

EVALUATION OF EARLY LEARNING AND SCHOOLS INITIATIVES IN THE NATIONAL INNOVATION AND SCIENCE AGENDA

REPORT TO THE DEPARTMENT OF EDUCATION

JANUARY 2020

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Executive Summary

Through the National Innovation and Science Agenda (NISA), announced in 2015, the Australian Government has allocated funding to 15 STEM-focused initiatives across the education portfolio. Teachers, principals, students and industry have now been engaging with most of these initiatives for approximately three years.

The Department of Education (the Department) wants to understand what the impact of these initiatives has been — individually and as a package of initiatives. They have commissioned dandolopartners (dandolo) to conduct an evaluation that provides a sound evidence base for future decisions about support for STEM teaching and learning in schools and the early years.

1.1. Evaluation findings

The NISA initiatives are well-regarded by stakeholders with many positive outcomes for STEM education

Given there are 15 separate NISA initiatives, dandolo approached the evaluation in two ways. We evaluated each initiative individually, and all initiatives together as a package. This approach included relying on existing evaluation data available to dandolo, and supplementing this data with our own consultation processes through interviews and focus groups.

Overall, for individual initiatives we found that:

- Programs or activities successfully reached their target audiences
- Most were positively received
- Most achieved their objectives through increased STEM confidence and engagement in their target audiences.

For our evaluation of NISA initiatives as a package,¹ findings were generally positive and affirm the Australian Government's current approach. However, there are some clear opportunities for future focus. Figure 1 outlines a summary of these findings.

¹ In order to evaluate NISA initiatives as a package, dandolo developed a framework using four analytical lenses (why, who, what and how). See Section 1 for more information.

Figure 1. Summary of findings from evaluation of NISA as a package

	Analytical lens	Finding	Commentary on finding
Why	Do initiatives focus on student engagement or achievement?	Most initiatives focus on improving engagement through building teacher capability	It's positive that most initiatives focus on increasing student engagement given it's a precursor to increasing achievement.
	Do the initiatives have a universal focus or are they trying to increase equity or excellence?	Most initiatives have a universal focus but there's a notable segment (30%) focusing on specific equity groups	The mix of universal and equity focus achieves a balance between maximising breadth of coverage and addressing inequities. Particularly for underrepresented cohorts (e.g. STEM participation and achievement by female, low SES and Indigenous students).
Who	Who is the main target audience for the initiatives?	Most initiatives have teachers as the target audience	This focus indicates initiatives are responding to the current area of greatest need in STEM education (building teacher capabilities). However, there are potential future opportunities to also support other important stakeholders (principals, parents and pre-service teachers) to better ensure a long-term improvement in STEM education.
	What education level do the initiatives target?	While there are some early years initiatives, most initiatives take a broad focus across the school years (primary and secondary)	The broad focus is a sensible way to maximise the reach of initiatives. However there are trade-offs to this decision; e.g. missing specific opportunities to improve STEM at important points of transition (e.g. subject selection). There's also less focus on early years, where foundational STEM skills are developed. Future strategies should consider increasing focus on the early years.
What	What is the main output of the initiatives?	Most initiatives offer professional learning, rather than specific resources	Professional learning to build teacher capability is a valuable focus area. Stakeholders suggest there could be more support to use specific resources provided. Approximately one third of the initiatives currently do this, but this approach could be more consistent among initiatives.
	What curriculum area do the initiatives focus on?	Most initiatives focus on Digital Technologies (DT)	This is a strategic decision to support the rollout of DT in the Australian Curriculum. To an extent, this inadvertently reduced the focus on math, which provides important foundational skills for STEM and other subjects, but this is now being addressed through a targeted budget measure.

How	What are the partnerships, processes and supports that have been used?	Most initiatives engaged and consulted widely with the education sector	The Australian Government is well-regarded for its stakeholder engagement and contributions in the sector.
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However, there are some limitations to this evaluation as it relates to comparing impact between initiatives

There are some limitations to this evaluation and findings, for example:

- Existing evaluations are inconsistent. This means that they each use different measures and language to describe success.
- Each initiative varies in terms of their goals and approaches.
- There is varying reliability of evidence of impact, with most relying on proxy measures.

These challenges mean that while our individual evaluations remain robust, they may not necessarily provide a clear and comparable indication of impact between each initiative.

1.2. Changes in the operating environment

It's important to consider the future of the NISA initiatives within the context of the changing operating environment

In addition to evaluating the NISA initiatives, dandolo identified changes in the operating environment that may influence decisions about future funding. Since NISA funding was announced in 2015 the policy environment has continued to evolve. For example, the Digital Technologies curriculum is no longer new, although it is far from being fully and effectively implemented. Additionally, a number of other STEM-related strategies and packages have been released. These include:

- Greater Choice for Australian Women: Women's Economic Security Statement (2018)
- Women in STEM Decadal Plan (2019)
- Advancing Women in STEM strategy (2019)
- Federal budget investments in:
 - Strengthening Australia's capability in artificial intelligence and machine learning over four years (2018-19)
 - Cyber security arrangements and workforce capability (2019).

Beyond commitments made at a federal level, states and territories are also continuing to advance their own STEM strategies and agendas, contributing to the national landscape of STEM investment.

1.3. Towards a forward strategy for investment in STEM education

There are some clear opportunities forward in considering a future approach to STEM investment

Our analysis suggests that there are some clear areas where the Australian Government could maximise its impact in supporting STEM education.² These include:

- Continuing to **build STEM capability** among educators across the education system
- Continuing to prioritise **scaling up** initiatives to a national level
- Building a robust and consistent **national evidence base** on what success looks like in STEM education
- Leveraging existing networks and relationships to **coordinate and link actors** in the STEM space for collaboration

² See Section 5 for more detail.

This does not mean to suggest that the Australian Government should **only** focus on these areas. Rather, it is a useful framing to inform where it might make sense to intervene and invest based on need and potential for impact. Beyond this analysis, we considered specific recommendations in line with evaluation findings. These are shown in the image below.

Figure 2. Summary of recommendations and rationale

	Analytical lens	Conclusion / recommendation	Rationale
Why	Should initiatives focus on student engagement or achievement?	<ul style="list-style-type: none"> The Australian Government should continue investing in initiatives that promote both engagement and achievement, particularly noting that engagement is integral to future STEM education outcomes. 	This approach acknowledges the interdependence of the twin goals of engagement and achievement, while ensuring investment in both.
	Should initiatives have a universal focus or should they aim to increase equity or excellence?	<ul style="list-style-type: none"> Prioritise initiatives with a focus on universal service provision, but encourage targeted initiatives for equity purposes. Continue to limit investment in approaches that focus on achieving excellence alone. 	This approach maximises the Australian Government's reach and impact while still helping to address the persistent inequities in STEM education.
Who	Who should be the main target audience for the initiatives?	<ul style="list-style-type: none"> Continue to prioritise building system capability through teachers, while decreasing focus on individual schools and students. Consider expanding reach to principals and pre-service teachers through existing initiatives. 	This approach makes the most of the Australian Government's existing relationships. It is also well-suited to delivering mechanisms that lift system capability.
	What education level should the initiatives target?	<ul style="list-style-type: none"> While the Australian Government should continue investing in school years, it's a crowded space and there are other opportunities to consider. For example, further investing in the early years. 	This approach ensures the Australian Government's investment in STEM education fills gaps and avoids duplication.
What	What should be the main output of the initiatives?	<ul style="list-style-type: none"> Continue to support existing professional learning and resources Invest in approaches that focus on coordination, evidence and communication across the national STEM landscape. 	There is positive work in this space, and professional learning is incredibly important to lifting STEM outcomes. There is a need for a more evidence-based, coordinated approach to STEM education.
	What curriculum area should the initiatives focus on?	<ul style="list-style-type: none"> Continue to define STEM broadly but promote approaches that build general capabilities and incorporate real world experiences. 	This approach recognises the unresolved debates in STEM education, addresses areas of significant need and advances other

		<ul style="list-style-type: none"> Continue to support digital technologies, however, balance this with the need to invest in maths. 	Australian Government education policy agendas.
<i>How</i>	What partnerships, processes and supports should be in place?	<ul style="list-style-type: none"> Celebrate successes on positive stakeholder engagement 	The Australian Government is also well-regarded by stakeholders for their approach to, and investment in, STEM education.

Introduction

In 2015, the Australian Government recognised the importance of STEM education by allocating funding for a range of early years and schools initiatives through the National Science and Innovation Agenda (NISA). Since 2016, funding has been provided for 15 Initiatives through the NISA including:³

- Digital Technologies Massive Open Online Courses (MOOCs)
- Digital Technologies in Focus (DTiF)
- STEM Professionals in Schools
- Digital Literacy Schools Grants
- Australian Digital Technologies Challenges and Dive into Code
- digIT summer schools
- Principals as STEM leaders
- Science ASSIST Advisory Service
- Curious Minds summer school for girls
- Primary Connections: Linking Science with Literacy
- Science by Doing
- reSolve: Mathematics by Inquiry
- Early Learning STEM Australia (ELSA) Pilot
- Let's Count
- Little Scientists

Teachers, principals, students and industry have now been engaging with most of these initiatives for at least three years (noting some are continuations of previously funded programs). The Department wants to understand what the impact of these initiatives has been — individually and as a package of initiatives — and has commissioned dandolo partners to conduct an evaluation that provides a sound evidence base for future decisions about support for STEM teaching and learning in schools and the early years.

This report is structured in six major sections:

³ A more detailed explanation on each is provided in Section 3.

This report	
Section 1	Approach to this evaluation
Section 2	An overview of STEM education
Section 3	Findings on NISA initiatives in aggregate
Section 4	Changes in the operating environment
Section 5	Approach to recommendations
Section 6	Recommendations

Detailed information on funding and evaluations of individual initiatives is provided in the Appendix.

1 Approach to this evaluation

We conducted an individual evaluation for each NISA-funded initiative (15 in total), and an overall evaluation for the initiatives as a package. This section describes our approach to this process.

NISA initiatives and their evaluations have diverse goals and approaches

The NISA initiatives represent 15 discrete programs which broadly aim to increase STEM outcomes for students in schools and early years education.⁴ Each incorporate varying goals (e.g. building teacher capacity in inquiry-based maths, to supporting principals to be leaders of STEM in their schools), age groups (e.g. F to 10) and approaches (e.g. online courses, to student camps, to placing STEM professional in schools).

Given the importance of initiatives at an individual level, as well as looking at the wider investment in aggregate, we utilised two evaluation approaches.

We conducted two separate kinds of evaluations to appreciate the individual and wider impact of the NISA initiatives

In addition to establishing impact between different kinds of initiatives, dandolo also relied heavily on existing evaluations of NISA initiatives to inform data collection. There are some limitations to this process, for example:

- Existing evaluations are inconsistent. This means that they each use different measures and language to describe success.
- Each initiative varies in terms of their goals and approaches.
- There is varying reliability of evidence of impact, with most relying on proxy measures.

Together, these limitations mean that it is difficult to compare the relative success (or otherwise) of the individual initiatives. Our methodology is described in full below.

⁴ Our analysis focuses on NISA funded initiatives and we also looked at STEM education initiatives funded by state and territory governments. There is significant government and community activity in STEM, including initiatives funded and delivered by universities, industry or other providers, and by other Australian Government departments. While we acknowledge this, the focus of our analysis has been the NISA initiatives in the education portfolio. Detailed analysis of these other initiatives was outside the scope of our work.

Figure 3. Methodology to evaluate NISA initiatives⁵

Project establishment	Research and field work	Reporting
Project initiation <ul style="list-style-type: none"> • Inception meeting to agree on project objectives and scope • Develop project plan 	Desktop research <ul style="list-style-type: none"> • Desktop review of publicly available data to identify gaps to request data • Submit data request to evaluators of initiatives, e.g. performance and participation data, web analytics, policy documents • Review secondary data to establish initial fact base 	Individual evaluation reports <ul style="list-style-type: none"> • Produce short reports on each initiative using the evaluation framework to assess their impact
The Department's data request and review <ul style="list-style-type: none"> • Submit data request to the Department for existing evaluation • Liaise with DIIS to understand and align with their NISA evaluation 	Interviews <ul style="list-style-type: none"> • Conduct phone interviews with: <ul style="list-style-type: none"> - Providers of each initiative (15) - Evaluators of initiatives (~9) - All State and Territory authorities to understand the policy context and unique aims from each jurisdiction (8) 	Draft evaluation report <ul style="list-style-type: none"> • Develop draft report that assesses initiatives as a whole package and draws out common lessons from individual evaluations
Finalise framework and field work approach <ul style="list-style-type: none"> • Refine evaluation framework based on data provided • Test and finalise the framework with the Department 	Focus groups <ul style="list-style-type: none"> • Conduct 10 online focus groups with initiative participants to understand their experience and the initiative's impact 	Final report <ul style="list-style-type: none"> • Test draft report and seek feedback from key Department staff • Incorporate feedback and finalise report • Present to the Department and provide final report
	Additional fieldwork for non-evaluated initiatives <ul style="list-style-type: none"> • Conduct initiative-specific fieldwork to collect data on initiatives that do not have evaluations, which will include some: <ul style="list-style-type: none"> - Web analytics - Online focus groups - Pop-up survey - Reviews of applications / acquittal forms - Reviews of feedback forms or surveys - Desktop research 	Evaluation training workshop <ul style="list-style-type: none"> • Workshop with Department's staff to <ul style="list-style-type: none"> - Present frameworks and evaluation guide - Share lessons and suggestions for evaluating packages of initiatives / programs - Build internal capabilities

⁵ Our consultation processes are based on qualitative fieldwork. This involves asking broad, open-ended questions, and interview structure / questions vary on a case-by-case basis. We aggregate stakeholder feedback into themes. We apply critical judgement to qualitative fieldwork based on features like alignment with research, consistency, biases, frequency and relevance of stakeholder feedback.

Initiative mapping

- Map reach and scope of initiatives
- Compare with State and Territory initiatives

In order to remedy some of these limitations we:

- Supplemented existing data with:
 - A deep dive into desktop research, including the analysis of internal reports, contracts and existing evaluation reports
 - Our own consultation process included interviews, online and face-to-face focus groups with approximately 207 stakeholders including:⁶
 - Providers and evaluators of programs (approximately 22 stakeholders)
 - Peak bodies for STEM, teacher associations and industry representatives (approximately 12).
 - Teachers, early childhood educators, principals and parents (approximately 149)
 - A combination of government and non-government education authorities (approximately 24).
- Used the standardised evaluation framework from the STEM Education Resources Toolkit⁷ to establish some consistency between initiatives (shown in Figure 4 below)
- Developed a conceptual framework which outlines key questions to frame our understanding of the NISA initiative in aggregate. A rationale for these categories is provided in Table 1 below.

An evaluation framework helps organise information we need to assess impact

This evaluation was used as an opportunity to road-test the evaluation framework proposed in the STEM Education Resources Toolkit. This evaluation framework was developed with the intention that it would be able to be applied to a broad range of STEM education initiatives, only requiring that the detail and effort involved would need to be scaled depending on the initiative size. Figure 4 outlines this evaluation framework.

⁶ A detailed breakdown is available in the Appendix.

⁷ The STEM Education Resources Toolkit refers to a document, commissioned by the Department and developed by dandolopartners, that provides guidance on how to evaluate STEM initiatives. It includes a standardised framework for all STEM initiatives, with some flexibility for tailoring objectives and outcomes.

Figure 4. High-level evaluation framework developed in STEM Education Resources Toolkit

Key evaluation question: Did the initiative achieve its intended outcomes?				
Design	Implementation	Outputs	Outcomes	
Does the initiative's design set it up for success?	How has the initiative been implemented in practice?	What has the initiative produced or delivered?	What impacts or consequences did the initiative have for students?	
Potential measures for design	Potential measures for rollout	Potential measures for things produced	Direct measures of engagement and achievement	
	Generic program measures	Potential measures for people reached	Direct measures of engagement	Direct measures of achievement
		Potential measures for time spent	Proxies to measure engagement and achievement	
		Potential measures about who received the initiative	Potential behaviours to use as proxies	Potential beliefs to use as proxies

A conceptual framework helps us frame information we collect through important key questions

Our conceptual framework for this project is organised into four major questions:

- **Why?** *What are the NISA initiatives trying to achieve?*
- **Who?** *Who is the target audience?*
- **What?** *What are the initiatives delivering?*
- **How?** *How are they being delivered?*

We've provided a table that outlines are rationale for each lens below.

Table 1. Rationale for conceptual framework

	Analytical Lens	Rationale
Why	Do initiatives focus on student engagement or achievement?	<p>STEM education initiatives aim to improve STEM outcomes for students. This typically focuses on two factors:</p> <ul style="list-style-type: none"> • Increasing engagement in STEM • Increasing achievement in STEM <p>These two factors directly influence student outcomes. Student engagement is understood as the degree of attention and interest a student shows when they are being taught which extends to the motivation they have to learn. Student achievement refers to improved performance, knowledge or skills. Both are closely interlinked and influence the other. It's a useful way to understand what different STEM initiatives are seeking to achieve, and to ensure there are initiatives that serve both purposes.</p>
	Do the initiatives have a universal focus or are they trying to increase equity or excellence?	<p>Generally, there are two ways to design a program to reach participants:</p> <ul style="list-style-type: none"> • Universal approach • Targeted approach. <p>Initiatives with a universal focus aim to serve a wide population, e.g. all students, or all students in Year 7. They do not target people with a particular background. Equity-focused initiatives target groups that are underrepresented in STEM such as students who are female, Indigenous or from low SES backgrounds. Excellence-focused initiatives target high-performing students in STEM. Universal and targeted programs may have different objectives and impact. For example, a universal program may reach a lot of people but have shallow impact, while a targeted program may reach a smaller cohort of people but leave a greater impression.</p>
Who	Who is the main target audience for the initiatives?	Initiatives can target school leadership, teaching staff, students directly or other groups such as parents. Outcomes will vary depending on intended target audience.

	What education level do the initiatives target?	Initiatives can focus solely on one education level such as the early years, primary or secondary, or span across two or three different education levels.
What	What is the main output of the initiatives?	The main outputs include resources, professional learning or student mentoring. Resources refers to those initiatives that produce materials such as lesson plans or contribute information to online portals. Professional learning, although linked to resource-use, relates to initiatives which involve workshops or conferences to train and coach educators on delivering STEM curriculum or using digital technologies (either via online, face-to-face or mixed mode delivery).
	What curriculum area do the initiatives focus on?	Curriculum areas specific to STEM include science, mathematics and digital technology learning areas. Engineering is part of STEM but is not a learning area in the Australian curriculum. General STEM is the categorisation given to initiatives which span more than one subject or have an interdisciplinary focus.
How	What are the partnerships, processes and supports that have been used?	NISA initiatives have been delivered in partnership with providers. It's important to understand the nature of these relationships and any perceived or real challenges that might create barriers for initiative success.

