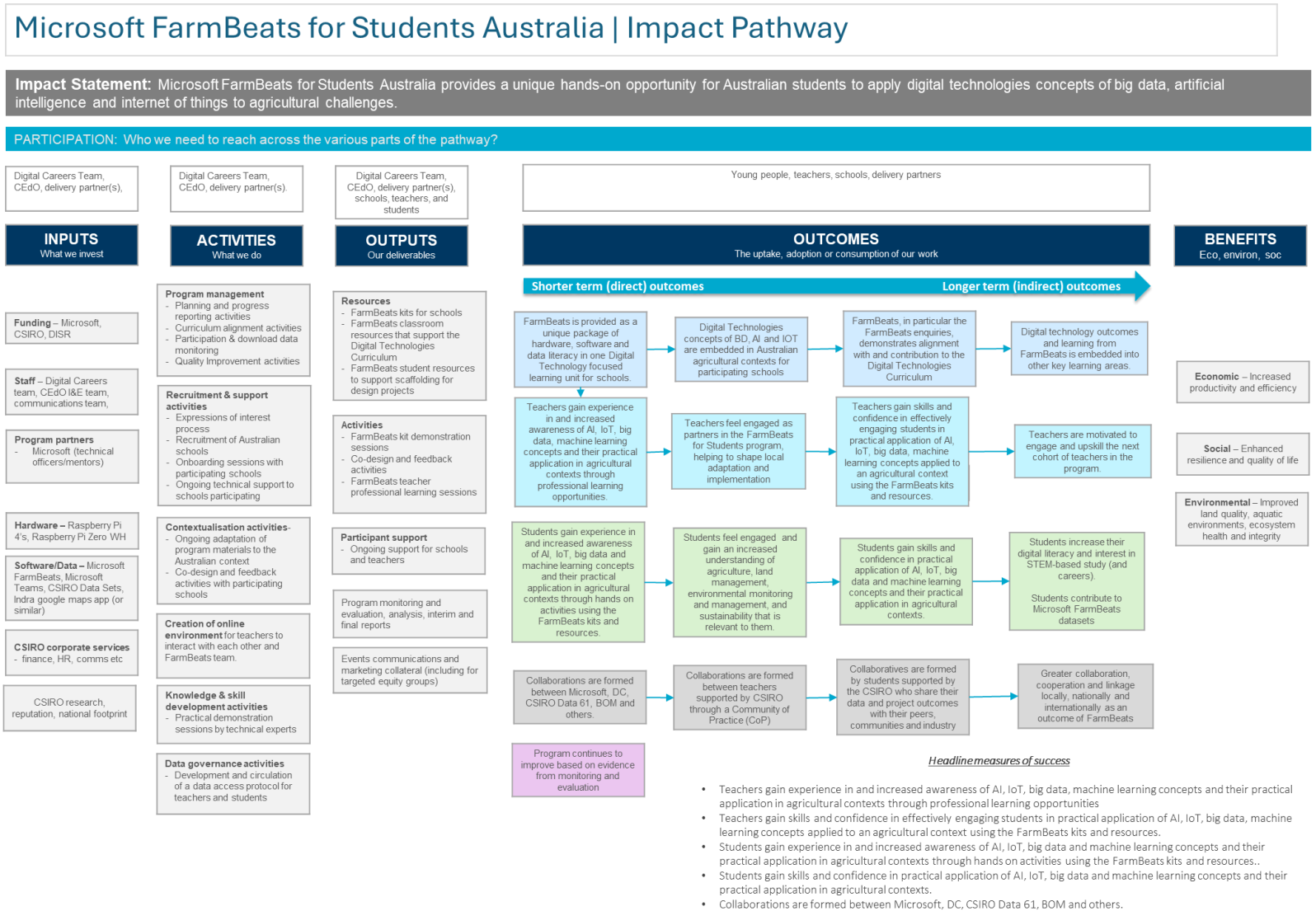


A.1.3 CyberTaipan Impact Pathway



** Underrepresented groups in STEM Include: females, people from regional and remote regions, Aboriginal and/or Torres Strait Islander people, people with disability.*

A.1.4 FarmBeats Impact Pathway



A.2 Evaluation methodology

This appendix includes more detailed information regarding the evaluation methodology employed to evaluate the Digital Career program elements, and includes information about the evaluation approach, key evaluation questions, data collection methods, data analysis and the use of an evaluation rubric to determine evaluative judgements regarding program performance.

A.2.1 Evaluation approach

The evaluation of the Digital Careers program used a mixed method approach, drawing on analysis of existing secondary data (e.g. program operational data) and creating new primary source data (e.g. participant experience and outcome data). Both primary and secondary data have included quantitative data (numerical data) and qualitative data (data using words and observations). Mixed method approaches have been adopted to provide a balance between rigour, sensitivity and feasibility.

A.2.2 Key evaluation questions

The key evaluation questions that guide the evaluation of the Digital Careers program are as follows:

1. To what extent did the Digital Careers Program successfully engage students, teachers/educators, schools and industry?
2. To what extent did the Digital Careers Program deliver intended benefits for students, teachers/educators, schools and industry?
3. How significant is the Digital Careers Program in relation to being unique, efficient, valued and sustainable?

A.2.3 Data collection methods

This evaluation has used different data sources and data collection methods, as can be seen in Table 32, to evaluate the different elements of the Digital Careers program.

Table 32 Digital Careers data collection methods

Digital Careers program element:	Data source					
	Program Team	Program data	Program website	Educators	Students	Industry partners
Bebras	Workshop	Registration & participation		Survey		
CyberTaipan	Workshop	Registration & participation		Survey Interviews	Survey	Survey Interviews
FarmBeats		Participation		Interviews		
Educator PD		Registration & participation		Survey		
Research				Focus Survey Interviews	Focus Groups	
Web resources			Analytics			
CAT						Data Reports
YICTE						Data Reports

Program team workshops – a CSIRO Monitoring & Evaluation team member co-facilitated a review workshop to reflect on what was working well, what was challenging, and what opportunities existed to strengthen program delivery and outcomes.

Program operational data – program registration and participation data was analysed, and key program documents were reviewed.

Program website activity data – this included information and resources made available and downloaded.

Survey data – program participants (educators, students and industry partners) were invited to complete online anonymous surveys using the Qualtrics survey platform to help us better understand how a program has been received, what difference it has made and how it can be improved.

Interviews – semi-structured virtual interviews conducted via Microsoft Teams were used to to illicit a deeper understanding of the impact of a program element, what outcomes it created or contributed to and how it could be improved or strengthened.

Stories of Change – proposed as a means to illicit a deeper understanding of the impact of Bebras, educators were invited to submit written stories; however, this opportunity was not taken up by educators.

A.2.4 Data analysis

Qualitative data: The process of organising and analysing qualitative data is described below.

Sorting and coding interview, open-ended survey responses and any other unstructured data such as observational data. Data was coded in various ways including by evaluation question, theme and subtheme, and source. The strength and interconnectedness of re-occurring themes helped to determine what aspects of the program and its outcomes and impacts (intended and unintended) were most important to participants and whether there was consistency or differences across stakeholder groups and subgroups.

Quantitative data: The process of organising and analysing quantitative data depended primarily on the quantity of the data available.

Descriptive statistics was used to summarise and describe raw quantitative data such as closed-ended survey responses to make it easy to identify patterns and determine what the data is showing. Examples include determining the mean, median or mode, minimum and maximum values, percentages, and frequency.

Inferential statistics was used to determine the differences and relationships between two or more timepoints in the same group. Examples of inferential statistics include determining if there is a correlation between two variables, analysis of variance to determine the strength or significance of a relationship and regression to determine if are one variable is the predictor of another variable.

A.2.5 Evaluation rubric and evidence rating scale

Based on the key program outcomes identified in Section 1 of this report, an evaluation rubric has been created to assess the success of each Digital Careers program (Table 33).