2 Overview of STEM education

This section sets out why quality STEM education is an important goal for Australia. It outlines what actions have been taken by the Australian, and State and Territory governments, to make progress against this goal.

4.1. STEM education in Australia

STEM education is a national priority

Governments across Australia recognise the importance of high-quality STEM education to the nation's current and future economic productivity and wellbeing. Today's pre-schoolers will be employed in jobs yet to be created and face enormous social, economic and environmental challenges with technologies yet to be imagined.

A strong STEM education is integral in preparing students for these changes by building students' skills in critical and creative thinking, problem solving, analysing and communicating quantitative data. These skills enable students to think adaptively and access a range of careers. The best investment in STEM education starts in the early years and in schools and continues through vocational education and training (VET) and higher education.⁸

There are different definitions of STEM

The term 'STEM' can mean different things in different contexts. Under the *National STEM School Education Strategy 2016-2026* (National Strategy), STEM refers collectively to the teaching of the disciplines within its umbrella – science, technology, engineering and mathematics – and also to a cross-disciplinary approach to teaching that increases student interest in STEM related fields and improves students' problem solving and critical analysis skills. STEM sits within a broader foundational knowledge base and the teaching of STEM is only a part, albeit important, of a balanced program of learning.⁹

There are widespread concerns about current levels of student achievement and engagement in STEM as well as under-representation of some groups in STEM

Despite the future opportunities associated with STEM education, Australia could improve the following aspects of STEM education:

⁸ *Australia's National Science Statement 2017*, www.industry.gov.au/data-and-publications/australias-national-science-statement

⁹ *National STEM School Education Strategy 2016-2026*, See also the discussion of the term STEM and related terms in the STEM Partnerships Forum Report, *Optimising School-Industry Partnerships*, <http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/Reports%20and%20publications/Publications/Optimising%20STEM%20Industry-School%20Partnerships%20-%20Final%20Report.pdf>

- **Student engagement** – Student enrolment in STEM subjects in senior secondary has decreased, particularly in advanced STEM subjects and among girls.¹⁰ While none of the NISA initiatives target senior secondary directly, student engagement and interest in STEM at F-10 can define later decisions about electives in senior secondary and work or tertiary pathways.
- **Student achievement** – International tests, such as the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), show that Australian students' achievement scores in science and mathematics have either declined or remained stagnant.¹¹
- **Representation and achievement of specific cohorts** – Currently, specific cohorts are underrepresented in STEM education. This includes disparities in STEM outcomes for students living in rural or regional areas of Australia, Aboriginal and Torres Strait Islander students and students from low-socio economic backgrounds.¹²

4.2. Commitments and actions to improve STEM education

Governments have sought to improve STEM education — at a national, state and territory level. NISA represents an important part of the Australian Government's contribution in this space.

National, State and Territory Strategies

The *National STEM School Education Strategy 2016-2026* strives to ensure that students have a stronger foundation in STEM and are inspired to engage with more challenging STEM subjects. It has two high-level goals:

- To ensure all students finish school with strong foundational knowledge in STEM and related skills
- To ensure that students are inspired to take on more challenging STEM subjects.

The National Strategy acknowledges the work that is being done by the states and territories of Australia. Each state, as well as the Northern Territory, has developed its own strategy while the Australian Capital Territory has adopted the National Strategy directly. While states and territories differ slightly in their approach, their end goal, like the National Strategy, is to build students' STEM capabilities to encourage students to take up STEM-related career pathways when exiting school. The NISA initiatives also include a focus on early years STEM education, as a pivotal point to develop the foundational STEM knowledge of a child.

National Science and Innovation Agenda (NISA)

¹⁰ Timms, M, Moyle, K, Weldon, P & Mitchell, P, 2018, *Challenges in STEM learning in Australian schools: Literature and policy review*, ACER, p.10

¹¹ Thomson, S, De Bortoli, L & Underwood C, 2017, *PISA 2015: Reporting Australia's Results*, ACER; Thomson, S, Wernert, N, O'Grady, E & Rodrigues, S, 2017, *TIMSS 2015: Reporting Australia's Results*, ACER.

¹² Education Services Australia, 2018, *Optimising STEM Industry-School Partnerships: Inspiring Australia's Next Generation Final Report*, Carlton.

The Australian Government's NISA is a \$1.1 billion four-year whole-of-government package focused on science, research and innovation as long-term drivers of economic prosperity, jobs and growth. NISA allocated \$64.6 million worth of funding for three early years initiatives (\$14.0 million) and six school initiatives (\$50.6 million) to prepare students with the STEM skills for a changing future. However, as implementation of the school initiatives proceeded, the overall cost of the initial projects was lower than anticipated. This enabled the remaining funding to be utilised for a new research project with principals and to extend five pre-existing STEM initiatives that were due to cease.

NISA early learning and school STEM initiatives

The NISA school initiatives are designed to support implementation of the *National STEM School Education Strategy*. The early years initiatives also aim to support such implementation by contributing to a smooth transition from preschool to Foundation and throughout the early primary years. Figure 5 provides a short description of each initiative. Appendix 2 provides more detail about each initiative, including a summary of the completed evaluation and the challenges and future plans for each initiative.

Figure 5. NISA early learning and school STEM initiatives

Focus	Initiative	Description
School initiatives	Digital Technologies Massive Open Online Courses (University of Adelaide)	Expansion of the University of Adelaide's MOOCs for teachers on implementing the Australian Curriculum: Digital Technologies (AC: DT).
	Digital Technologies in Focus (ACARA)	Digital Technologies educators are working with school leaders of around 155 disadvantaged schools to drive change in their schools through face-to-face workshops, webinars and online mentoring
	STEM Professionals in Schools (CSIRO)	Flexible partnerships between STEM professionals and schools, which will help students to understand how STEM is applied in the real world
	Digital Literacy School Grants (schools)	Funding for schools to implement their own innovative projects
	Australian Digital Technologies Challenges and Dive into Code (University of Sydney – Australian Computing Academy)	An online series of structured, progressive teaching and learning activities and challenges for Year 3-8 students and professional learning workshops for teachers. Dive into Code—fun and engaging coding activities and challenges for Year 3-12 students

	digIT summer schools (Australian Mathematics Trust)	Intensive camps and mentoring to target students at risk of not benefiting from the AC: DT to engage them in ICT and future careers
Additional school initiatives	Principals as STEM leaders (University of Tasmania)	Developing and trialling support for principals to provide high quality STEM leadership in schools. The resources developed through the project will be made available for all Australian schools to use at the end of the project
	Science ASSIST Advisory Service (Australian Science Teachers Association)	An online advisory service for science teachers and laboratory technicians that provided advice on science laboratory safety and procedures, including factsheets and a Q&A service
	Curious Minds summer schools for girls (Australian Mathematics Trust)	A hands-on extension program that combines residential camps and a mentoring program to ignite girls' passion in STEM
	Primary Connections: Linking Science with Literacy (Australian Academy of Science)	Professional learning and inquiry curriculum resources for primary teachers linking science and literacy teaching
	Science by Doing (Australian Academy of Science)	Professional learning modules for secondary science teachers and online science resources for students in Years 7 to 10
	reSolve: Mathematics by Inquiry (Australian Academy of Science)	Teaching and professional learning resources that support teaching mathematics from F-10 through inquiry-based methods
Early years initiatives	Early Learning STEM Australia (ELSA) Pilot (University of Canberra)	Developing and piloting play-based digital apps for preschool children with a focus on foundation STEM learning concepts to inspire curiosity and engagement in STEM, including a supporting app for educators and families
	Let's Count (The Smith Family)	An early mathematics program for children aged 3-5 that supports early years' educators and parents to develop the mathematics skills of the children in their care by noticing, exploring, and talking about mathematics using everyday activities. The program involves professional learning for educators, and information and physical resources for parents.
	Little Scientists (Froebel Australia)	A series of education workshops for early learning educators to improve their confidence and ability to introduce STEM concepts in a fun and engaging way to children in their care

3 Evaluation of NISA initiatives as a package

The NISA initiatives were designed to be more than the sum of their parts. This evaluation reflects this by evaluating the initiatives as a package. The evaluation of the NISA initiatives as a whole provides a better

assessment of the impact of the Government's investment in STEM education and helps with future decision-making by understanding:

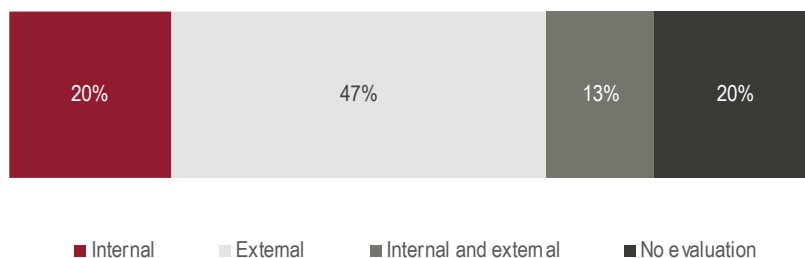
- The benefits and potential improvements to the NISA initiatives' approach
- How NISA initiatives map to the needs of schools and early childhood settings
- Whether there are gaps, duplications or opportunities for change (including relative to other programs provided by individual jurisdictions)

The evaluation of the initiatives as a package has been challenging due to variation in initiatives and their individual evaluations

While valuable, assessing a package of initiatives is not straightforward. dandolo encountered the following challenges during this evaluation:

- **Not all of the NISA initiatives have been or will be evaluated individually.** Nine initiatives have been evaluated externally by independent evaluators while two have internal evaluations. Four have not been formally evaluated.

Figure 6. Initiatives broken down by evaluation status



- **Initiatives that have been evaluated have not necessarily been evaluated consistently, making it difficult to draw comparisons.** Where external evaluations took place, most providers organised their own evaluators, however some had an independent evaluator engaged and managed by the Department. Some of the evaluators include ACER, Deakin University, and Monash University. Each of the evaluators have adopted different methodological approaches and evaluation frameworks making it difficult to compare initiatives and draw conclusions from this.
- **The status of evaluations and initiatives varies.** There is inherent variability within initiatives due to different starting dates and project timeframes. Different starting dates mean evaluations are at different stages, some have been running for ten years and others are more recent. In one instance, project delays also contributed to challenges in evaluation. For example, the independent evaluation of

Principals as STEM leaders has produced one preliminary report, focused on the governance and communication arrangements of the initiative because this program is still early in its implementation. It is not possible at this stage to make an assessment of the effectiveness of this program. Other programs such as Primary Connections (Academy of Science) have been running for more than ten years and have conducted multiple internal and external evaluations.

- **Varying reliability of evidence of impact.** Some evaluations only include measures of outputs, for example, the number of people reached or the number of downloads of online resources. In seeking to measure outcomes, many evaluations, including external evaluations, rely on proxy measures to evaluate the impact of an initiative. These include teacher reports on student progress and teacher confidence. The lack of direct measures in many evaluations is understandable given the challenges involved with measuring student learning or engagement directly, including accessing students, finding a representative sample and securing ethics approval.¹³ The consequence of this is that there are some limitations around what report can say about effectiveness and impact of the initiatives individually and as a package in terms of its impact on students in STEM. See Appendix 2 for the evaluation measures used by each evaluation.¹⁴

To address the challenges outlined above and evaluate NISA initiatives as a package, we have framed the following questions around the analytical lenses of *why, who and what* (see figure 9 below).

These questions enabled us to overcome some of the challenges of evaluating the NISA initiatives as a package, including the variability of the initiatives and their evaluations. They also pose critical questions for program design and policy development. These questions constituted the lens through which we analysed state and territory government funded STEM initiatives and developed our recommendation for a forward-looking strategy. The objective was to provide our evaluation with the coherence that will assist with future decision making. In addition, we supplemented existing evaluation findings and activities with our own extensive program of stakeholder consultation, described in more detail in Section 1.

Figure 7 presents the questions raised above and the findings from our evaluation of NISA as a package. The following section steps out rationale for each one in more detail.

¹³ One of the program evaluations explained the difficulties associated with gaining consent to run focus groups with students in remote communities. The evaluation team for this project came to the conclusion that 'parental informed consent for student focus groups is not feasible due to English language barriers and, in some cases, difficulties in locating parents/guardians.'

¹⁴ https://www.parliament.vic.gov.au/archive/etc/Submissions/prof_learn/australiancouncilforeducationalresearch280607.pdf

Figure 7. Summary of findings of evaluation of NISA as a package

	Analytical lens	Finding	Commentary on finding
Why	Do initiatives focus on student engagement or achievement?	Most initiatives focus on improving engagement through building teacher capability	It's positive that most initiatives focus on increasing student engagement given it's a precursor to increasing achievement.
	Do the initiatives have a universal focus or are they trying to increase equity or excellence?	Most initiatives have a universal focus but there's a notable segment (30%) focusing on specific equity groups	The mix of universal and equity focus achieves a balance between maximising breadth of coverage and addressing inequities. Particularly for underrepresented cohorts (e.g. STEM participation and achievement by female, low SES and Indigenous students).
Who	Who is the main target audience for the initiatives?	Most initiatives have teachers as the target audience	This focus indicates initiatives are responding to the current area of greatest need in STEM education (building teacher capabilities). However, there are potential future opportunities to also support other important stakeholders (principals, parents and pre-service teachers) to better ensure a long-term improvement in STEM education.
	What education level do the initiatives target?	While there are some early years initiatives, most initiatives take a broad focus across the school years (primary and secondary)	The broad focus is a sensible way to maximise the reach of initiatives. However, there are trade-offs to this decision; e.g. missing specific opportunities to improve STEM at important points of transition (e.g. subject selection). There's also less focus on early years, where foundational STEM skills are developed. Future strategies should consider increasing focus on the early years for future strategies.
What	What is the main output of the initiatives?	Most initiatives offer professional learning, rather than specific resources	Professional learning to build teacher capability is a valuable focus area. Stakeholders suggest there could be more support to use specific resources provided. Approximately one third of the initiatives currently do this, but this approach could be more consistent among initiatives.
	What curriculum area do the initiatives focus on?	Most initiatives focus on Digital Technology (DT)	This is a strategic decision to support the rollout of DT in the Australian Curriculum. To an extent, this has inadvertently reduced the focus on math, which provides important foundational skills for STEM and other subjects, but this is now being addressed through a targeted budget measure.

How	What are the partnerships, processes and supports that have been used?	Most initiatives engaged and consulted widely with the education sector	The Australian Government is well-regarded for its stakeholder engagement and contributions in the sector.
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Why

5.1. Do the initiatives focus on student engagement or achievement?

Framing outcomes in terms of students' outcomes was not common practice, as most NISA initiatives focus on supporting teachers

Providers did not always frame their goals in terms of improving student outcomes. This may be because the NISA initiatives are quite deliberately focused on supporting teachers, to build their capability through professional learning and resources. The ultimate goal and motivation behind teacher professional learning is to improve student outcomes. Measures that show improvement, or lack thereof, in teacher understanding, confidence and capability are measures of effectiveness. Additional measures that go more directly to student outcomes would be ideal, however this can be difficult in practice as it can be hard to isolate the impact of one program, particularly for a short-term period. Additionally, high-quality, robust measurement of student achievement can also dramatically increase program costs.

As a result, dandolo had to make judgements about whether an initiative aimed to improve student engagement or achievement, acknowledging that the two are mutually reinforcing. However, the concepts of engagement and achievement both help understand initiative objectives, and it's useful to understand initiative outcomes – or the challenges each initiative is trying to address - through this lens.

Most initiatives aim to increase student engagement, although this focus ultimately supports achievement as well

The main aim of most initiatives was to increase student engagement, rather than student achievement. This was also reflected in the funding, with 87 percent of funds directed at initiatives focused on student engagement, rather than student achievement (13%). Based on initiative objectives, the NISA initiatives focused on achievement were MOOCs and Primary Connections.¹⁵

¹⁵ For example, the initiative objectives specifically state increasing skill levels, and increasing uptake in STEM classes – which we have framed as 'achievement'. Whereas other initiatives tend to emphasise building enthusiasm and interest in STEM, which we have framed as focusing on engagement.

Stakeholders highlight that a focus on engagement does not always come at the expense of achievement. However, engagement is often described as a precursor to achievement and so it's important to examine the extent to which initiatives focus on these twin goals.

5.2. Do the initiatives have a universal focus or are they trying to increase equity or excellence?

NISA funding achieves a balance between breadth of coverage while still addressing equity issues in STEM

Most NISA funded initiatives have a universal focus (they do not target a particular group). This enables initiatives to maximise their reach to a larger audience. However, a significant proportion of initiatives have an equity focus (they do target a group that is underrepresented in STEM). This is also a legitimate focus as the research on STEM education and stakeholder consultation emphasised there are persistent barriers that exist for underrepresented groups. There need to be initiatives focused on removing these barriers to ensure that STEM is more diverse and equitable.

Figure 8. Initiatives broken down by equity, excellence or universal focus

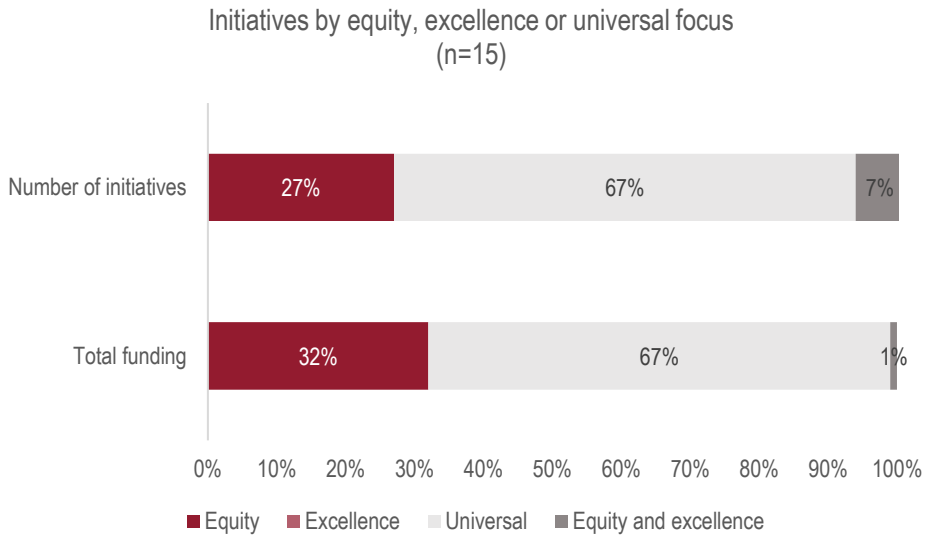
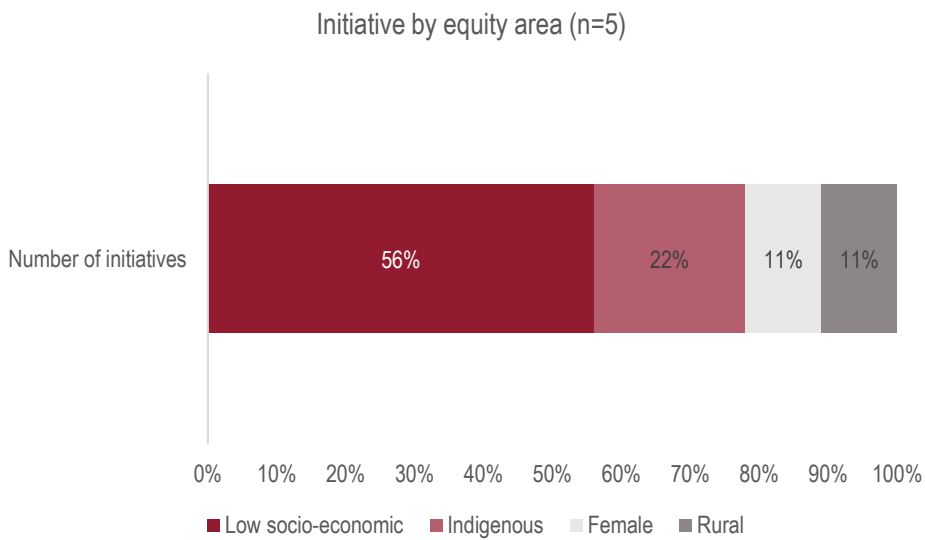


Figure 9. Initiatives broken down by equity area



Students from low-socio-economic backgrounds are well-targeted by NISA initiatives, with less funding directed toward female students

An analysis of NISA funding by equity-focused initiatives reveals that students from low-SES backgrounds are well-served. Among initiatives that are equity-based, 56% of funding going towards students from low-socio-economic backgrounds. These initiatives are also likely to target rural students and Indigenous students¹⁶ because of the overlap between these groups and low socio-economic status. Only 11% of equity funding is targeted specifically towards female students (noting that girls could also be a sub-set of other equity groups). Only one NISA initiative, Curious Minds, specifically targets girls by providing summer school and mentoring to female students in year 9 and 10 to increase their interest and participation in STEM.

“I believe we need programs that target girls. The girls at our school love not having to compete to have a go on equipment and not feel self-conscious” – Teacher

Providers of initiatives with an equity focus face additional challenges to implementation, however, they are adopting and developing approaches to address these challenges

Initiatives that target equity groups face additional challenges, although they are developing approaches to address these challenges. Providers of equity-focused programs identified the following challenges:

- Lack of IT infrastructure such as poor Internet connection and out-of-date hardware and software,
- High staff turnover,
- Difficulties communicating with rural educators who do not often check their emails, and
- The high cost and time required to travel to attend activities for teachers, students, and school leaders who work in remote settings.

“I teach middle years digital technology in a very remote community school in NT. During wet season we are isolated from the world by water.” - Teacher

“Access to professional learning is a critical issue. In my case I have to travel over 300km to the city.” – Teacher

“Access to workshops in order to upskill and gain a better understanding is a big barrier. Educator education is a huge one.” – Early Childhood Educator

Despite these additional challenges, providers are seeking to incorporate approaches that work with specific groups. For example, Northern Territory stakeholders said that the model that ‘Digital Technologies in Focus’ uses which involves physically going into schools and spending several days or a week working with teachers and building their capability, works well in

¹⁶ While 22 per cent of funding goes to targeting Indigenous students, stakeholders from two states/territories with a high number of indigenous students noticed that there was a gap in programs that incorporate indigenous knowledge and perspectives into their approach to STEM education. Examples of these types of programs that are not funded by NISA include the Stronger Smarter Institute Indigenous Knowledges in Science, Technology, Engineering and Mathematics (SSiSTEMIK) and CSIRO’s Indigenous STEM Education Project. In 2018 the Department of Prime Minister and Cabinet also invested \$20 million for the Indigenous Girls’ STEM Academy, delivered by CSIRO in partnership with CareerTrackers.

disadvantaged schools. Future funding decisions should take into account the additional difficulties associated with targeting equity groups and can also learn from the approaches being developed by current NISA initiatives.

Who

5.3. Who is the main target audience for the initiatives?

The main target audience for most initiatives is teachers, which maximises impact and targets an area of significant need

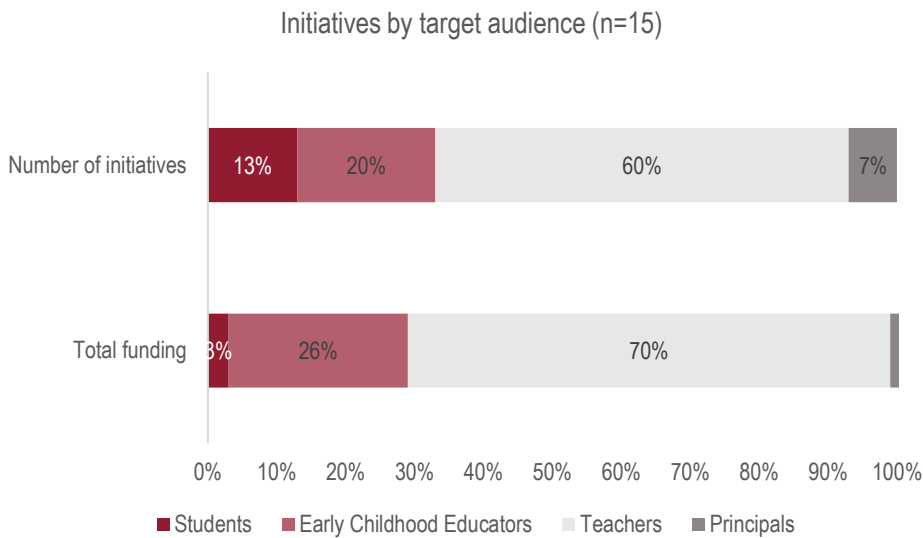
The main target audience for most NISA funded initiatives is teachers. This is a legitimate focus for NISA because this is an area of significant need – stakeholders consistently said that increasing teacher capability is an issue in STEM education and that teachers need help to develop more confidence, skills and knowledge to teach STEM effectively. Investing in teachers is also valuable because research shows that quality teachers are the most important factor contributing to student achievement.¹⁷ Increasing teacher capability in STEM will likely have broader positive impact beyond STEM, especially for primary school teachers who teach a range of subjects. By investing in teacher-focused programs, NISA was able to reach more students than if it invested mostly in student-focused programs. While impactful for individual students and appreciated by stakeholders, student focused programs are only able to reach a small number of students.

“To get change, school executive attitudes need to change, teacher awareness needs to be raised and good practitioners need to mentor others.” – Principal

“There is no doubt that the greatest challenge facing the effective implementation of STEM education is teacher pedagogical knowledge and how this translates to effective daily practice.” – Stakeholder

¹⁷ Stronge, JH & Hindman, JL 2003, 'Hiring the best teachers', *Educational Leadership*, vol. 60, no. 8, pp. 48-52.

Figure 10. Initiatives broken down by target audience



There is scope to increase focus on principals through NISA-funded initiatives, given their centrality in achieving school-wide, sustained change

Principals are critical to the effectiveness of STEM initiatives. They determine the extent to which teachers can prioritise STEM and create the conditions that enable teachers to change their practice and adopt more effective STEM practices. They also enable whole-school change by helping to spread and consolidate changes across their school. There are two NISA initiatives that explicitly target principals, Principals as STEM leaders (PASL), and Digital Technologies in Focus. However, there could be more opportunities to consider principals as an audience – and a key mechanism for change within a school environment – including considerations of how to achieve principal ‘buy-in’ and support, across all initiatives.

“Professional learning should include principals. Without leadership support a lot of STEM ideas will never get off the ground” – Teacher

“Changes are likely to occur if the administration of the school see STEM as a priority” – Teacher

Early childhood programs engage parents, but school years programs do not, even though parents continue to influence students throughout their schooling

The NISA-funded early childhood programs explicitly target parents and communities to build their support and knowledge in STEM. For example, Let's Count (Smith Family) aims to support parents to develop the mathematics skills of the children in their care by noticing, exploring, and talking about mathematics using everyday activities. ELSA has developed an app for families to help extend children's learning into the home and to support families to engage with STEM concepts.

By contrast, NISA-funded programs for primary and secondary school do not focus on parents and families. While it does not make sense for parents and communities to be the main target audience for NISA-initiatives, they are important stakeholders and have a significant influence on students, especially when it comes to subject selection and forming career aspirations.

"Parents can only do so much and without effective engagement and communication from schools it is difficult for parents to support learning at home in a meaningful way" - Parent

Two resources through which the Australian Government engages parents to help support their child's interest in STEM are the Learning Potential platform and the Digital Technologies Hub (which links to most of the NISA-funded schools programs). Neither is funded by NISA however, and they are therefore beyond the scope of this evaluation.¹⁸

Pre-service teachers are only targeted by one program, despite their inclusion in NISA funding objectives

Pre-service teachers are only targeted by one program despite being a stated objective of NISA funding for school and the early years. NISA funding aimed to ensure 'Pre-service teachers develop foundational skills and knowledge to teach STEM and Digital Technologies'.¹⁹ Despite this aim, Primary Connections is the only NISA-funded initiative that explicitly engages pre-service teachers. Several stakeholders perceived this as a gap, arguing that it is important to improve the quality of STEM teachers before they enter the profession. It is important to note however that, beyond NISA, there has been significant national reform and effort in the pre-

¹⁸ Learning Potential is a freely available national platform that is targeted at parents and families, containing resources to help parents support their child's interest in STEM from the early years through to the end of high school. The Digital Technologies Hub is another resource that, in addition to resources for teachers and students, includes a range of materials for parents and families. All NISA projects are required to publish their resources on the Hub, and some make quite extensive use of it, such as MOOCs.

¹⁹ Evaluation of National Innovation and Science Agenda (NISA) early learning and schools initiatives (Discussion paper for stakeholder interviews and focus groups)

service teacher space in recent years, following a report released by the Teacher Education Ministerial Advisory Group (TEMAG).²⁰

5.4. What education level do the initiatives target?

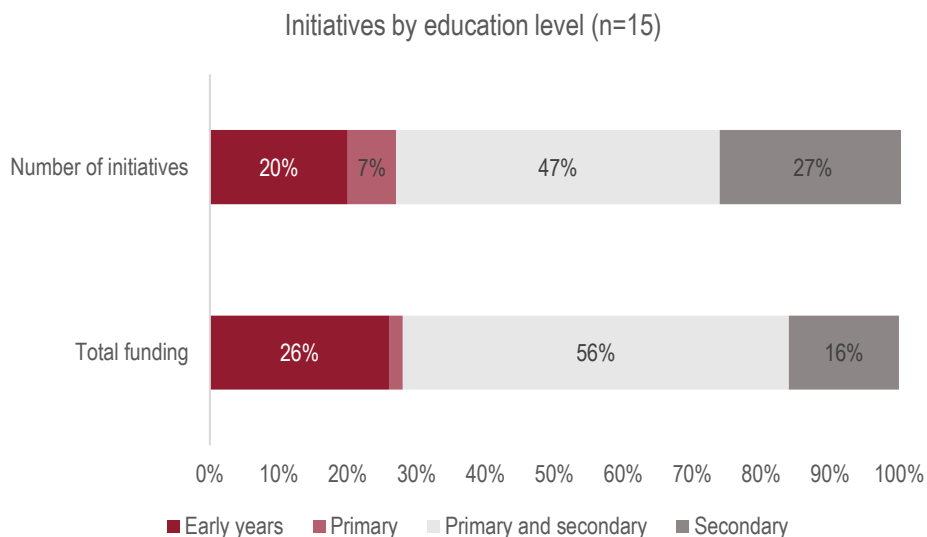
Most initiatives have a broad focus on both primary and secondary school – this will maximise reach, but there are some tradeoffs

Almost half of all NISA initiatives have a broad focus, catering for both primary and secondary school. This broad focus is legitimate because primary and secondary school is where the most students are, so providers can maximise their reach. However, there are some tradeoffs with this broad focus. A broad focus means there is less investment in programs that address the challenges associated with particular year levels. For example, there are no programs that target senior secondary school students enrolled in STEM subjects, including those enrolled in vocational educational pathways (several stakeholders identified a lack of focus on VET in schools as a gap). This is difficult to address through NISA however, as the funding focuses on areas where there is a nationally agreed framework or curriculum, which is only available in early years and F-10, not senior secondary. In terms of primary education, only one program (Primary Connections) targets the early primary years, which is an important time for STEM education, but may require a different pedagogical approach than later primary school years.

“The combination of teacher professional learning programs and initiatives for students of all ages and abilities is valuable” - Teacher

²⁰ In response to the [TEMAG Report](#), the Australian Government committed \$16.9 million over four years to reform teacher education courses to ensure new teachers are adequately skilled. The bulk of reforms have been implemented through the revised Accreditation of Initial Teacher Education Programs in Australia: Standards and Procedures. Changes include more rigorous selection processes, introduction of the Lantite test and compulsory teacher performance assessments.

Figure 11. Initiatives broken down by education level



Investing in the early years was strategic because there are not many STEM programs for this sector, while the school years are a crowded space

School years are the primary focus of STEM initiatives, and represent a crowded space for products and services. This means investment in the early years is a strategic approach because it addresses a gap in service delivery. Stakeholders reported that the STEM education space in the school years feels crowded, duplicative and difficult to navigate. More specifically, in relation to the new learning area of digital technologies, stakeholders believed that the number of resource offerings and the broad scope of these made it difficult to filter through which were applicable to their specific school context. This was significant given the scarcity of teachers with content knowledge in this area, as those with no or limited content knowledge are more likely to be unclear on what to look for or how to determine the utility of a particular resource. In contrast, stakeholders in the early childhood sector flagged that there are limited initiatives targeting the early years, and that this represents a missed opportunity.

This suggests there may be scope to help teachers navigate service offerings in the school years to better identify high-quality resources, for example through promoting higher uptake of the Digital Technologies Hub.

What

5.5. What curriculum area do the initiatives focus on?

Most of the initiatives and initiative funding focuses on Digital Technologies, which was a strategic decision designed to respond to the policy environment

Five of the six school initiatives initially funded through NISA had a focus on Digital Technologies. The reason for this was because the NISA report emphasised coding and computing²¹ and there was a need to support a new Digital Technologies curriculum as it began to be rolled out in states and territories. No stakeholders disagreed with this investment in digital technologies and many stakeholders acknowledged that there is an ongoing need in this area. Several providers of digital technology-focused programs stated that continued investment was required because schools are still in the early stages of implementing the curriculum and there are significant challenges, as described below.

Any future investment in supporting the digital technologies curriculum needs to be aware of and address the following challenges

Providers, evaluators and stakeholders raised the following issues around digital technologies that would need to be addressed with any future investment in digital technologies.

- Lack of, or underdeveloped, technology infrastructure in schools such as Internet connectivity.²²
- Inequities between schools in terms of digital technology capabilities – some schools are still focused solely on literacy and numeracy while other schools are ready to teach more advanced technology content.
- The need to continually update and refresh teacher capability to deliver curriculum content in the context of rapid developments in the field. For example, increasing capability to use and teach more advanced technologies such as artificial intelligence and big data.

“Improving the digital infrastructure is important if we are expecting students to be 21st century learners” - Teacher

“If we want to teach using 21st century technologies, then we need to be able to access IT that works consistently.” – Principal

²¹ Commonwealth of Australia, Department of the Prime Minister and Cabinet, *National Innovation and Science Agenda*.

²² We note that school infrastructure is a matter for state and territory government and non-government education authorities and individual schools, not the Australian Government.

- Schools often implement digital technologies in a shallow way. For example, schools may set up coding or robotics clubs, rather than teach computational thinking that is a fundamental part of the Digital Technologies curriculum.

“Limitations of device capacity, access and bandwidth make access to emerging technologies difficult” – Principal

The digital technology focus has left gaps in other STEM areas of need such as mathematics

Only two programs focused on mathematics – one in the early years (Let’s Count) and one for school years (reSolve: Maths by Inquiry). As shown in the graph below, only seven per cent of initiative funding was allocated to math-focused initiatives. Mathematics is an important area to focus on because it is a foundation that underpins other STEM areas such as digital technology and engineering. In our consultations, many stakeholders – including those who don’t have a specific subject-matter interest in mathematics – identified low teacher confidence in mathematics as a barrier to effective STEM teaching. Particularly at the primary school level where literacy was viewed as a greater area of strength. Maths anxiety among teachers is a great concern as research suggests that educators can transmit negative attitudes about maths to their students, which can affect their learning in this area and potentially their interest in STEM careers.²³

Stakeholders also identified educators teaching out-of-field (due to a lack of mathematics teachers) as a potential reason for lower teacher capability in maths, as most are not well-trained in the subject matter. According to the Australian Mathematical Sciences Institute, one in three secondary mathematics classes are taught by out-of-field teachers.²⁴ While the Australian Teacher Workforce Data Strategy aims to collect Initial Teacher Education data and teacher workforce data nationally, there is currently no national data collection that describes the connection between out-of-field teaching and student achievement in maths. Additionally, stakeholders consistently spoke positively about both reSolve: Mbl and Let’s Count²⁵ – however they thought that mathematics did not receive enough funding through NISA and that it should be a greater priority in future decisions about funding.²⁶

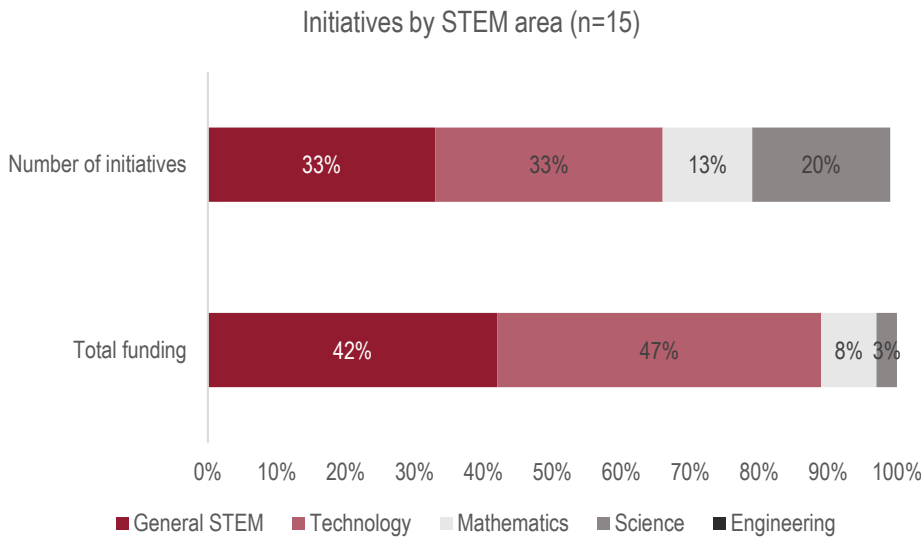
²³ Jackson, CD & Leffingwell, RJ 1999, 'The role of instructors in creating math anxiety in students from kindergarten through college', *The Mathematics Teachers*, vol. 92, no. 7, pp. 583-586.