Table 33 Digital Careers evaluation rubric

Program aims	Program objectives	Indicator ratings			
		1. Emerging	2. Developing	3. Consolidating	4. Leading
Student participation and engagement	Increased participation in computational thinking, digital technologies, including historically under-represented students	The program developed strategies to increase participation.	The program implemented strategies to increase participation.	The program created measurable increase in student participation.	The program created substantial measurable increase in student participation.
Student awareness and interest	Increased awareness and interest amongst school students in computational thinking, digital technologies, computational thinking, ICT and STEM careers	The program developed strategies to increase student awareness and interest.	The program implemented strategies to increase student awareness and interest.	The program created measurable increase in student awareness and interest.	The program created substantial measurable increase in student awareness and interest.
Student capability and confidence	Improved student capability and confidence in computational thinking, design and systems thinking skills, cybersecurity, AI, IoT and big data	The program developed strategies to improve student capability and confidence.	The program implemented strategies to improve student capability and confidence.	The program created measurable increase in student capability and confidence.	The program created substantial measurable increase in teacher capability and confidence.
Teacher capability and confidence	Improved teacher capability and confidence in delivery of the Australian Curriculum: Technologies	The program developed strategies to increase teacher capability and confidence.	The program implemented strategies to increase teacher capability and confidence.	The program created measurable increase in teacher capability and confidence.	The program created substantial measurable increase in teacher capability and confidence.
Program significance	The program can be described as: unique, efficient, valued, sustainable	The program was one of the following: unique, efficient, valued, or sustainable.	The program was two of the following: unique, efficient, valued, and sustainable.	The program was three of the following: unique, efficient, valued, and sustainable.	The program was all of the following: unique, efficient, valued, and sustainable.

The evaluation rubric provides a framework to assess achievement of outcomes relating to the key evaluation questions, determining progress and performance against general and program-specific intended outcomes.

Table 34 Digital Careers Impact rating scale

Program progress	Emerging – developed strategies	Developing – implemented strategies	Consolidating – measurable increase in domain of interest	Leading – substantial measurable increase in domain of interest
Strength of evidence	Not available or out of scope	Low – one source of evidence with moderate reliability	Medium – one or a few sources of evidence with moderate reliability	High – multiple sources of reliable evidence

Evaluation limitations

Table 35 provides a summary of the main limitations associated with the evaluation of the Digital Careers program, and where mitigation strategies have been applied to enhance the rigour of the evaluation.

Table 35 Evaluation methodology limitations and mitigation strategy

Type of limitation	Limitations	Mitigation
Sphere of influence	The evaluation does not employ experimental design and therefore cannot determine to what extent the Digital Careers program in isolation has directly influenced participant outcomes.	Survey questions ask program participants to consider changes that have occurred since taking part in the program – this seeks to focus the respondent's attention on outcomes linked to the program.
Self-reported data	The evaluation uses self-reported data as a principal source of outcome data, which comes with some inherent bias. It was not possible to obtain school administrative data, for example on students' academic results or elective selections.	Where possible the evaluation has used multiple data sources over multiple years (data triangulation).
Point in time	The evaluation uses point in time rather than longitudinal data collection methods to collect individual participant outcome data.	Data has been captured over multiple years for CyberTaipan, Bebras, and Educator Professional Learning program elements and these indicate data trends. In addition, retrospective pre-post survey questions have been used where possible.
Small sample size bias	Sample sizes for the evaluation have generally been small and therefore lack the ability to generalise findings to wider population due to the potential for response bias.	Statistical analysis has been undertaken where possible, for example using Wilcoxon Signed Rank test for small sample sizes.

A.3 CyberTaipan impact case studies

The following impact case studies have been developed through an interview process with mentors representing five organisations and include reflections on CyberTaipan benefits and impact.

Australian Air Force Cadets Impact Case Study

Melissa Jones, Flight Lieutenant (AAFC) Commanding Officer – 346 Squadron and National Lead CyberTaipan
61 Australian Air Force Cadet teams have participated in CyberTaipan 2021–2023

Getting involved in CyberTaipan

Commanding Officer Melissa Jones has been the CyberTaipan national lead for the Australian Air Force Cadets (AAFC) since the end of 2021. She heard about the competition from a cadet.

> *One of my cadets approached me with their parents (about competing in CyberTaipan), which they had heard about from their sibling in the Army Cadets.*

When she contacted her headquarters to find out more about CyberTaipan, their enthusiastic response to her enquiry was that Melissa could lead AAFC's participation in CyberTaipan nationally. So, that is exactly what Melissa did, and she has mentored cadets through two years of competition. She has provided fortnightly virtual sessions each Sunday covering different cyber security concepts in during 45–90-minute sessions. In addition, Melissa explained,

> *We also had a couple of parents who offered to give presentations on their cyber careers… I think the cadets enjoyed it, judging by some of the questions they asked during the presentations.*

Measures of success

While CyberTaipan is a competition, Melissa explained that her measures of success for cadets were much broader than making the top 10 leaderboard.