²⁴ Prince, G & O'Connor, M 2018, *AMSI Occasional Paper 1: Crunching the number on out-of-field teaching*, Australian Mathematical Sciences Institute.

²⁵ Positive stakeholder perceptions about reSolve in this evaluation are consistent with stakeholder consultations through dandolo’s separate, independent evaluation of reSolve.

²⁶ The Australian Government is aware of the need for a greater focus on mathematics, directing \$9.5million from the 2019-20 budget towards a new 'online teaching and learning courses' initiative that will create Massive Open Online Courses (MOOCs) and an online resources Hub for mathematics, following the success of the Digital Technologies MOOCs and Hub model.

Figure 12. Initiatives broken down by STEM area²⁷



There are differences in opinion about which approach to STEM (discipline based or interdisciplinary) is preferable, indicating that both are important

Many stakeholders said that STEM education needs to address the issues in specific disciplines, such as mathematics and technology. Other stakeholders emphasised the importance of interdisciplinary approaches saying that they are more engaging for students and help students develop general capabilities. Parents are also supportive of this interdisciplinary approach to STEM and want schools to do more in this area.

5.6. What is the main output of the initiatives?

The main output of most initiatives is teacher professional learning (as opposed to teaching resources and student mentoring), which is the best way to improve teacher capability

“I feel like the disparity between various interpretations of what STEM education is and what its purpose is has led to confusion with many teachers” - Teacher

“Often educators may lack experience, resources and ability to turn their training into practice” – Early Childhood Educator

“Money is always a barrier but more than that, I think staff training needs to be addressed.” – Principal.

²⁷ Note: ‘General STEM’ refers to where no specific subject-focus stated. Could include more than one subject or an interdisciplinary focus. Engineering is a part of STEM, although no NISA initiatives specifically focus on this subject area. Beyond NISA, Qwestacon have recently secured funding for a national roll-out of *Engineering is Elementary*, a program they have been piloting which supports primary schools.

The main output of most initiatives is professional learning, as opposed to providing teaching resources or student mentoring experiences.²⁸ This is consistent with the finding that most initiatives have teachers as their target audience. The research asserts that teachers need a deep understanding of their subject area to be effective (in this case STEM disciplines) and cites investment in high quality professional learning as an effective means through which to improve teacher capability.²⁹ Stakeholders supported this focus on professional learning saying that it is necessary for improving STEM education because teachers needed more skills and knowledge to teach integrated STEM. They also said that professional learning which involves experts or coaches working collaboratively with teachers in their classrooms was most likely to be effective at achieving change in teacher practice and sustained school-wide change. This was especially important for schools that had limited capacity and capability in STEM and schools in disadvantaged contexts. Education research also supports this argument made by stakeholders about best practice professional learning.

“Teachers need time to get together and explore problems with an expert. It needs to be focused on altering teacher beliefs.” - Stakeholder

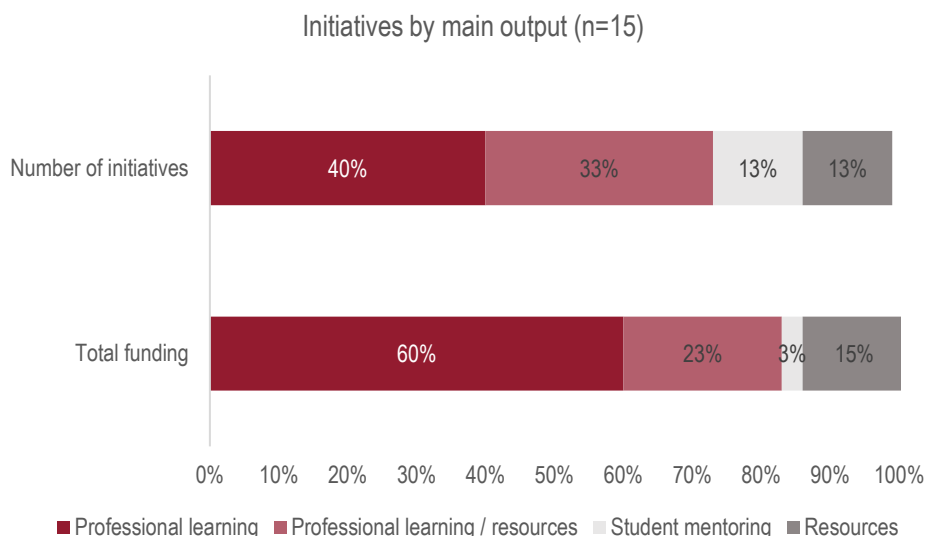
“Making sure teachers have time to explore resources and are given professional upskilling is the biggest challenge to integrating STEM

“Teachers have little access to the latest in technology that real STEM specialists have access to” – Teacher

²⁸ In our analysis, resources and professional learning were characterised separately. ‘Resources’ was taken to mean those initiatives that produced materials such as lesson plans or contributed information to online portals. ‘Professional learning’, although linked to resource-use, was interpreted as those initiatives which involved workshops or conferences to train and coach educators on delivering STEM curriculum or utilising digital technologies. Professional learning includes all modes (mixed-mode, online and face-to-face). Student mentoring refers to programs which directly engage students such as coding camps.

²⁹ Greenwald, Hedges & Laine 1995; Guskey & Huberman 1995; Elmore & Burney 1997; Hawley & Valli 1999; Elmore 2002

Figure 13. Initiatives broken down by main output



Resource-based initiatives can also increase teacher capability, but they need to be accompanied by professional learning

Generally, programs that provide resources as their main output also provide professional learning. Science by Doing and reSolve: Maths by Inquiry are two NISA-funded initiatives that explicitly do both. This is important because without some professional learning, it is unlikely that teachers will use NISA-funded resources at all or use them in an effective manner that leads to better teaching and learning in STEM.

Resources must be high quality and accessible

Quality and accessibility are important as they increase the likelihood that resources are successful at achieving their aims. This is also significant because STEM education is already a crowded space, with many low-quality resources competing for teachers’ attention.

“You can have all the resources in the world but if you don’t feel confident and see value in using them, they will just sit there on the shelves” – Teacher

“Just throwing money at it won’t get results. Staff need time to actually think, investigate, design or research potential projects” – Teacher

Stakeholders spoke positively about the resources provided by NISA initiatives. When asked about quality resources, stakeholders cited curriculum alignment, the use of research-based pedagogy and resources that were tested by teachers as effective. Some of the barriers that stakeholders faced in accessing resources included difficulty navigating websites on which resources are hosted and intellectual property restrictions. For example, in the case of the Australian Digital Technologies Challenges, resources were only available for teachers of Years 3-8 students, as opposed to any teacher who wanted to access them.

“There seems to be a massive range of resources for teachers. This is somewhat overwhelming and very time consuming to sort through and filter what is actually worthwhile.” – Teacher

How

5.7. What are the partnerships, processes and supports that have been used?

Service providers consistently raise challenges with meeting compliance requirements

Almost all initiatives face challenges in meeting their compliance requirements. The most common issue raised by providers was the compliance requirements related to information security.³⁰ Several providers and evaluators also said that the processes around securing ethics approvals from state and territory education authorities were a constraint. This is particularly difficult for initiatives operating in more than one state that must secure ethics approval in each state through separate processes. The impact of these challenges has varied across the initiatives, but for some has included:

- Challenges in building an open and collaborative relationship with the Department
- Implementation delays
- Additional work for providers
- Reluctance to collect student data to measure impact, and a subsequent limited understanding of initiative impact.

³⁰ Services need to comply with official information/data security frameworks including: Commonwealth's Protective Security Policy Framework, Commonwealth's Information Security Manual in relation to ICT systems and Commonwealth's strategies to mitigate security incidents.

Partnerships and consulting with the sector are important for reaching audiences and ensuring support. Initiatives that did not do this effectively were criticised

Initiatives that established strong partnerships and consulted with the sector they were targeting had more support from educators and other stakeholders. Stakeholders praised programs that consulted widely and made moderations to their product and approach as a response to feedback from the sector. One program was criticised by a peak body for not building strong partnerships and consulting widely. Additionally, state and territory curriculum authority representatives appreciated being consulted and informed, so they could support educators and promote initiatives and present a coordinated and coherent approach. They were not always informed about NISA-funded initiatives.

Stakeholders value opportunities for networking and sharing ideas, however, they still think lack of coordination is an ongoing problem in STEM education

Providers appreciate where they have access to opportunities for networking and sharing ideas. While they appreciated these opportunities, a strong theme emerged from stakeholder interviews that there is an overall lack of coordination in STEM education, including between:

- NISA initiatives
- Initiatives across states/territories and
- Federally funded and state/territory funded initiatives.

Some of the consequences of this lack of coordination according to stakeholders include:

- Difficulties reaching teachers and schools, especially for the programs that move between states
- The same schools may be reached by all or most of the programs whilst other schools might not be getting any support. This may be due to:
 - Limited sharing between initiatives and some competition
 - Too many initiatives overall in the school years in some states
 - Capacity of the school to engage with and implement programs.

Lack of coordination was not raised as an issue in the early years, presumably because there are only a few programs.

4 Changes in the operating environment

There has been a lot of activity in STEM education at a national and state and territory level since the NISA initiatives were first announced. This section outlines what some of these activities and developments have been, serving as further context for making decisions on the future of the NISA initiatives.

6.1. Policies and reports

The national policy environment in STEM education has evolved

The national conversation about STEM education now includes more stakeholders and a greater range of information. Some of the key developments since 2015 include:

- **Schools are more familiar with approaches to teaching STEM.** Schools are generally aware of the importance and urgency of improving national STEM outcomes. While the Digital Technologies Curriculum has been introduced, it is still in the process of being embedded in classrooms across Australia.
- **There is now more advice on how to make STEM education effective.** Expert organisations have been providing advice on:
 - Common objectives to work towards, such as how to improve Australia's innovation system (Innovation and Science Australia) and commitments to increase the participation of women in STEM (Advancing Women in STEM strategy)³¹
 - How to maximise certain models of STEM education (e.g. industry-school partnerships and teaching pedagogies)
- **There is more information on what others are doing.** There have been efforts to understand the different approaches taken by different states and territories

The following section describes these developments in greater detail.

The Digital Technologies curriculum is no longer new

When NISA funding was allocated to STEM schools education initiatives in 2015, the Digital Technologies curriculum (a component of the Technologies learning area) had just been endorsed by the Education Council.

³¹ Department of Industry, Innovation and Science, 2019, *Advancing Women in STEM*, Commonwealth of Australia, Canberra.

The large NISA investment in initiatives focused on digital technologies reflected the need to support the adoption and implementation of this curriculum. As the Government considers its forward strategy for STEM education, this curriculum will have been in place for a few years, albeit not fully implemented. Moving forward, schools are likely to require greater support in embedding the Digital Technologies curriculum and STEM concepts such as computational thinking into teaching practice beyond 'shallow' engagement with resources (e.g. robotic usage unaccompanied by critical problem solving).

The STEM Partnerships Forum identified areas that industry-school partnerships should focus on in order to have the greatest impact on the engagement of young people in STEM disciplines

The STEM Partnerships Forum identified areas that industry-school partnerships should focus on in order to have the greatest impact on the engagement of young people in STEM disciplines. This report explored the role of industry in the provision of resources for teacher professional learning.³² Industry was identified as important in helping educators link real world practice to curriculum content. Industry also has a role in providing workforce data to enable better analysis of the STEM student pipeline to demonstrate to policymakers the greatest areas of need. The Government should consider these recommendations when developing its forward strategy for STEM education.

ANAO's 2017 report *Design and Monitoring of the National Innovation and Science Agenda* identified evaluation of STEM initiatives as an issue

A 2017-18 report by the Australian National Audit Office (ANAO) examined the effectiveness of the design process and monitoring arrangements for the NISA by relevant entities. ANAO identified a few issues including variability in the quality of performance measures and data collections systems that will likely affect impact assessment. It also found there to be ambiguity in the rating system for implementation, which was not clearly defined and failed to demonstrate that seven measures did not meet the publicly announced timeframe. Recommendations were made to remedy the aforementioned issues and the Department of Prime Minister and Cabinet and Department of Industry, Innovation and Science released a response in agreement with these, contained in the report.³³

Australia 2030: Prosperity through Innovation – A plan for Australia to thrive in the global innovation race

Innovation and Science Australia (ISA) released a strategy in 2017 containing 30 recommendations for improving Australia's innovation system by 2030. Some of the recommendations have implications for decision-making in

³² Education Services Australia, 2018, *Optimising STEM Industry-School Partnerships: Inspiring Australia's Next Generation Final Report*, Carlton.

³³ Australian National Audit Office, 2017, *Design and Monitoring of the National Innovation and Science Agenda*, Commonwealth of Australia, p. 50

STEM education including strengthening training for pre-service and in-service teachers, better preparing students for post-school STEM occupations and raising student ambition and achievement in literacy and numeracy. Beyond the education sector, the report notes that investment in artificial intelligence and machine learning should be prioritised.

The Department of Industry, Innovation and Science *Advancing Women in STEM* strategy shows the Australian Government's commitment to increase the participation of women in STEM moving forward

The *Advancing Women in STEM* strategy³⁴ outlined the steps the Australian Government has taken to address gender inequity in the STEM sector including through supporting girls' education initiatives at school. Actions include providing funding for the development of a Girls in STEM Toolkit, ongoing support for an Indigenous Girls STEM Academy, as well as a *Superstars of STEM* Initiative to promote visibility of women in STEM careers.

An analysis of Australian STEM education strategies³⁵ highlights the gap between goals and actions in relation to equity and inconsistencies with STEM definitions

Each state and territory government within Australia (except for the ACT) has developed its own respective STEM education strategy. Collectively, these strategies largely focus on enhancing educator capacity and building STEM capabilities, particularly through inquiry-based learning. Less consideration is given for how to enhance STEM dispositions (attitudes such as curiosity which support success) and sustainably addressing equity issues in STEM (strategies mostly reference short-term interventions). There is also a lack of consensus among the strategies as to whether STEM education should be delivered through discrete disciplines or as a learning experience where the disciplines are integrated. While there is no impetus to necessarily resolve this tension, it's worth highlighting that perspectives on best-practice vary within research and between education sector stakeholders. Additionally, less than half the strategies focus on STEM education in early childhood. The Government's forward strategy for STEM early years and school education could give more attention to these under-examined areas.

Through Growth to Achievement Report of the Review to Achieve Educational Excellence in Australian Schools March 2018 (referred to as Gonski 2.0) supports an increased emphasis on general capabilities

The Gonski 2.0 Report (2018) argued for increased prominence on the acquisition of the general capabilities, emphasis on digital assessment links to formative assessment and the inclusion of learning progressions for the Australian curriculum. The recommendations from the report have implications for future STEM initiatives

³⁴ Department of Industry, Innovation and Science, 2019, *Advancing Women in STEM*, Commonwealth of Australia, Canberra.

³⁵ Murphy, S, MacDonald, A, Danaia, L & Wang, C 2018, 'An analysis of Australian STEM education strategies', *Policy Futures in Education*, vol. 17, no. 2, pp. 122-139.

because the general capabilities can be taught through explorations or investigations inherent to STEM disciplines – particularly numeracy, ICT and critical or creative thinking.

6.2. States and territories

Most states and territories have their own policy strategies in STEM education. In addition to (or as part of) these strategies, states and territories have funded initiatives of their own

Using Education Council research,³⁶ we looked at a selection of 58 'non-NISA' initiatives funded or run at a state and territory level relating to STEM education and compared them with the NISA initiatives. This analysis is based on a sample of various state and territory initiatives included in an Education Council report.³⁷ This means the report and subsequent analysis is not intended to be a comprehensive overview of all STEM related activities by jurisdiction. Rather, this analysis provides a snapshot of a selection of STEM activities occurring outside of NISA-funded initiatives within Australia. Initiatives represented are frequently part of state and territory approaches in STEM education. Box 1.1 summarises these approaches.

Box 1.1: Summary of the state and territories' strategies in STEM education

Since 2016, most³⁸ states and territories have been developing their own approach to improving STEM education in their own jurisdiction.³⁹

NSW is raising expectations and enhancing the quality of student learning in STEM, fostering quality teaching and leadership in STEM and supporting innovative ways of delivering STEM education. It has developed [STEM illustrations of practice and resources](#) for teachers.

Victoria's strategy focuses on building foundational STEM skills in young children, lifting STEM achievement in schools, and ensuring its higher education and training sectors are creating a STEM-skilled workforce.

Queensland's plan focuses on lifting participation of students, including girls and Aboriginal and Torres Strait Islander students, giving every school access to a specialist STEM teacher. It aims to transform the teaching of STEM by supporting teachers to innovate and engage with cutting edge science and teaching practice.

³⁶ <http://www.educationcouncil.edu.au/EC-Reports-and-Publications.aspx>. The Department identified the state and territory initiatives we have analysed and provided the data on program descriptions, objectives and funding (where available). Information on effectiveness of these initiatives was incomplete and was outside of our scope to verify so, as a result, we do not make any assessment on the effectiveness or impact of the non-NISA initiatives

³⁷ The group of initiatives examined is not intended to be an exhaustive list of all STEM education initiatives in Australia, but instead to provide a sense of what the key areas of focus are in major initiatives.

³⁸ ACT has adopted the National STEM School Education Strategy. All other states and territories have developed their own.

³⁹ See Appendix for links to individual strategies.

Western Australia focuses on building a globally competitive and innovative workforce with the skills to drive Western Australia's technological future and create new job opportunities.

South Australia is supporting its teachers to build expertise in STEM teaching and learning across all years of public education (from preschool to Year 12); engage students at all year levels in STEM education; and develop systemic excellence in STEM education.

Tasmania aims to equip its learners with knowledge, skills and capabilities to enhance their futures. It emphasises integrative, project based, real world and transdisciplinary learning. It aims to strengthen and optimise parental, business, further education and community partnerships to improve STEM learning outcomes.