> *I told the cadets, 'Look if you make the top 10, then great. But the main thing is you learnt something; you made a whole heap of new friends. And as long as that's done, I'm happy'.*

Student benefits

In relation to improvement in technical skills, Melissa noted Linux operating systems was the most significant.

> *Because the past two years have largely been Linux based, very few of [the cadets] (and we are probably talking only about 5%, if that) would have had any experience in Linux. So, there was a bit of learning for them in that regarding Linux but quite a few of them have actually been surprised with Linux.*

Melissa explained that her ethos is to get the students to learn for themselves and from each other in self-directed group chats to find solutions to problems.

> *In many regional squadrons, they don't have that ability to communicate with a larger cohort of cadets, so it's a good way to build up their networking skills in an area that they're actually all interested in.*

Impact on study or career choices

When asked if Melissa could recall if taking part in CyberTaipan had influenced any cadet's career choices she recalled:

> *I got an email from a cadet who participated in last year's competition (2022). And they said 'Mam just so you know, I wasn't really too sure what I wanted to do for uni or a career. But based on experience last year I now want to focus on cyber and I'm putting in an application at a couple of places. Would you mind being my referee?' And I was like, 'Certainly! I'd be more than happy to be referee'.*

Mentor/coach benefits

As a cyber enthusiast, Melissa explained the personal benefit of being involved in CyberTaipan.

> *It's a good way to consolidate a bit of knowledge and learn a few little tips. But obviously because coaches can't see the round scenarios, we can't access them, my ability to learn as much as the cadets from participating in the competition rounds might have been a bit limited.*

Opportunities

With regard to what could be improved, Melissa recommended a yearly refresh and/or expansion of CyberTaipan online resources, and a coach live chat community space to support all coaches to learn from each other.

Overall value of CyberTaipan

Considering the overall benefit of CyberTaipan, Melissa reflected:

> *The more people we have in the country able to deal with cybersecurity, I think the better. I think that's another good thing about CyberTaipan and cyber awareness, that we're definitely shoring up the future knowledge in the country.*

Australian Army Cadets Impact Case Study

Barry Cook, Captain (AAC), AAC STEM Advisor and CyberTaipan National Lead
55 Australian Army Cadet teams have participated in CyberTaipan 2021–2023

Getting involved in CyberTaipan
Captain (AAC) Barry Cook has been the CyberTaipan national lead for the Australian Army Cadets (AAC) for the last two years. As ACC's STEM Advisor and a STEM professional, he is one of few people well equipped to manage such an operation.

It was a natural fit for me to take this role on, given my cyber background and level of technical, administration and strategic expertise.

Barry's role over the last two years has included recruitment of technical mentors and non-technical managers (team coaches), running an eight-week virtual training program for the Cadets in preparation for the CyberTaipan Competition, sharing his experience and developing additional training resources.

Student benefits
Barry believed the most important benefit for cadets was learning how to practically respond to technical cybersecurity challenges. For example, learning to navigate through a problem, learning about Linux and applying it to cyber defence, and applying generative AI appropriately. Gaining knowledge through competing was a good experience for the cadets.

They like the idea of competing, challenging themselves, learning new things and doing better.

The virtual nature of the competition has enabled the Army Cadets to deliver their cyber program to regional and geographically distributed areas.

I had a team in New South Wales that was from five different units across NSW. So that was the benefit that they were able to work with other like-minded teams and like-minded individuals who nominated themselves and that helps with the motivation perspective.

Measures of success
Barry noted an indicator of CyberTaipan success is the large number of ACC teams registering to participate, and that some teams have taken part over multiple years.

Impact on study or career choices
As most participating cadets are 14–15 years old, Barry believed that it was a little too early for CyberTaipan to be influencing their career choices. However, he noted that Cadets get to practice their leadership skills in coordinating their cyber team's activities, which is a core capability in AAC training and a useful life skill.