The ACT has adopted the National Strategy directly, thereby explicitly sharing the focus on lifting foundational skills in STEM learning areas, developing mathematical, scientific and technological literacy, and promoting the development of 21st century skills including problem solving, critical analysis and creative thinking.

The **Northern Territory** has a focus on preparing students for life-long learning and work. It aims to support quality STEM education opportunities and ensure young people are equipped with coding skills as an emerging essential literacy. It also seeks to provide professional learning opportunities for teachers and trainers and expand enterprise education and innovation programs so students receive advice and training in newly emerging industries.

State and territory initiatives are analysed in the section below using the same conceptual framework (see Section 1) from earlier in this report:

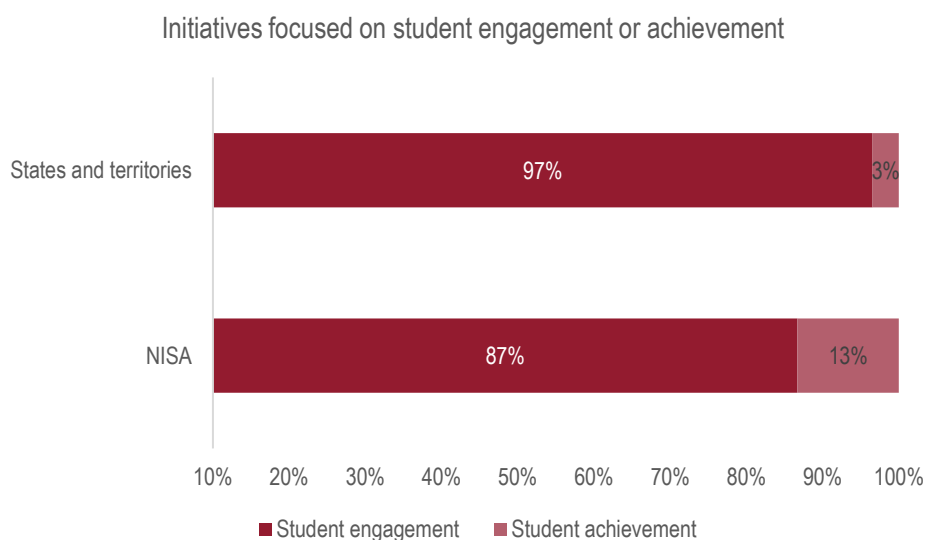
1. Is the focus on improving student engagement or achievement?
2. Is the focus on universal offerings, or targeting specific groups — and are these groups about improving excellence or equity in STEM?
3. Who is the target audience?
4. Who is the target student age group?
5. What curriculum area is the focus?
6. What is the product?

Our analysis under each lens includes a breakdown of the reported initiatives, in terms of number of initiatives rather than by amount of funding for each. Quite a high proportion of initiatives did not have funding information available (in some cases for entire jurisdictions) which does not provide an accurate evidence base for drawing conclusions or making assessments.

The majority of state and territory STEM initiatives focus on student engagement

The overwhelming majority of STEM initiatives focus on student engagement. In fact, of the 58 reported initiatives, there are only two initiatives addressing achievement. NISA has a similar focus as the states and territories' initiatives, where two of the fifteen NISA initiatives address student achievement – Primary Connections and MOOCs.⁴⁰

Figure 14. Initiatives focused on student engagement or achievement



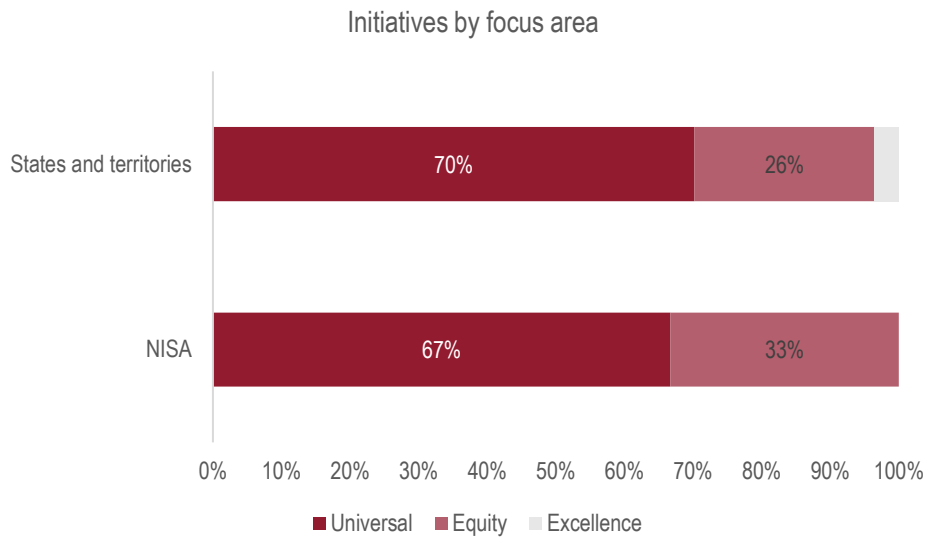
Most reported state and territory initiatives focus on universal offerings, whereas more targeted initiatives focus on improving equity in STEM education

States and territories focus on either universally-provided initiatives or more targeted initiatives (such as targeting equity or excellence). Over two-thirds of all reported initiatives are universally focused, which is similar to the breakdown of NISA initiatives.

Most states and territories have a mix of universally offered and targeted initiatives. Where states and territories' initiatives do target particular groups, most of these focus on groups that underperform or are underrepresented in STEM education (i.e. girls, regional or rural students, Aboriginal or Torres Strait Islanders) rather than targeting higher performing students (i.e. to raise excellence).

⁴⁰ See Section 1 of this report for the conceptual framework underpinning the achievement vs. engagement distinction. Primary Connections and MOOCs identified based on program objectives.

Figure 15. Initiatives by focus (universal, equity or excellence)

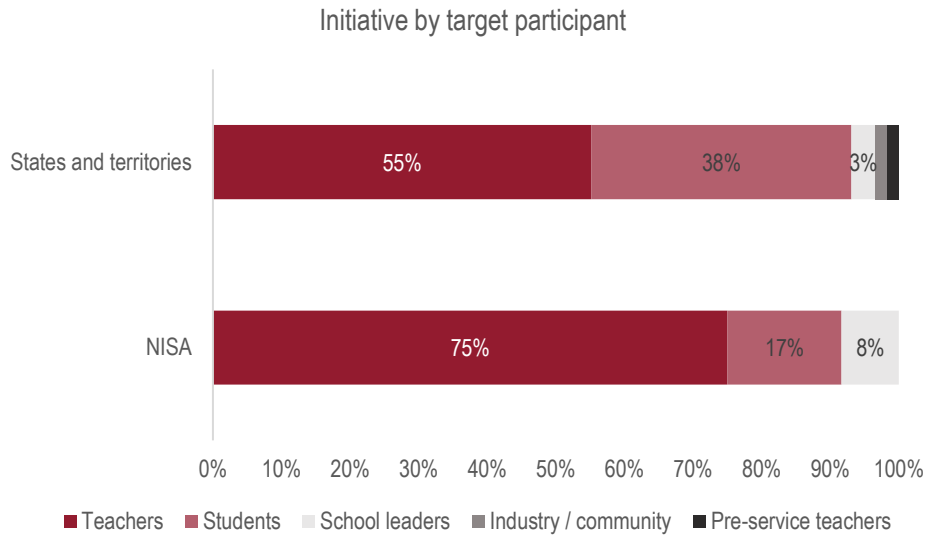


Note: One Western Australia initiative is universal (and has been categorised this way) but provides extra funding to regional schools.

Similar to NISA, reported state and territory initiatives also focus on teachers, however, there is a higher proportion of initiatives targeting students only, as well as a broader range of target audiences

For both NISA and state and territories, most initiatives focus on teachers. After teachers, the next most popular focus is students. The state and territory initiatives have a higher proportion of initiatives that focus on students only, compared with NISA initiatives. In contrast to NISA, state and territory initiatives also have a broader range of target audiences, including pre-service teachers and the industry/community.

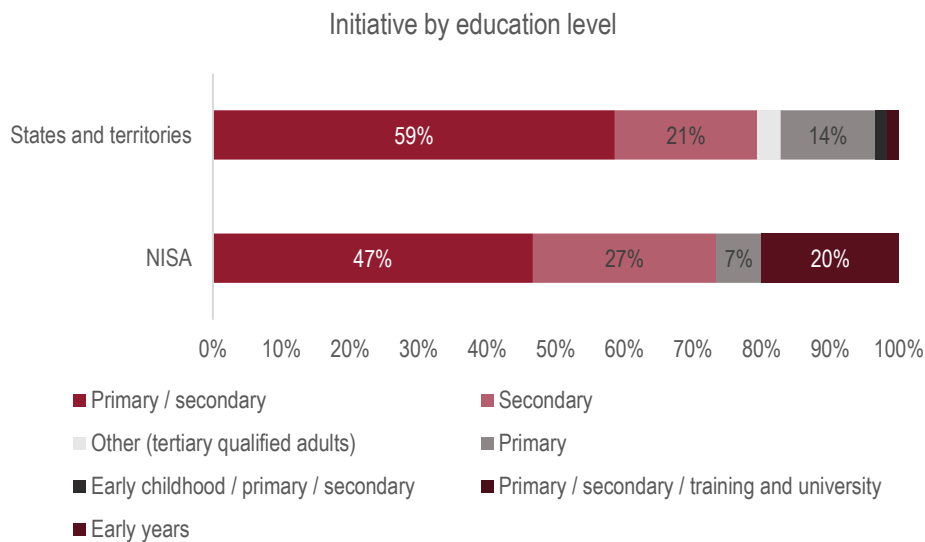
Figure 16. Initiatives by target participant



Similar to NISA, most states focus on combined primary and secondary level initiatives

Around 60 percent of state and territory initiatives focus on combined primary and secondary level initiatives, although there are more initiatives focusing explicitly on secondary level (21%) as opposed to primary only (14%).

Figure 17. Initiatives by education level



Most initiatives are based on general STEM skills rather than specific subjects

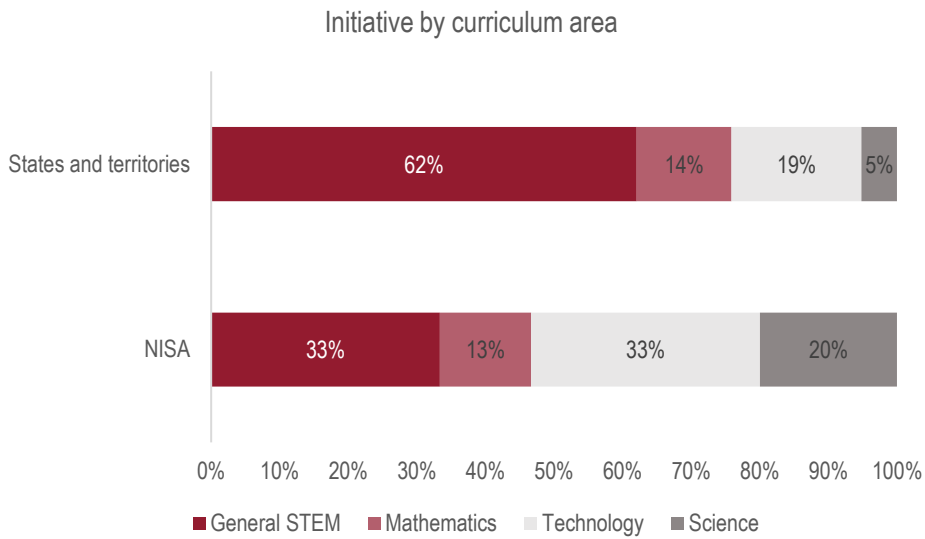
While general STEM initiatives only make up one third of NISA initiatives, most states and territories use initiatives that take a more general approach to STEM.⁴¹ Both NISA and the reported non-NISA initiatives have roughly the same proportion of maths-focused initiatives.

Initiatives which focus solely on the Digital Technologies curriculum area comprise 19 per cent of the reported state and territory STEM initiatives analysed as part of this report. Their main activities are similar to the NISA-funded initiatives and include either professional learning, student mentoring or teaching resources and all but one initiative focuses on primary and secondary school.

While all programs have slightly different features, there are similarities between some of the state and territory programs and the NISA-funded programs. For example, two state and territory programs provide technology such as robots to schools to support programs and the implementation of curriculum. The NISA-funded Digital Technologies Massive Open Online Courses also provides technology to schools. Three state and territory programs are similar to the NISA-funded Digital Technologies initiatives, for example, Digital Technologies in Focus, in that they aim to build teacher capacity to implement the Digital Technologies area of the curriculum. Given the similarities there may be opportunities for collaboration between the state and territory initiatives and NISA funded programs.

⁴¹ Beyond NISA, Qwestacon recently secured funding for a national roll-out of *Engineering is Elementary*, a program they have been piloting which supports primary schools.

Figure 18. Initiatives by curriculum area⁴²



⁴² Note: 'General STEM' may refer to STEM practices/ways of thinking or initiatives which focus on multiple subject areas (e.g. maths and science)

5 Towards a forward strategy for investment in STEM education

In thinking about the future strategy for investment in STEM education, we know that there are:

- Major themes from this evaluation that identify gaps and opportunities for future focus – see Section 3.
- Changes in the education policy environment that have implications – see Section 4.

In order to understand where the Australian Government should place future emphasis for STEM education, we followed several steps outlined in the image below.

Figure 19: Process to develop recommendations for a forward strategy

Step 1.	Step 2.	Step 3.	Step 4.
Consider potential roles as: <ul style="list-style-type: none"> • Celebrator / promoter • Coordinator / linker • Evaluator • Incubator • Capacity builder • Scaler / accelerator 	Assess potential roles against criteria listed below: <ul style="list-style-type: none"> • Fill gaps • Align with policy • Ability to deliver • Value for money • Findings from NISA evaluation 	<i>Check against best practice principles</i>	Recommendations for a forward strategy

This process focused on answering two key questions:

- 1. What should the role of the Australian Government be in STEM education?** This involved looking at potential roles for the Government, and assessing each against a set of criteria.
- 2. Where should the Government place its focus?** This involved triangulating major findings from this evaluation to understand gaps and opportunities for the Government

We also used generic best practice principles for service delivery (e.g. avoid duplication) to consider the viability of our proposed suggestions.

This section describes the first step of this process in more detail.

7.1 What's the role of the Australian Government in STEM education?

In deciding a future strategy, the Australian Government should consider its role in supporting STEM education.

The Australian Government can play multiple roles to support STEM education. We've identified six potential roles based on:

- A broad approach to defining the different means of supporting and / or influencing STEM education.
- Our understanding of government's key capabilities and levers, e.g. where can governments have influence in public policy
- The Australian Government's role in the wider education landscape and context, e.g. against the backdrop of state and territory jurisdictions and other players
- Existing roles of Australian Government and potential roles based on other national and international models and approaches.

The table below shows each potential role.

Table 2. Potential roles for the Australian Government

Potential role	What does it mean?	Example
Celebrator and promoter	<p>Celebrating and promoting successes in STEM education (for example, number of students enrolled or employment numbers) to:</p> <ul style="list-style-type: none"> • Raise the profile of STEM education in Australia • Increase awareness and understanding of the importance of STEM across the education system. 	<ul style="list-style-type: none"> • Hosting events to put a spotlight on promising programs • Communications campaigns to highlight Australian successes in STEM
Co-ordinator and linker	<p>Acting as the coordinator between different parties (e.g. schools and industry partners, or states and territories) to:</p> <ul style="list-style-type: none"> • Improve STEM networks in education. This will allow more parties to collaborate on new ideas and approaches. 	<ul style="list-style-type: none"> • Raising awareness of existing initiatives e.g. through mechanisms such as the DT Hub

	<ul style="list-style-type: none"> • Inform the sector of existing initiatives. This helps avoid 'reinventing the wheel' with new initiatives. 	<ul style="list-style-type: none"> • Linking organisations who are thinking of doing similar activities (e.g. two states who want to set up an Engineering Academy) • Bringing together and building consensus between different stakeholders
Evaluator and assessor	<p>Evaluating and assessing initiatives to:</p> <ul style="list-style-type: none"> • Better understand impact and opportunities for future improvement • Share lessons learned with the sector • Build an evidence-base about what success looks like to inform future policy decisions. 	<ul style="list-style-type: none"> • Evaluating, or funding the evaluation of, individual or packages of initiatives • Facilitating evaluation activities (e.g. by developing or promoting resources to help others run evaluations)
Capability builder	<p>Focusing on building system capability to:</p> <ul style="list-style-type: none"> • Support schools, school leadership and teachers to provide high-quality STEM education • Ensure the system maintains relevance and remains up-to-date with evolving leading practice 	<ul style="list-style-type: none"> • Professional development or online resources for schools on new STEM strategies or best-practice evidence
Incubator	<p>Acting as an innovation incubator to:</p> <ul style="list-style-type: none"> • Fund and support new programs • Enable pilot programs and assess impacts 	<ul style="list-style-type: none"> • Providing funding to launch a new initiative
Accelerator	<p>Acting as an accelerator to:</p>	<ul style="list-style-type: none"> • Rolling out a local program nationally

	<ul style="list-style-type: none"> • Fund and support programs that have been successful as pilots • Look at scaling up existing successful programs 	
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Different roles should be assessed based on relative value to the wider education system

Given the broad nature of these roles, we developed a series of criteria to understand which potential roles might offer the most value to the education system:

Table 3. Criteria for considering roles

Criteria	Why does this add value?
Does the role fill a gap?	<p>It doesn't make sense to duplicate existing services. For example, there is limited value in expending time and resources in implementing an initiative that others are already doing.</p> <p>Rather, it is better to focus attention on perceived or real gaps in existing service delivery / approaches.</p>
Does the role align with government policy?	<p>It's important that any role aligns with existing government policy. For example, does it align with Government objectives or areas of focus?</p>
Is the government well-equipped to deliver this role?	<p>It's important to consider whether:</p> <ul style="list-style-type: none"> • Government has the right capabilities and resources to deliver the role. For example, considering internal evaluation capability • Government is best-placed to deliver. For example, does it disincentivise states and territories? Is it someone else's role?
Does the role deliver value for money?	<p>Where the role entails funding or resourcing, it's important to consider:</p> <ul style="list-style-type: none"> • Potential ROI and impact • Whether there is a more effective or efficient approach • Others are better placed to deliver.

We then assessed each role against criteria. This is shown in the table provided below.