Coach benefits
Army cadets are supported by volunteer coaches (referred to as 'managers') to participate in CyberTaipan, which Barry explained the majority of have no technical skills in cybersecurity and rely on CyberTaipan resources and Barry's mentorship to build their own cyber capability.

Challenges and opportunities
Barry explained that when the CyberTaipan Competition transferred to VM Ware in 2023, a number of AAC teams experienced significant difficulty as the competition images required downloading. Differences in internet download speeds and the Defence firewalls restrictions hampered participation and performance which Barry explained,

I had to scramble to find suitable computers and alternative unrestricted internet sources. I had to ship computers all around over the place.

A few other issues also hampered participation, including a misunderstanding regarding the deadline for student consents in 2023, which Barry explained meant that a notable number of Cadets and teams could not take part. In addition, some potential volunteers were initially confused by the term 'coach', which was seen to imply the need to have technical skills. Also, the registration of Cadets not having the ability to record two parent/carer email addresses for communication purposes posed another challenge.

Overall value of CyberTaipan
Despite some challenges, Barry explained that the closure of CyberTaipan at the end of 2023 will be leaving *'a massive hole'* for the Army Cadets Cyber Program. He acknowledged that Cadets had benefited a great deal over the last few years, with CSIRO leading Cyber Camps and delivering the CyberTaipan Competition.

This sentiment has since been officially recognised in a letter from a Commander in the AAC, who also acknowledged the work of the CyberTaipan Team and one team member in particular who was awarded an AAC Coin in recognition of his work.

Barry explained that while the AAC were not in a position to take over the running of CyberTaipan or similar; however, they were there to provide whatever support they could to any future cyber security focused opportunity.

Australian Mensa Impact Case Study

Ronald Yu, Chris Barnett, and Yang en Xu: Australian Mensa & CyberTaipan Mentors/Coaches
10 Mensa teams have participated in CyberTaipan 2021–2023

Getting involved in CyberTaipan

As the National Gifted Children's Coordinator and a research scientist, Ronald Xu has been the national lead for Australian Mensa in CyberTaipan since 2019, with Chris Barnett and Yan en Xu joining the core support crew in 2022. Chris explained the attraction of CyberTaipan to him was:

> *The fact that it's an intellectual team sport is, I think, a really precious opportunity. There's not enough of that combination. So that's central to what draws me to invest in in this project. (Chris Barnett)*

Measures of success

Mensa's participation in CyberTaipan has been growing, especially over the last two years.

> *We've got a very high percentage of enrolment, so it is one of our best national events in Australia. (Ronald Yu)*

Young Mensa students are also doing extremely well in the competition.

> *I think one of the things I'm most proud about this time is the fact that we had all these beginner kids who are under 12 years old who are getting more than 100 points. (Yang en Xu)*

Student benefits

The Mensa mentors explained that young people with a high IQ can often find it difficult to collaborate with others and may find school-based academic performance challenging.

> *The thing that's most impressed me in how they're developing is in learning teamwork — that that's been the weakest area for all of them in this competition… I've really seen an inspiring amount of growth in this competition is that they're learning these structures for cooperating, to start listening to their peers, to delegate and it's a pretty advanced project in that regard… They're discovering that for the first time in their lives for many of them, learning to cooperate actually pays off in the rewards of greater performance. (Chris Barnett)*

The Mensa mentors explained that CyberTaipan also provides young people with the opportunity to evaluate a range of potential solutions and not expecting there to be one clear answer, and to learn how to use AI, designing questions and evaluating outputs.

Impact on study or career choices

Mensa teams have performed well in CyberTaipan, and two former champions were known to be embarking on careers in digital technology. The mentors also explained how participation in CyberTaipan had helped one female CyberTaipan team captain challenge negative gender stereotyping about girls not being good in cyber.

> *She is the captain for the team. She started from nothing, and she learnt all the IT skills… she can go back to the to the school and tell them… girls are good at programming, they can do it… and also to go back to the community, they can spread the idea about cybersecurity and also empowering the next generation. (Ronald Yu)*

Mentor/coach benefits

The team of Mensa mentors are all volunteers and have contributed extensively to CyberTaipan, both in supporting the teams and also supporting the CyberTaipan Competition by developing and sharing images, working out solutions to the technical difficulties of running the program, and sharing their technical knowledge and skills with mentors from other teams.