Table 4. Applying criteria to potential roles

Role	Criteria			Assessment
	Fills gaps	Aligns with policy	Ability to deliver	
Celebrator and promotor	<p>There is not perceived as a gap by stakeholders</p> <p>Others play an ongoing role e.g. states and territories, tertiary institutions</p>	Aligns with Australian Government policy in improving current and future STEM productivity	<p>Well-placed to improve national narrative based on existing partnerships, wide stakeholder network and credibility</p> <p>Australian Government shares successes through existing roles (e.g. promoting new innovative approaches)</p>	While this seems like a good fit for the Australian Government given its existing networks and capabilities, there is no major gap in this area to fill and is not a priority.
Co-ordinator and linker	Stakeholders and research identify a particular gap in this area. Particularly given there are many players working in the STEM space across Australia, e.g. states and territories, industry, universities, not-for-profits – with common goals but different approaches.	Aligns well with Australian Government objectives to support national consistency and ensuring equitable access to support across states and territories	The Australian Government is particularly well-placed to deliver this role because of its natural visibility at a national level, and its role in coordinating and liaising with major stakeholders and jurisdictions. In fact, the Australian Government already has many mechanisms in place to achieve this	There is a significant opportunity for the Australian Government to leverage, and build on, its existing work and capabilities in this role to better coordinate and link STEM initiatives and stakeholders.

	There is also no natural incentive for other major stakeholders to take ownership of this role, for example no direct benefits to a state or territory in coordinating or facilitating efforts at a national level		(e.g. national resources like Learning Potential and the DT Hub) and is well-regarded among stakeholders for this role.	
Evaluator and assessor	While there is a strong evidence-base about what works in some aspects of STEM education, many areas are still mixed or disputed. There are opportunities to ensure all stakeholders – including the Australian Government - work towards building a consistent national consensus on what success looks like, and how to achieve it.	Clear alignment with Australian Government policy and objectives to achieve specific STEM outcomes and monitor ongoing national performance	<p>The Australian Government is well suited to this role given its:</p> <ul style="list-style-type: none"> • Credibility as a source of expertise • Role in providing leadership and advice to stakeholders • Ability to collect data / evidence from a range of national sources, in particular evaluations across multiple jurisdictions <p>There are also opportunities to refine approaches to data collection and</p>	This is an important space for the Australian Government to continue investing effort. There are clear opportunities for the Government to oversee data collection approaches that facilitate a more consistent evidence-base that contributes to high-quality STEM education across Australia.

			analysis – for example, more consistent approach to data collection – that the Australian Government is well-placed to focus on, given its role within many different initiatives.	
Capability builder	<p>Building system capability in STEM skills, for examples, principals, teachers and pre-service teachers, is a major driver for improving student outcomes.</p> <p>Stakeholders and research routinely identify this is a gap in the current landscape, and that high-quality capability building approaches would support stronger STEM performance and outcomes. However, states and territories also work in this space.</p>	Building the capability of the Australian education system naturally aligns with Government policy and objectives	<p>The Australian Government is well placed to play this role, also evidenced by the successes of existing teacher capability approaches through NISA.</p> <p>There is an additional role the Government can play at a national level to map and assess capability gaps and opportunities across the system in aggregate, to complement and build on the work states and territories already do.</p>	The Australian Government should continue to build on its work in this role through initiatives that target system capability at a principal, teacher and pre-service teacher level to contribute to broader STEM goals.
Incubator	Many stakeholders in the system are able to play this role, and while valuable,	This role aligns with Government policy particularly as it relates to investing in	The Australian Government has the capability and resource in place to fulfil this role, however there is also a risk	There is a role for the Australian Government in this space, however it does not necessarily represent the

	<p>this may not represent the best area to prioritise or focus on.</p>	<p>initiatives that support STEM education outcomes</p>	<p>that stakeholders become over reliant on the Australian Government. In this sense, the Australian Government could continue its approach in investing in targeted initiatives where practical and there is scope for wide reach and impact.</p>	<p>highest priority given there is not a significant gap in stakeholders providing this support.</p>
<p>Accelerator</p>	<p>Initiatives often need more support to scale up, particularly to expand nationally. For example, local initiatives are generally scaled within each state or territory, but not always beyond that remit. There is low-risk that this would duplicate existing approaches. Stakeholders have appetite for the Australian Government to fill this gap.</p>	<p>This role aligns with Government policy particularly as it relates to investing in national initiatives and architecture that support STEM education outcomes, and aiming to achieve national consistency</p>	<p>The Australian Government is uniquely placed to fill this gap because of its ability, and existing practice, in supporting initiatives to scale. Particularly at a national level. This represents an area where the Government can contribute a high level of impact.</p>	<p>There is significant scope for the Australian Government to continue playing a major role in this area. Particularly given its likelihood for national scale and impact.</p>

The Australian Government could play a greater role in some areas – for example, building capability across the system – while placing less emphasis on others

Our analysis suggests that there are some clear areas that the Australian Government could maximise its role based on criteria.⁴³ There is a clear opportunity to prioritise activities in:

- Continuing to **build STEM capability** among educators across the education system
- Continuing to prioritise **scaling up** initiatives to a national level
- Building a robust and consistent **national evidence base** on what success looks like in STEM education
- Leveraging existing networks and relationships to **coordinate and link actors** in the STEM space for collaboration

This analysis does not mean to suggest that the Australian Government should **only** focus on certain roles. Rather, it is a useful framing to inform where it might make sense to intervene and invest based on need and potential for impact. Put another way, we do not suggest refraining entirely from other activities, for example, investing in pilots, but acknowledge that the Australian Government should maximise its strengths to best achieve STEM objectives.

⁴³ This analysis is not intended to be completely definitive and binary.

6 Where should the Australian Government place its focus?

This section draws conclusions and recommendations about the future strategy for STEM education by using the same lenses of analysis as earlier sections and drawing on the considerations of appropriate roles for the Australian Government. Figure 24 provides a high-level summary and rationale for each of these.

The following section provides more detailed explanations of each of the conclusions and recommendations.

Figure 20. Summary of conclusions and recommendations

	Analytical lens	Conclusion / recommendation	Rationale
Why	Should initiatives focus on student engagement or achievement?	<ul style="list-style-type: none"> The Australian Government should continue investing in initiatives that promote both engagement and achievement, particularly noting that engagement is integral to future STEM education outcomes. 	This approach acknowledges the interdependence of the twin goals of engagement and achievement, while ensuring investment in both.
	Should initiatives have a universal focus or should they aim to increase equity or excellence?	<ul style="list-style-type: none"> Prioritise initiatives with a focus on universal service provision, but encourage targeted initiatives for equity purposes. Continue to limit investment in approaches that focus on achieving excellence alone. 	This approach maximises the Australian Government's reach and impact while still helping to address the persistent inequities in STEM education.
Who	Who should be the main target audience for the initiatives?	<ul style="list-style-type: none"> Continue to prioritise building system capability through teachers, while decreasing focus on individual schools and students. Consider expanding reach to principals and pre-service teachers through existing initiatives. 	This approach makes the most of the Australian Government's existing relationships. It is also well-suited to delivering mechanisms that lift system capability.
	What education level should the initiatives target?	<ul style="list-style-type: none"> While the Australian Government should continue investing in school years, it's a crowded space and there are other opportunities to consider. For example, further investing in the early years. 	This approach ensures the Australian Government's investment in STEM education fills gaps and avoids duplication.

What	What should be the main output of the initiatives?	<ul style="list-style-type: none"> Continue to support existing professional learning and resources Invest in approaches that focus on coordination, evidence and communication across the national STEM landscape. 	There is positive work in this space, and professional learning is incredibly important to lifting STEM outcomes. There is a need for a more evidence-based, coordinated approach to STEM education.
	What curriculum area should the initiatives focus on?	<ul style="list-style-type: none"> Continue to define STEM broadly but promote approaches that build general capabilities and incorporate real world experiences. Continue to support digital technologies, however, balance this with the need to invest in maths. 	This approach recognises the unresolved debates in STEM education, addresses areas of significant need and advances other Australian Government education policy agendas.
How	What partnerships, processes and supports should be in place?	<ul style="list-style-type: none"> Celebrate successes on positive stakeholder engagement 	The Australian Government is also well-regarded by stakeholders for their approach to, and investment in, STEM education.

WHY

8.1. Should initiatives be universal, or promote equity or excellence?

It is useful and appropriate for the Australian Government to focus on initiatives that have a universal focus. In some circumstances addressing equity is useful, and it's important to ensure that universal programs do not accidentally exacerbate the inequities in STEM.

Funding initiatives with a universal focus would have the greatest potential for impact...

Universal provision of initiatives has the greatest potential for impact because it equips a large cohort of young Australians with STEM skills and knowledge that will enable them to address complex challenges and meet future workforce demands, which aligns with the *National STEM School Education Strategy* that has informed the objectives of the NISA initiatives. A universal approach also increases student access and opportunity to participate in STEM programs, which research has shown can be limited outside of formal education, due to factors such as program cost, parent availability to support travel or program scheduling outside of school hours.⁴⁴ Additionally, funding initiatives with a universal focus has a large potential for impact because they can more easily reach large numbers of students. One example is the Digital Technologies Massive Open Online Courses (MOOCs) initiative which has a universal focus. This initiative provides free professional learning for

⁴⁴ Australian Industry Group, 2017, Strengthening School- Industry STEM Skills Partnerships

teachers on the Digital Technologies component of the Australian Curriculum. Over 30,300 teachers have enrolled across the three MOOCs, and an estimated 1,357,638 students are undertaking digital technologies activities in the classroom as a result of teacher engagement with the MOOCs.

.... provided they have a differentiated strategy for underrepresented groups to ensure they do not exasperate inequities

However, universal approaches are at risk of targeting 'excellence' or high-socio-economic groups by accident because the schools and teachers who seek out STEM education opportunities and voluntarily participate are more likely to be those who are already interested and passionate about STEM.

"Funding is needed to ensure that low ICSEA schools and regional schools have equitable access to high performing teachers, resources and excursions." – Principal

To overcome this problem, the Australian Government can further encourage providers to have a differentiated strategy for targeting equity groups, even if they have a universal focus. This might involve insisting that initiatives set goals for targeting a certain number of disadvantaged schools or students from underrepresented groups and collect data around these goals. For example, despite its universal focus, almost 30% of teacher enrolments for the MOOCs initiative are from target areas including regional and remote, low socio-economic and schools with high Indigenous enrolments. Without a differentiated strategy, there is a risk that certain groups are missed, and inequities in STEM are exacerbated. The best manner in which to do this will vary from project to project and detailed consideration is needed for each. We acknowledge that most current government contracts include such requirements and recommend this continues. Stakeholders reaffirmed that this approach reasonably mitigates inequity.

When funding initiatives that target equity, be aware of the additional challenges that providers and schools face

In addressing inequity in STEM education, the Australian Government should be aware of the additional challenges regarding work with underrepresented groups and encourage approaches that address these challenges and have been proven to work in these specific contexts. This might include removing any cost barriers to travel for rural and remote teachers and students and providing professional learning that involves on-going collaboration with teachers in their schools. This is in line with the current Government approach, with respect to those initiatives that target equity.

"The distance of our rural school creates a barrier for students and staff." – Teacher

"Perhaps having video links to workshops and conferences might help those of us in rural areas" – Early Childhood Educator

Investing in excellence isn't a good place to focus

Investing in excellence is not the best way for the Australian Government to make an impact in STEM education because focusing on excellence means that initiatives will only reach a small cohort. This is in alignment with current Government strategy. Reasons for this approach are because high achieving students are well-served by initiatives of this kind, which are funded and delivered by other institutions or industry. For example, a number of universities across Australia offer scholarships to students applying for courses within STEM faculties such as Science and Engineering. RMIT University, University of South Australia and Deakin University are institutions which do so. Industry has an incentive to focus on excellence to attract high performing students and ensure a steady supply of graduates. Other independent groups such as the Australian Academy of Technology and Engineering (ATSE) also run programs like the Industry Mentoring Network in STEM (IMNIS).

Who

8.2. Who should the initiatives target?

Continue to invest in building the capability of teachers

The Australian Government should continue to target teachers to build their capability to deliver STEM in classrooms and schools. By targeting teachers, the Australian Government can maximise their impact. Initiatives that target teachers will reach a larger number of students than student-focused programs and the evidence shows that quality teaching has the most influence on student learning.⁴⁵ This approach also addresses a need identified by the research into STEM education and consultations conducted as part of this evaluation, which show that teachers (especially primary teachers) need more confidence and capability to be able to deliver quality STEM teaching and learning. An approach that prioritises teachers will align with other STEM national policy agendas.⁴⁶

“The biggest problem I’ve encountered is getting other educators keen and excited. In some respects, I feel they may find STEM daunting.” – Early Childhood Educator

“Programs are only as good as the person delivering it, educating teachers should be a focus” – Principal

Consider placing less emphasis on funding school-led initiatives

In considering where to best expend effort to maximise impact, it makes sense to prioritise or deprioritise certain approaches. As outlined in previous sections, the Australian Government is less likely to interact with schools directly given the role of states and territories, and others in the sector (e.g. universities). This means there are challenges for the Australian Government in delivering a school-level initiative, for example:

⁴⁵ Stronge, JH & Hindman, JL 2003, ‘Hiring the best teachers’, *Educational Leadership*, vol. 60, no. 8, pp. 48-52.

⁴⁶ For example, one of goals of the [National STEM School Education Strategy](#) is ‘Increasing teacher capacity and STEM teaching quality’

- Limited reach and engagement with users
- Barriers to conducting evaluations / understanding impact
- Competing with others already providing initiatives to schools e.g. states and territories.

There are also some equity challenges to consider. For example, it's difficult to understand where there is most need for investment across the system based on grant applications alone. There is a risk that grant programs tend to favour high-performing or well-resourced schools who have the capacity to apply and implement initiatives. This means it is difficult to know who is missing out, and how to better target school-led funding. As a result, we propose prioritising initiatives that cater to building teacher capability over school-led initiatives where practical.

To be clear, this doesn't mean that the Australian Government should avoid funding initiatives that are organised around delivery within particular schools. For example, Digital Technologies in Focus is a NISA initiative where the Government funded the Australian Curriculum, Assessment and Reporting Authority (ACARA) to take a school-wide or whole-of-school approach. ACARA organised a carefully designed intervention which could be successfully targeted, and evaluated at a school-level.

Similarly, consider placing less emphasis on initiatives that target students directly

In the same way that we suggest reducing emphasis on funding school-level initiatives, the same is true for initiatives that target students directly (for example, coding camps). Findings for existing programs such as Curious Minds and digIT acknowledge positive outcomes for students. These include an increased likelihood of students pursuing STEM subjects in later years.⁴⁷ However, in considering the wider impact and best use of Australian Government investment, there are several reasons to decrease emphasis on similar programs in the future:

- The NISA initiatives seek to strengthen teacher capability to deliver STEM education. This means NISA objectives are not well supported by student specific initiatives like coding camps.
- STEM activities for students is a crowded space and currently well served by other players. This means there is no perceived gap in service offerings for initiatives of this kind, and the Australian Government is better placed working towards the needs of system capability to overcome STEM challenges.

While we wouldn't propose entirely ruling out future student-level initiatives, we suggest prioritising opportunities that focus specifically on lifting system capability through teacher targeted programs.

⁴⁷ See evaluation summaries for Curious Minds and DigIT in Appendix 2 for further details

The value of specifically targeting principals is unclear, but their involvement is critical for sustained change

The Principals as STEM leaders is an interesting project with significant potential to develop the capabilities of principals to lead school-wide improvements in STEM. However, because the program started later than the other NISA initiatives it is still too early to draw conclusions about its effectiveness. Given that the research and stakeholders emphasise the importance of school leaders, we advise that products that touch teachers should include strategies that link in principals or ensure their support for teacher-focused activities. Beyond that, depending on the findings and experiences of PASL, it may be worth more investment in initiatives that target principals as a separate group, and incorporating the lessons learned from PASL into other investment decisions.

“Classroom level issues are dictated by school level issues. STEM needs to be a focus from the Governing bodies of our schools so that Principals prioritise STEM teaching” – Teacher

Stakeholders perceive a gap in support for pre-service teachers, however more research is required to define specific support required

Consultation revealed a perceived gap in STEM education support for pre-service teachers. Given pre-service teachers aren't the direct target audience of NISA initiatives, it wasn't in scope of this evaluation to clearly articulate and determine specific challenges for pre-service teachers. However, it's important to flag as a future opportunity the Australian Government might consider exploring. It also aligns with NISA objectives, and our view that the Australian Government prioritise building capability among teachers. This might involve conducting further research targeting pre-service teachers and providers to understand specific challenges and barriers as it relates to STEM education.

Stakeholders perceive a gap around support for parents in the school years. The Australian Government could build on its current efforts to meet this need

Parent engagement was one of the four pillars of the Australian Government's *Quality Schools, Quality Outcomes* platform⁴⁸ and guides the range of work the Department does in this space. For example, the Digital Technologies Hub (in addition to teacher and student resources) provides resources parents can complete with their child to build their STEM knowledge, while the online *Learning Potential* platform provides support for parents around numeracy skills in primary years. We know this is important because research consistently identifies parent engagement as a significant principle of STEM education best practice, and we know that

⁴⁸ *Quality Schools, Quality Outcomes*, Australian Government Department of Education, 2016, <https://docs.education.gov.au/documents/quality-schools-quality-outcomes>

parents have a major impact on student learning outcomes.⁴⁹ However, despite the Australian Government's work in this space, stakeholders report low awareness of these resources. A major theme of stakeholder consultation concentrated on a perceived gap in support for parents to help build STEM engagement.

Given this, there is an opportunity for the Australian Government to consider whether existing resources are best maximised to reach intended audiences. For example, looking at access and uptake of parent resources and considering how to increase promotion of online resources. Another suggestion might be increasing investment in this space through collaboration with subject matter experts to create *Learning Potential* activities that help parents support their child's science skills, for example through expanding on the parent engagement aspects of the early years STEM programs. Or, broadening the scope of content from primary years to secondary and early years.

8.3. What education level should the initiatives target?

STEM resources for primary and secondary schools is an increasingly crowded space – therefore, quality and accessibility are paramount

There are hundreds of initiatives that provide STEM curriculum resources to teachers. This has created a crowded space in the school years that may be difficult to navigate, and to identify high-quality resources.⁵⁰ Stakeholders want more quality resources that are widely available and easy to access. Quality resources are those that are:

- Aligned to the standards of state/national curriculum
- Evidence-based
- Knowledge rich as supported by research-based effective pedagogy.⁵¹

Program materials should also be accompanied by instructional professional learning training to build an understanding of how to use the resources. Without accompanying professional learning, it is unlikely that there will be a large uptake of resources, even if they are of high quality. This can be seen through the Maths by Inquiry (reSolve) initiative, whose high-quality resources were developed by the Australian Academy of Science and mathematics education experts. A barrier to uptake of these resources identified in a program evaluation was that teachers who were unfamiliar with the inquiry-based practices promoted through reSolve lacked the capability to

⁴⁹ Emerson, Fear, Fox & Sanders, 2012, *Parental engagement in learning and schooling: Lessons from research*

⁵⁰ Learning First, 2019, *High-quality curriculum and system improvement*, John Hopkins Institute for Education Policy.