The mentors acknowledge that CyberTaipan has provided them with an opportunity to create a context for learning what works for young people with high IQ. They also explained that they have learnt from other mentors and perhaps surprisingly from their students.

> *It's taken a bit of effort for me to get to a place where I'm emotionally comfortable acknowledging that I don't know how to do all the things in the Linux machine that they [Mensa students] do. (Chris Barnett)*

Challenges or opportunities

Challenges for the Mensa mentors have included difficulty with the competition platform, in particular this year when competition images needed to be downloaded.

The Mensa mentors could see an opportunity to grow CyberTaipan by connecting national winning teams up with their peers in other countries where the competition is held, for example the US, UK, Japan and Saudi Arabia.

Overall value of CyberTaipan

The mentors saw CyberTaipan as being critical for engaging Australia's brightest minds in ethical ventures that could contribute to Australia's future security and prosperity.

> *I am most aware of how relevant it is for intellectually gifted kids who are often isolated socially by being such outliers that they don't relate to the people geographically close to them and so being able to bring them together into a competition that they're really engaged with, help them find their peers and learn to work together with them in a competition that matters. It's just a recipe that, everything fits together to be awesome value. (Chris Barnett)*

CSIRO Young Indigenous Women's STEM Academy Impact Case Study

Zoe Whittingham, Computer Science Undergraduate and CyberTaipan Mentor CSIRO Young Indigenous Women's STEM Academy
4 YIWSA teams have participated in CyberTaipan 2021–2023

Getting involved in CyberTaipan

Zoe Whittingham is a computer science undergraduate and has been volunteering as CyberTaipan mentor, alongside two CSIRO coaches, for CSIRO's Young Indigenous Women's STEM Academy (The Academy) for the last two years. Prior to that Zoe volunteered as a CyberTaipan coach for her local Army Cadet team. Zoe explained that she 'had so much fun' as a coach that she wanted to do more. So, when her local cadets were not competing in 2021, she reached out to the CyberTaipan team to volunteer, and was invited to become a mentor for CSIRO Young Indigenous Women's STEM Academy.

Zoe highlighted how enjoyable it has been as a mentor for the young women of the Academy who are 13–18-year-old young women from all over Australia:

> *I find them inspiring, and I think that they help me in my learning leadership. The young women they are so smart, and they come to the meetings every week on top of their normal school programs…they're very knowledgeable and they're very polite and they're easy to work with, so I really enjoy the time that we have learning together.*

Measures of success

Zoe wants to inspire young women. She explained that she provided the YIWSA young women with information about her own experience as a young woman interested in computers and cyber; a story about Alyssa Carson a young female astronaut from the US; and also referred the young women to a 'Because of her we can' ADF NAIDOC 2018 video telling the story of Aboriginal and/or Torres Strait Islander women who've served, inspired, or supported generations of service men and women in the Australian Defence Force.

> *With Cyber Taipan, it's Australia's first National Defence cybersecurity competition. So, I stayed in the theme of that and found some YouTube videos to show them of Indigenous people that have gone on to do well in defence with these topics.*

Student benefits

Zoe's knowledge and experience as a current computer science undergraduate has been directly benefitting the young women as Zoe has been developing additional resources and instructions to prepare the young women to compete in CyberTaipan. Zoe explained that she has seen 'a drastic improvement' in the young women's technical knowledge and skills through participating in CyberTaipan.

In addition, she has noticed the young women develop friendships and strengthen their communication skills when working with other YIWSA students who participate in CyberTaipan from all over Australia.

Mentor/coach benefits

Zoe explained that she has enjoyed being involved in CyberTaipan, firstly as a coach and then as a mentor.

> *So CyberTaipan for me opened up my eyes and opened up doors and it has been a lot of fun actually. It's been a competition that I've looked forward to for the last four years. I've really enjoyed every year that I've been a part of it.*

After completing training to be a CyberTaipan coach in 2020, Zoe decided to study a Bachelor of Information Technology and has chosen an elective in cybersecurity. Zoe also noted the mentorship and support she has received from CSIRO and other mentors over the years.