⁵¹ Steiner method of teaching

adapt such resources in their own classroom teaching.⁵² Greater professional learning would support teachers in implementation.

In contrast there is a lack of STEM supports in early childhood and an opportunity to realise first mover advantage

The limited number of STEM education initiatives in the early childhood sector means there is an opportunity to realise the first mover advantage. Continuing to invest in early childhood would mean that the Australian Government can play a bigger role in shaping STEM education in this sector than it can in the school years.

The Australian Government could play a role in scaling up initiatives that align with the early years learning framework that have proven to be effective. There are also opportunities to expand early years programs into the early primary years, which is only targeted by one initiative at present (Primary Connections). This could serve to better connect approaches to STEM education across the Australian Curriculum F-2.

A compelling reason to invest in this sector is because it is decentralised and is not run by state/territory education departments. This creates some challenges regarding reaching these early childhood centres but would mean that the initiatives are less likely to be mediated or overlap with state and territory priorities. Taking advantage of the opportunities in the early years could help to create a more coherent, coordinated and effective STEM education landscape than exists in the school years. It would also support other national and state/territory policy and funding initiatives focused on early childhood.⁵³

The divide between early childhood, primary and secondary shouldn't necessarily define the borders of a target cohort...

Our analysis of the education of NISA and other STEM initiatives reveal that most initiatives target their professional learning and resources at primary and secondary

“Often the scope of STEM seems so wide that educators don't know where to start or where to aim” – Teacher

“STEM is an area that is relatively new in early childhood and so I lacked confidence in teaching it” – Early Childhood Educator

“I think that all Early Educators should be able to get this type of professional learning to understand how to recognise and provide for learning all areas of STEM” – Early Childhood Educator

“I think the biggest need in STEM is integration. The silos in high school that drive the F-10 curriculum add an unnecessary layer of complexity for teachers trying to plan.” – Stakeholder

“The curriculum needs to catch up and become more interdisciplinary for it to keep pace with what kids are wanting to engage with” - Parent

⁵² dandolopartners, 2019, *Evaluation of the Maths by Inquiry Program* (Second Progress Report)

⁵³ 2019-20 Budget to extend the National Partnership on Universal Access to Early Childhood Education until the end of 2020

school, through tailored professional learning and resources that reflect the distinct challenges primary and secondary schools face.

...yet opportunities do exist to focus on particular cohorts, such as senior secondary

There are opportunities to explore investments that address the problems facing narrow cohorts, such as senior secondary students. The tensions between the way that secondary school is structured with high stakes exams and traditional discipline-based subjects and interdisciplinary STEM was a strong theme in focus groups. Suggestions raised by stakeholders in consultations include looking into alternative assessments regimes, such as completion of practical activities that are tracked in a log book and verified by an expert. Another suggestion related to greater communication between teaching staff from different faculties, to foster an interdisciplinary approach, although it was acknowledged that this would be difficult to achieve considering current school planning arrangements. The National School Reform Agreement that was signed by all states and territories in late 2018

“Many students, particularly females, are turned off STEM due to having to sit high-stakes examinations. This is the most significant barrier to getting more students into STEM” – Principal

“Anything that needs more cross-curricular input is so hard to achieve. We already have so many meetings so trying to get together with other faculties is challenging” – Teacher

includes a commitment to review senior secondary pathways into work, further education and training. The review is currently underway. A number of states have already undertaken their own reviews into senior secondary as well.⁵⁴ The collective findings from these reviews could inform the direction for future STEM education programs targeted at the senior secondary cohort, which the Australian Government should explore further.⁵⁵

What

8.4. What curriculum area should be prioritised?

There is ongoing and unresolved debate about whether it is better to think about STEM as one concept or a set of independent disciplines

⁵⁴ South Australia completed a review into Senior Secondary in 2018, Tasmania's took place in 2016 and Queensland completed theirs in 2014. Victoria recently reviewed setting minimum literacy and numeracy standards.

⁵⁵ External to NISA, the Australian Government is investing \$5.1 million to pilot the Pathways in Technology (P-TECH) model in Australia. P-TECH offers secondary students an industry-supported education pathway to a science, technology, engineering and mathematics related diploma, advanced diploma or associate degree. Beyond STEM, the Australian Government aims to support students transition from school to further education, training or work through its National Career Education Strategy and Preparing Secondary Students for Work framework.

The research on whether STEM should be taught through specific subject areas or in an interdisciplinary (integrated) manner is mixed and arguments for both have been put forward. An 'integrated STEM education' refers to 'teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning.'⁵⁶ The difference between the two methods became apparent during stakeholder interviews for this evaluation and is reflected in the inconsistent approaches taken by schools towards delivery of STEM education.

In the literature, integrated STEM is a relatively new area of research, which means there is inconclusive evidence of what best practice looks like. With this in mind, we advise that the Australian Government maintain its current position for the time being, by recognising both the benefits and challenges of having mixed approaches to STEM teaching, until further research and evaluations reveal which is more effective. This is consistent with different compositions of the NISA initiatives in comparison with states and territories' initiatives.

Promotion of existing STEM practices, while incorporating an inquiry-based learning approach would support national reform agendas

The Government does not need a definitive position on this matter. This is because there are opportunities to maintain existing siloed approaches that have been effective previously, whilst also investing in new programs underpinned by an integrated inquiry-based approach, subject to best practice. General capabilities (also referred to as enterprise skills or 21st Century skills) are the dispositions and abilities considered important for students to succeed in a rapidly changing world and were embedded into the Australian Curriculum in 2010. Inquiry-based pedagogical approaches have been found to be effective at developing these general capabilities, as inquiry methods involve a shift from subject matter to skills-based learning.⁵⁷

There are opportunities for the Government to promote and build capacity for an integrated approach to STEM learning that incorporates inquiry-based strategies and aligns with the general capabilities' curriculum. However, the Government should consider that schools require assistance to deliver integrated STEM, especially at the

"I find the approach to STEM in high schools not consistent with the interdisciplinary approach that should be taken" - Teacher

"There needs to be a clearer definition of what STEM is and what it should look like when delivered in schools" - Stakeholder

"Industry engagement offers great opportunities for students to see end goals and real problems whilst industry get to have an input on the skills they value in future employees." – Teacher

"If our students are engaged and see the relevance in what we are teaching them, they will want to learn" – Teacher

"There still needs to be explicit teaching of the different domains but if integration is not expected from leadership, teachers can tend to revert to old ways." – Teacher

⁵⁶ Kelley, T. and Knowles J., 2016, 'A Conceptual Framework for Integrated STEM Education', International Journal of STEM Education.

⁵⁷ Amagir, A Groot, W Massen van den Brink, H & Wilschut, A 2018.

secondary level, where teaching and subject-specific learning is not structured in a way that lends itself to inquiry-based learning. This approach would support the National Schools Reform Agreement that commenced in 2019, which includes a point in relation to strengthening the development of the general capabilities within Australia's education system. Curriculum reform movements in other parts of the world are also arguing for a larger role for such skills and dispositions.

Continue to support digital technologies while addressing the barriers to successful implementation

There is a continued need in digital technologies, but the pace of curriculum implementation across states and territories varies considerably. Evidence from individual initiative evaluations and this evaluation suggest that while the investment has been successful, many schools are still in the early stages of implementation and others have not begun. Reasons cited for this include lack of infrastructure and technology in schools to support rollout, limited availability of teaching staff with expertise in this area and higher priority given to literacy and numeracy. Actions the government can take to support schools to step-up their digital technologies implementation might be to fund schools in need of technology and to support further upskilling of teachers. When investing in digital technologies, the Government should consider the barriers to implementation in this curriculum area, such as difficulties with timetabling and an overcrowded curriculum, which were raised as issues during stakeholder consultations. They also need to be mindful of the rapid pace of change in the area of digital technology and the need for ongoing teacher professional development to keep up with this.

However, balance this with the need to invest in mathematics

The ongoing need in digital technologies needs to be balanced with the need in the maths learning area. Only seven per cent of NISA funding was allocated to initiatives that focused on maths. In contrast, a wide-range of stakeholders, beyond just maths teachers, identified this as an area of significant need because teachers (many of whom are teaching out of field)⁵⁸ do not have the skills and confidence they need to effectively teach maths. In particular, stakeholders said that maths teachers need more help to understand the value of, and develop skills in, using contemporary pedagogies that have been proven to be more engaging for students.

“I think that many of the STEM programs are too heavily based on technology and not enough on the beauty and wonder of mathematics” – Teacher

“Teachers needs more than gadgets; they need rich professional learning and support as they introduce or integrate STEM learning into their classrooms” – Teacher

⁵⁸ According to the Australian Mathematical Sciences Institute (2018), one in three secondary mathematics classes are taught by out-of-field teachers.

Stakeholders generally agreed that the science learning area is sufficiently catered for by existing STEM initiatives and did not see this as a significant gap which needs to be addressed by government.

“Ensuring teachers have access to professional learning will vastly increase the buy-in and effective teaching of STEM” – Principal

8.5. What should the output or product be?

Prioritise professional development and resources over student mentoring

Consistent with the view that teachers should be the main target audience, the most beneficial categories for products are professional learning and classroom materials/resources. Both professional development and resources can help to build teacher capability in STEM. This is in alignment with the Australian Government’s current approach which focuses on professional learning.

“There is a great need for freely-available, high-quality lesson plans. The government needs to pay for experts to edit these for quality.” - Stakeholder

Invest in other products that focus on coordination and evidence

There are opportunities for the Australian Government to offer additional products that focus on coordination and evidence – roles identified as high value in Section 5. Coordination might include investing in an online portal that provides a directory of current initiatives across the STEM education space, accompanied by evidence about why these particular approaches are effective. An example of a tool which currently promotes coordination is STARportal, which was developed by the Office of the Chief Scientist in collaboration with Engineers Australia and other industry partners. It aims to connect parents, teachers and student with information about STEM activities and includes a section for providers. It is important to note that STARportal’s focus is on extracurricular, external school activities. It is not a source of curriculum-aligned teaching and learning resources.

“Improving teacher quality and status through training and professional development, as well as funding individual planning time for teachers, would make a difference” –Principal

Many stakeholders and providers identified a lack of coordination of resources across STEM disciplines as an issue. Investing in products that help educators to identify effective STEM programs and approaches is a key area where the Australian Government could add significant value. The Government is well-placed to fill such a role as it is unlikely that other institutions, will invest in these types of tools. For example, an Education Council report⁵⁹ described an opportunity for the Australian Government and states and territories to ‘share and synthesise research and evaluation findings to identify successful STEM interventions and inform school practice’. The report shared information about existing STEM initiatives, including evaluation findings, to establish

⁵⁹ Action Item L from the 2015 *National STEM School Education Strategy*

a stronger evidence base to improve understanding around what works in the Australian context. Such insights could inform content contained on the portal.

How

8.6. What processes, support and partnerships should be in place?

Continue to support independent evaluations, and consider using a standardised evaluation framework

It's critical to build and maintain an evidence-base that contributes to an understanding of what 'works' and doesn't 'work' in STEM education. The Australian Government should continue commissioning independent evaluations of NISA initiatives to support this. However, one major challenge in gathering meaningful data from evaluations is inconsistent data collection and impact measures. One way to mitigate this in future would be to create a standardised evaluation framework that suppliers can use to gather and report on data. This would include some flexibility around initiative objectives and specific outcomes. The STEM education toolkit commissioned by the Department and developed by dandolopartners provides a standardised framework which has been tested in this evaluation. This Department could pursue use of this framework as standard practice. Ensuring consistent data collection will enable policy makers and the sector to make better decisions around the evolving nature of best-practice approaches, for example the tension between teaching STEM in an integrated or siloed approach.

Appendix 1: Stakeholder consultation detail

The table below provides a detailed breakdown of stakeholder consultation for this project. Stakeholders were engaged via phone and face-to-face interviews, and focus groups. It's important to note that engagement with stakeholders varied on a case-by-case basis. For example, stakeholders were asked broad, open-ended questions that were tailored to context and stakeholder responses. Stakeholders engaged in the process on the basis of anonymity, this means that we are unable to attribute specific stakeholder views by identifying factors, e.g. organisation or name.

Stakeholders consulted	
Name	Position / Organisation
Anna Maria Arabia	Chief Executive, Australian Academy of Science
Lora Bance	Innovation Officer, National Catholic Education Commission
Sarah Brown	Chief of Staff, Office of the Chief Scientist
Sue Carter	Member Digital Technologies Steering Committee, NT Department of Education
Dene Cranwell	Assistant Director, Teaching and Learning Services, WA Department of Education
Paolo Damante	Senior Policy Officer Education and Training, AI Group
Janet Davy	Director, Curriculum, ACARA
Vic Dobos	CEO, Australian Science Teachers Association
Karen Elliott	Office of the Chief Scientist
Katrina Elliott	Project Officer: Mathematics and Science, Department for Education South Australia
Justine Freeman	Member Digital Technologies Steering Committee, WA Department for Education
Dr Margaret Hartley	Chief Executive Officer, Australian Academy of Technology and Engineering
Kate Highfield	Early Childhood Australia
Sally Hodgson	Director Quality Teaching, Education Policy and Programs, NT Department of Education
Belinda Hoult	Assistant Director, Early Childhood Programs, NT Department of Education
Ewan Johnston	Senior Research Officer, Office of the Chief Scientist
Michelle Kriening	Manager, Literacy, Numeracy, EAL/D, WA Department of Education
Julie King	Member Digital Technologies Steering Committee, ACARA

Penny Leggett	Office of the Chief Scientist
Jessica McDonald	Manager, Science Policy, Department of Industry, Innovation and Science
Mary Mulcahy	Director, CSIRO Education
Duncan Rayner	Chief Executive Officer, The Australian Association of Mathematics Teachers
Leanne Robertson	Member Digital Technologies Steering Committee, ESA
Rose Wood	A/Manager STEM, Queensland Government Department of Education
Project Managers, NISA funded initiatives	
Name	Project (Organisation)
Katrina Faulkner	Digital Technologies Massive Open Online Courses (University of Adelaide)
Mary Mulcahy	Digital Technologies in Focus (ACARA)
Derek Williamson	
David Lowe	Australian Digital Technologies Challenges & Dive into Code (University of Sydney)
James Curran	Australian Digital Technologies Challenges & Dive into Code (Australian Computing Academy)
Karsten Schulz	
Sharon Fraser	Principals as STEM Leaders (University of Tasmania)
Kim Beswick	
Vince Geiger	
Claudette Bateup	Primary Connections: Linking Science with Literacy (Australian Academy of Science)
	Science by Doing (Australian Academy of Science)
	reSolve: Mathematics by Inquiry (Australian Academy of Science)
Ruth Carr	Curious Minds summer schools for girls (Australian Mathematics Trust)
Nathan Ford	
Matt Bacon	Early Learning STEM Australia (ELSA) Pilot (University of Canberra)
Tom Lowry	
Jo Carter	Little Scientists (Froebel Australia)
Olde Lorenzen	Let's Count (The Smith Family)
Sybille Seidler	
Vic Dobos	Science ASSIST Advisory Service (Australian Science Teachers Association) Primary Connections: Linking Science with Literacy

Evaluators	
Name	Evaluation
Julianne Lynch	Digital Technologies in Focus (Deakin University)
Amy McDonald	Little Scientists (Charles Sturt University)
Lotti O’Dea	reSolve: Maths by Inquiry (dandolopartners)
Sam Rothman	ELSA Pilot (ACER)
Focus group participants (detail below refers to number of participants in focus groups) ⁶⁰	
Early childhood educators	16
Primary teachers	32
Maths secondary	7
Science secondary	30
Digital Technologies secondary	11
Primary school leaders	4
Secondary school leaders	16
Interested stakeholders (NB: this may also involve industry leaders / associations)	13
Parents	9
Mixed group of stakeholders as part of face-to-face focus group (including associations, education authorities, teachers, school leaders etc)	23

⁶⁰ Numbers are based on self-identification in focus groups, and not all participants chose to identify or disclose their identity.

Appendix 2: Evaluation summaries

School initiatives

Digital Technologies Massive Open Online Courses (MOOCs)

Provider	University of Adelaide
Initiative description and objectives	<p>The Digital Technologies Massive Open Online Courses (MOOCs) provide free professional learning for teachers on the Australian Curriculum: Digital Technologies (DT). The Digital Technologies MOOCs also provides free access to the latest DT equipment through a National Lending Library, including equipment, lesson plans, maps to the Australian Curriculum and assessment support.</p> <p>Part-time project officers based in every state and territory work with schools to support teachers' ongoing engagement in professional development. Teachers use the Library and its resources, what they've learned from the MOOC and professional learning sessions (online/face-to-face) to develop their teaching.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Raise awareness, skill levels and confidence in Digital Technologies for Australian teachers, with a specific focus on teachers from disadvantaged and Indigenous schools • Update and expand the MOOC professional development materials • Develop and deliver facilitated face-to-face support and an equipment lending library
Target audience	Teachers; students
Initiative funding	NISA funding is \$6,900,000 (exclusive of GST) for the period of 2016-2020.

Evaluation	<ul style="list-style-type: none"> • dandolo completed interviews and a series of online focus groups with stakeholders including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including MOOCs. In addition to dandolo’s evaluation, we’ve described an internal evaluation below. • No external evaluation was funded as part of the initiative • Internal evaluation activities have been undertaken to inform internal evaluations and progress reports – a mid-term evaluation report was completed in June 2018 and a Progress Report #6 was completed in June 2019
Evaluation purpose (internal evaluation)	<p>The purpose of the evaluation is to better understand the impact to date and to explore ways to improve the efficiency and effectiveness of the program in its remaining time.</p>
Evaluation framework / methodology (internal evaluation)	<ul style="list-style-type: none"> • An analysis of associated learning analytics and program demographics • Longitudinal impact analysis, including pre- and post-survey analysis and evaluation of content knowledge development • Case studies of program engagement • dandolo completed interviews with stakeholders, including STEM organisations, representatives from state and territory departments of education – stakeholders were asked to provide feedback on individual NISA initiatives, including MOOCs.
Summary of evaluation conclusions (internal evaluation and dandolo comments)	<ul style="list-style-type: none"> • Stakeholders interviewed consistently report positive feedback about MOOCs, in particular its ability to translate digital technologies concepts and availability of project officers and lending libraries. • Stakeholders value the ability to have contact with project officers in a coaching capacity – including in regional or rural areas. Project officers are known for their helpful engagement, approachable manner and detailed information sharing. Lending libraries are beneficial for schools who want to ‘try’ before they buy.