> *I think that it was really great receiving mentorship from the CSIRO…I think that everyone's made friends. Everyone's met new role models and been inspired. I didn't really know very much about it [cybersecurity] actually, and since I've done it, I've been improving every year.*

Challenges or opportunities

The only challenges that Zoe experienced were in relation to balancing time to commit to supporting the young women and her own studies. She did, however, mention that when she first participated in CyberTaipan as a coach she felt that she enjoyed the closer relationship with the students on competition days that was not permitted later on as the students had to compete on their own. She did, however, acknowledge the solutions need to come from the participating students and not from coaches and mentors.

Zoe can see opportunities for other young people to compete in CyberTaipan and has presented information to Police Service Academy Cadets.

Overall value of CyberTaipan

In reflecting on the value of CyberTaipan, Zoe commented:

> *Most of their life will be on their computers so it's very important for them to have protection for themselves. So, they're not only learning that… but if they enjoy it, there's so many opportunities now in cybersecurity, because it is so important for the country, and for the government in defence... There's a lot of work going to be available for them, so they're not going to be wasting their time studying for a career that's not going to happen.*

Islamic College Brisbane Impact Case Study

Yang en Xu, Digital technologies Teacher, Islamic College Brisbane and CyberTaipan Mentor
The first Islamic College Brisbane (ICB) team took part in CyberTaipan in 2023

Getting involved in CyberTaipan

Yang en Xu has been involved in CyberTaipan for three years before starting to work with students from the Islamic College Brisbane (ICB) as a digital technologies and robotics teacher. In 2023, Yang mentored the first team of six students from ICB in the CyberTaipan Competition, providing an hour a week of support for 15 weeks. The ICB team was made up of students from grade 9–12, including two female students.

I have two girls, which is amazing because Islamic girls in cyber are super underrepresented and they're both brilliant.

Measures of success

Yang explained that the students came a long way and did well for a first attempt.

It was challenging getting the kid's knowledge up to a level when they started from scratch, and most of them started from scratch. But we had 15–16 hours, it was a good time to try and get the basics up. I'm really proud of them.

Yang noted that taking part in CyberTaipan was not only important for the participating students who were recognised and supported by the school, but it was also important for the entire school, in addition parents also showed a keen interest.

Benefits for students

Yang explained that CyberTaipan teaches young people teamwork.

It really is a very, very good opportunity for kids to learn teamwork and to learn all the soft skills. And in the world of cyber careers, these are people who are going to be the biggest salary earners in future, the people who are entrusted with the biggest secrets, and these are people you want to have these soft skills.

Teamwork can be challenging when students come from diverse backgrounds, and at ICB students originate from 52 countries. The ICB team in 2023 represented students from six different nationalities. Regardless, Yang expected the students to work through problems together and commented that the student's teamwork 'did improve significantly' by the end of the competition.

Impact on study or career choices

Yang explained that of the six students in the ICB team, three are definitely keen to go into cyber.

The team captain, while waiting for university to start, has commenced studying for his CompTIA certificate (an industry-recognised computer technology qualification). Yang explained:

CyberTaipan has been quite instrumental in letting the kids see that this is what professionals could be doing or possibly are doing, and because of that, this is what they learn in class and how it could relate to the level that professionals are at.

Mentor/coach benefits

As the students gained more confidence and skills, they were able to ask Yang more challenging technical questions, which he explained were sometimes too complex for him, which he saw as a positive. He also explained that having a good positive relationship with the students made his job as a teacher easier.

Challenges or opportunities

Yang noted that students having an overreliance on AI was the only real challenge, as they trusted the AI rather than question it.

Mainly the over reliance on AI. They use it and they don't read the code and then they run the script, and then they're upset that it breaks the machine. They're upset that it doesn't work and they're wondering why.

Overall value of CyberTaipan

In the school system, Yang felt that students are not usually able to develop advanced skills in programming, and that competitions like CyberTaipan are beneficial for developing both technical and soft skills that are equally important for Australia's future.

This is an opportunity for the brightest, the smartest and the people who are most persistent, the people who want to learn to solve problems and people who want to solve problems together. This is a great opportunity for people to come and work together regardless of physical space or cultural norms... In terms of Australia, we are short…80,000 technology/cyber workers in the next 5 years (something like that), so this is a great start.

Yang also wanted to acknowledge the hard work of the CyberTaipan Team and for prompt responses to emails.

I'd like to put this on record to say thanks to the CSIRO team. Thanks [team member names] for organising everything, it's been a great process. The communication was clear, and everything was smooth.

References

Australian Computer Society. (2022) ACS Australia's Digital Pulse. Retrieved from https://www.acs.org.au/insightsandpublications/ reports-publications/digital-pulse2022.html

Australian Council for Educational Research. (2018) Challenges in STEM Learning in Australian Schools, Policy Insights: May 2018. Retrieved from https://research.acer.edu. Retrieved from au/cgi/viewcontent.cgi?article=1007&context=policyinsights

Australian Curriculum Assessment and Reporting Authority (2022) Digital Technologies. Retrieved from https://www.australiancurriculum.edu.au/f-10-curriculum/technologies/digital-technologies/

Banks, C., Buckley, S. & Osborne, K. (2023). Factors facilitating greater engagement of young women in digital technologies education. Teacher Magazine, August 2023. Retrieved from https://www.teachermagazine.com/au_en/articles/factors-facilitating-greater-engagement-of-young-women-in-digital-technologies-education

Boom, K.D., Bower, M., Siemon, J., & Arguel, A. (2022) Relationships between computational thinking and the quality of computer programs. Education and Information Technologies. Retrieved from https://link.springer. com/article/10.1007/s10639-022-10921-z

Buckley, S., Ahmed, S.K., Osborne, K., McNeilly, C., Sniedze-Gregory, S.& Felgate, R. (2022). Engaging young female students in digital technology programs: Part One. CSIRO, Australia. Retrieved from https://www.csiro.au/-/media/Education-media/Files/Impact-and-Evaluation/ACER_CSIRO-Report_PartOne_25062023_annotated.pdf

Commonwealth of Australia, Department of the Prime Minister and Cabinet (2021) Digital economy strategy 2030. Retrieved from https://digitaleconomy.pmc.gov.au/ sites/default/files/2021-07/digital-economy-strategy.pdf

Dagienė, V., & Sentance, S. (2016). It's Computational Thinking! Bebras Tasks in the Curriculum. In A. Brodnik & F. Tort (Eds.), 9th International Conference on Informatics in Schools: Situation, Evolution, and Perspectives, ISSEP 2016 (pp. 28–39). Retrieved from http://www.springer.com/series/7407

Department of Industry, Innovation and Science. (2020). Youth in STEM Research 2019/20. Retrieved from https:// www.industry.gov.au/sites/default/files/2020-03/ youth-in-stem-research-2020-summary-results.pdf

Hubwieser P., Hubwieser E., Graswald D. (2016) How to Attract the Girls: Gender-Specific Performance and Motivation in the Bebras Challenge. In: Brodnik A., Tort F. (eds) Informatics in Schools: Improvement of Informatics Knowledge and Perception. ISSEP 2016. Lecture Notes in Computer Science, vol 9973. Springer, Cham. Retrieved from https://doi.org/10.1007/978-3-319-46747-4_4.

Kingsley, I. (2020). Evaluating STEM Gender Equity Programs: A guide to effective program evaluation. Office of the Women in STEM Ambassador. Retrieved from https://womeninstem.org.au/national-evaluation-guide

Osborne, K., Felgate, R. & Buckley, S. (2023). Engaging young female students in digital technology programs: Part Two. CSIRO, Australia. Retrieved from https://www.csiro.au/-/media/Education-media/Files/Impact-and-Evaluation/ACER_CSIRO-Report_PartTwo_25062023_annotated.pdf

Wing, J.M. (2006) Viewpoint: Computational thinking. Communications of the ACM. 49(3), 33–35. Retrieved from https://dl.acm.org/doi/fullHtml/10.1145/1118178.1118215

Zagami, J. (2022) Computer education in Australian schools 2022. Australian Computer Society. Retrieved from https://www.acs.org.au/content/ dam/acs/acs-publications/ACS-Digital-TechnologiesEducation-Whitepaper_A04_FA_WEB.pdf.

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

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

For further information

I**mpact and Evaluation**
C**SIRO Education and Outreach**
Sarah Renals, Principal Advisor
Sarah.Renals@csiro.au
cedoimpact@csiro.au
csiro.au/Education