	<ul style="list-style-type: none"> • MOOCs is widely credited as making a significant difference in teachers' understanding of digital technologies, this also aligns with provider internal evaluation findings, and was often referred to as a 'stand-out' NISA initiative. • The provider has already seen significant benefit and impact of the program on participants, including increased confidence, skill development, and school-level impact • Target metrics have been exceeded, with strong engagement by participants in all parts of the program: professional learning events, online course and community participation, and lending library access. • There has been good engagement across all of Australia; there is less engagement in the eastern states, and unmet demand for lending library access nationally. This is expected to increase. • The flexible structure of the program has proven beneficial, with participants able to negotiate a pathway through the program that meets their organisational or personal needs • For many individuals and schools, engagement with Digital Technologies professional learning is a journey, taking a period of time – in many cases a number of years – to achieve whole of school engagement and the development of deep content knowledge and rich pedagogical practice
<p>Evaluation limitations</p>	<ul style="list-style-type: none"> • No external evaluation has been undertaken. The evaluation was conducted by the provider and is therefore not independent • Final conclusions have not been reached because the internal evaluation is ongoing – the project will continue until July 2020 • The internal evaluation does include any direct measures of the impact on student engagement or achievement • The internal evaluation does not investigate the way that the materials or lending library are used in schools

<p>Challenges faced by provider</p>	<ul style="list-style-type: none"> • Demand has far exceeded supply for the Lending Library and the professional learning from both target and non-target schools • It has been challenging running a national professional learning program because each offering has had to be adapted to account for variations in the curriculum in different states and territories. Project officers based in each state are able to show schools how to make these adaptations • The most effective professional learning is ongoing and sustained, however, many low SES schools have limited resources and time. Project officers have had to visit these under-resourced schools more than was expected to engender greater engagement and confidence in teachers, many of whom haven't done a lot of professional learning before • The scale of the program means that it is difficult to disseminate Lending Library resources to the remote areas Australia
<p>Future plans and goals</p>	<ul style="list-style-type: none"> • The initiative is extending its project officer support in NSW to accommodate the growing interest in DT in the curriculum. This will mean reductions to project officer support elsewhere. • Increase in demand for pre-service teacher training within DT learning area requires specialist support in resource development – to build content knowledge and pedagogical content knowledge and technical skills. • Resources will have to evolve as teacher competence/confidence grows and past resources become too simple. There is a need for more advanced support addressing assessment and discipline-specific pedagogical needs to explore more challenging DT/Computer Science areas like Cybersecurity and AI • Continued expansion of the program and increased support for PL programs to improve accessibility
<p>Sources</p>	<ul style="list-style-type: none"> • Falkner, K. (June 2018). <i>For the expanded rollout and support of University of Adelaide Digital Technology MOOCS - Closing the digital</i>

	<p><i>divide for disadvantaged students</i> (Mid-program Evaluation Report). CSER, School of Computer Science, University of Adelaide</p> <ul style="list-style-type: none"> • Falkner, K. (n.d.). <i>For the expanded rollout and support of University of Adelaide Digital Technology MOOCS - Closing the digital divide for disadvantaged students</i> (Progress Report 5). CSER, School of Computer Science, University of Adelaide • Falkner, K. (n.d.) <i>For the expanded rollout and support of University of Adelaide Digital Technology MOOCS - Closing the digital divide for disadvantaged students</i> (Progress Report 6). CSER, School of Computer Science, University of Adelaide • Interview with provider • Contract between the Australian Government and the University of Adelaide
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Digital Technologies in Focus (DTiF)

Provider	Australian Curriculum, Assessment and Reporting Authority (ACARA)
Initiative description and objectives	<p>Digital Technologies in Focus provides support for around 155 disadvantaged schools to assist them in implementing the Australian Curriculum: Digital Technologies (DT). The Australian Curriculum, Assessment and Reporting Authority (ACARA) has been engaged to provide specialist digital technologies and ICT Curriculum Officers in these schools.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Support school leaders and classroom teachers to facilitate implementation of the Digital Technologies curriculum, in specific schools in disadvantaged areas • Deliver professional learning workshops across all of Australia to support change management in implementing the Digital Technologies curriculum in targeted schools in disadvantaged areas • Provide in-school, face-to-face and online support to enhance implementation of the Digital Technologies curriculum, in targeted schools in disadvantaged areas • Make freely and publicly available materials developed for use in delivery of the services as legacy products to provide ongoing support for other teachers and schools to implement the Digital Technologies curriculum
Target audience	Teachers; school leaders
Initiative funding	NISA funding is \$7,888,000 (excluding GST) for the period of 2016-2020.
Evaluation	dandolo completed interviews and a series of online focus groups with stakeholders including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including DTiF. In addition to

	dandolo's evaluation, we've described an internal and external evaluation below.	
	Internal evaluation activities are being conducted. An interim report was submitted in 2018 and the final report is due December 2020.	An external evaluation is being conducted by Deakin University for the period of 2018 to 2020. Progress Report 1 and 2 have been submitted.
Evaluation purpose	A series of interim evaluation reports will be prepared by the DTiF project team to inform next steps and a final project report.	The external evaluation conducted by Deakin University uses a case study design involving 6 case study schools to understand the impact of the initiative.
Evaluation framework / methodology	<p><u>Framework</u></p> <p>The success of the project will be based on three components:</p> <ul style="list-style-type: none"> • Impact – success including sustainability within each participating school • Outcomes – including transferability of outcomes to schools outside the project methodology, including transferability to similar initiatives. • Methodology – including transferability to similar initiatives. <p><u>Methodology</u></p> <p>This 2018 Evaluation Report is a collation of the data from the 160</p>	<p><u>Framework</u></p> <p>The evaluation will focus on six schools from four states and territories as a representative sample of all jurisdictions.</p> <p>The initiative will be evaluated against three data points:</p> <ul style="list-style-type: none"> • Data Point 1 – Site historical/contextual factors; participating teacher backgrounds; project engagement. • Data Point 2 – Narratives of curriculum, pedagogy and learning outcomes. • Data Point 3 – Narratives of curriculum, pedagogy and

	<p>schools involved in the project in November 2018:</p> <ul style="list-style-type: none"> • Pre-project teacher survey • Professional learning evaluations • Teacher self-assessment matrices • Pre-project student assessment 	<p>learning outcomes; Impact; Strategies for sustainability</p> <p><u>Methodology</u></p> <p>Data collection activities include:</p> <ul style="list-style-type: none"> • Interviews with school leaders, teachers and teacher's aides • School visits • The collection of relevant documentation in some schools
<p>Summary of evaluation conclusions</p>	<p>Initial findings and recommendations from internal evaluation - Evaluation Report 2018 include:</p> <ul style="list-style-type: none"> • Not all educators aware of digital technologies curriculum – even if they are, most educators are not implementing it • Some ICT infrastructure needs to be improved • Schools would benefit from partnerships to enrich the digital technologies curriculum • Most project schools participated in an introductory workshop – survey results show that the workshop was well-received • Teachers at the beginning of the project have a low 	<p>Findings from external evaluation - Progress Report 2 include:</p> <ul style="list-style-type: none"> • Establishing IT infrastructure was necessary for progress • All sites are working on ICT capability • Integrated curriculum approaches are evident at all sites • A high level of value is derived from contact with ACARA Curriculum Officers • Most sites report greater teacher confidence with using digital tools and resources; though sometimes confined to those staff members directly involved in the DTiF professional learning. • Provoked by the action research projects, methodologies of audit and ongoing professional learning have stimulated positive change

	<p>understanding of Digital Technologies and in particular, 'assessment'.</p> <ul style="list-style-type: none"> ▪ Year 2 students tested for ICT and computational knowledge had the lowest performance in abstraction/decomposition and logical thinking in computational thinking <p><i>Note: This report focuses more on testing the instruments and providing baseline data, rather than evaluating impact</i></p>	<p>at some schools, where the schools can identify their focus and track change.</p> <ul style="list-style-type: none"> • Professional networking (with other teachers in other schools) is noted as a positive • DTiF program's flexibility and responsiveness is considered necessary for highly disadvantaged context
<p>Additional dandolo comments</p>	<ul style="list-style-type: none"> • Some stakeholders suggest that DTiF is the only initiative within the NT to make genuine attempts to support and connect with Aboriginal communities • Despite the fact that dandolo suggests limiting emphasis on funding school-level initiatives, ACARA has had success with effectively tailoring, coordinating and monitoring progress within schools. However, there are some reservations about the scalability of this approach. 	
<p>Evaluation limitations</p>	<ul style="list-style-type: none"> • Both the providers and Deakin University evaluators are in the early stages of their evaluation of the initiative – there are limited findings and conclusions that address outcomes • The evaluations do not include any direct measures of the impact of the initiative on student engagement or achievement 	
<p>Challenges faced by the provider</p>	<ul style="list-style-type: none"> • It is challenging to ensure principal buy-in, especially if the principal does not attend the first workshop • There are difficulties associated in working with disadvantaged schools including high staff turnover 	

	<ul style="list-style-type: none"> • There is a potential risk of not meeting timelines because of highly complex nature of curriculum implementation in disadvantaged contexts
Future plans and goals	<ul style="list-style-type: none"> • Demonstrate that the model has a positive impact and is scalable • Continue to try to meet unmet need – 80 per cent of participants are still struggling to implement the Digital Technologies curriculum • The provider would like to involve other schools as current schools finish the program and is considering other models – for example a ‘train the trainer’ approach
Sources	<ul style="list-style-type: none"> • ACARA. (2018). <i>Digital Technologies in focus: Supporting implementation of Digital Technologies</i> (Project evaluation report) • Deakin University. (16 July 2019). <i>Supporting Implementation of Digital Technologies Progress report – Data Point 2 – Focus on curriculum and pedagogy and learning outcomes</i> • Deakin University. (28 September 2018). <i>Supporting Implementation of Digital Technologies</i> (Evaluation progress report) • Interview with provider • Interview with evaluator • Contract between the Australian Government and ACARA

STEM Professionals in Schools

Provider	CSIRO
Initiative description and objectives	<p>STEM Professionals in Schools (previously called Scientists and Mathematicians in Schools) is a STEM education volunteering program that partners primary and secondary school teachers with STEM professionals from industry and business, to help build the STEM skills of school educators and develop more engaging STEM education in Australian schools.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Bring the practice of real-world science and mathematics to students and teachers • Inspire and motivate teachers and students in the teaching and learning of science and mathematics • Provide teachers with the opportunity to strengthen their knowledge of current scientific practice and mathematical applications • Enable scientists and mathematicians to act as mentors or role models for students • Broaden awareness of the types and variety of careers that are available within the mathematics and science fields • Enable teachers, scientists and mathematicians to share ideas and practices with other Teachers, scientists and mathematicians; and • Increase scientists and mathematician's engagement with the broader community, thus raising public awareness of their work and its social and economic importance
Target audience	Teachers, STEM professionals
Initiative funding	NISA funding is \$10,000,000 (excluding GST) for the period of 2016 to 2020.

<p>Evaluation</p>	<ul style="list-style-type: none"> • In addition to dandolo's evaluation, the initiative has undergone four external evaluations (2007, 2008-9, 2011-12, 2015-16); however, no external evaluation was required for the extension of the project funded through NISA • Internal evaluation activities have been undertaken to inform progress reports. The information in this evaluation summary is from Progress Report #5 covering the period of July -December 2018 • Tessellate Communication Pty Ltd was awarded the contract to undertake an impact study and commenced work during late June/early July 2019. This evaluation summary does not include the Tessellate evaluation
<p>Evaluation purpose (internal evaluation)</p>	<p>The purpose of the evaluation is to provide the Australian Government with information about outcomes, activities and deliverables, as specified in the funding agreement.</p>
<p>Evaluation framework / methodology (internal evaluation – Progress Report 5)</p>	<ul style="list-style-type: none"> • dandolo completed interviews and a series of online focus groups with stakeholders including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including STEM Professionals in Schools. In addition to dandolo's evaluation, we've described an internal evaluation below. • Progress Report #5 used CSIRO's impact framework and template provided by the Department of Innovation, Industry and Science (DIIS). No more information was provided.

<p>Summary of evaluation conclusions (internal evaluation – Progress Report 5 and dandolo comments)</p>	<ul style="list-style-type: none"> • Stakeholders report that the initiative is well-regarded for the expertise STEM professionals bring into primary schools where teacher capacity in science can be limited. They also appreciate the opportunity to have access to role models for students to explore careers in STEM in an engaging environment for students. Stakeholders also value the opportunity to connect with CSIRO, given its strong brand reputation. • The provider completed a transition to a new Customer Relationship Management (CRM) system, which was the key activity for the reporting period. The decision was made not to migrate existing program data. One of the reasons for this was the requirement for all program participants to acknowledge and accept the CSIRO Child Safe Policy. While the uptake of participants engaging directly and re-registering with the new CRM was less than expected, this is expected to improve. • Program scalability and sustainability were a priority for the providers and Tesselate Communication Pty Ltd was awarded the contract to conduct an impact study • Significant work was undertaken in relation to partnership support with a new focus on a suite of networking resources to be made available for Project Officers to deliver locally. Additionally, new webinar content was trialled with positive feedback. • New key relationships have been established with Western Australia, Northern Territory, New South Wales and Victorian departments of education, with further engagement to continue with the Australian Capital Territory and Queensland
<p>Evaluation limitations</p>	<ul style="list-style-type: none"> • Internal progress reports do not provide information about the impact of the program on student engagement or achievement
<p>Challenges faced by provider</p>	<ul style="list-style-type: none"> • The provider has experienced high overall project team turnover during the current contract period. This has created challenges for delivery, consistency and continuity.

	<ul style="list-style-type: none"> • The provider undertook whole-of-organisation IT system change during the contract period, including moving operations from an unsupported Microsoft Access database to a Microsoft Dynamics Customer Relationship Management (CRM) platform. This transition has posed significant disruptions in terms of availability and scalability of program. • The uptake of participants engaging directly and re-registering with the new CRM was significantly less than expected, seeing a drop in reported partnerships numbers from around 1,700 to only around 462 initially. While this has steadily built back up over the course of 2019 to around 1,000 by August, there is still significant further work to do to re-build partnerships
<p>Future plans and goals</p>	<ul style="list-style-type: none"> • The provider would like to continue the program and expand partnerships, ideally with the support of the Australian Government beyond 2020 when the current funding agreement ends. The provider is also exploring other sources of funding to ensure program sustainability • Continue to support the external evaluation with Tesselate • Ongoing monitoring and adherence to Child Safety policies
<p>Sources</p>	<ul style="list-style-type: none"> • Hetherington, K. (n.d.). <i>STEM Professionals in Schools Progress Report</i> (#5 – Milestone #11, July - December 2018). CSIRO • Interview with provider

Digital Literacy School Grants (DLSG)

Provider	Australian Government Department of Education and Training
Initiative description and objectives	<p>The Digital Literacy School Grants initiative provided funding to 114 projects to support innovative methods for implementing the Digital Technologies Australian Curriculum in schools and enhancing digital literacy. As part of the initiative, two competitive grant rounds were held in the 2016-17 and 2017-18. There were 54 grant recipients in round one and 60 recipients in round two.</p> <p>Grants for projects under the program were application based. Grant application project proposals must drive enhanced digital literacy in schools, for example through:</p> <ul style="list-style-type: none"> • Partnership models whereby a school partners with one or more schools to exchange best practice ideas • Partnerships between a school with industry to gain access to professional expertise and/or equipment • Leveraging off existing facilities to establish cross curricular spaces (e.g. 3D printers) • Support professional learning for principals to become ICT champions
Target audience	Teachers, school leaders, students
Initiative funding	<ul style="list-style-type: none"> • NISA funding is \$3,989,273 (exclusive of GST) for the period 2016-2018 • Funding for round one projects totalled \$1,989,319 • Funding for round two projects totalled \$1,999,954
Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, there is no formal evaluation of individual grants or of the program as a whole • Grant recipients were required to report on their projects using a standard form provided by the Department of Education • This evaluation summary includes analysis of DLSG undertaken by dandolopartners as part of its 2019 Evaluation of Early Learning and Schools Initiatives in the National Innovation and Science Agenda
Evaluation purpose	The purpose of dandolo's evaluation of DLSG is to assess the effectiveness of the initiative in the absence of a formal evaluation and generate insights that will inform the

(dandolo evaluation)	2019 Evaluation of Early Learning and Schools Initiatives in the National Innovation and Science Agenda
Evaluation framework / methodology (dandolo evaluation)	<p><u>Framework</u></p> <ul style="list-style-type: none"> • Design: Does the initiative’s design set it up for success? • Implementation: How has the initiative been implemented in practice? • Output: What has the initiative produced or delivered? • Impact: What impacts, or consequences did the initiative have for students? <p><u>Methodology</u></p> <p>Data collection activities included:</p> <ul style="list-style-type: none"> • Conversations with STEM Team in the Department of Education • dandolo completed interviews and a series of online focus groups with stakeholders including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including DLSG. • Analysis of pro-forma acquittal forms submitted by grant recipient schools (Round 1 only) according to the following criteria: main target participant, STEM area, main project activity
Evaluation findings (dandolo evaluation)	<p><u>Design</u></p> <ul style="list-style-type: none"> • Objectives/rationale: The initiative aimed to encourage and facilitate implementation of the new Australian Curriculum: Digital Technologies in response to the new curriculum, which was released in 2015 • Target audience: Schools, teachers and students • Initiative type and approach to implementation: DLSG was a competitive grants program. Two state and territory stakeholders expressed a view that the grants process advantaged schools with more resources who were able to dedicate resources to producing high-quality grant applications and school needs.⁶¹ More detail provided on this hypothesis in the evaluation findings section below.

⁶¹ Assessment criteria prioritised low ICSEA and disadvantaged schools to mitigate risk of inequity

Implementation

- Delivery: 114 projects in total have been funded over the two rounds of the project in 2016-17 and 2017-18. While funding ended in June 2018, there will be projects being delivered until 31 July 2019. Approximately 3500 schools applied for a grant over the 2 rounds. 45 Round 1 projects have been completed to date (including submitting completion reports); 9 are still in progress. 27 Round 2 projects have been completed to date; 40 are still in progress.
- Budget: The average grant awarded was \$35,085 (\$36,839 round one; \$33,332 round two).
- Monitoring and reporting: No evaluation was conducted of the program as a whole; schools were required to complete standard acquittal form answering questions about their activities

Outputs

- Students reached: 34 193 school students directly benefited or participated in an initiative funded by the grants (24 704 primary school students and 9489 secondary school students)
- Schools reached: There were 54 grant recipients in round one and 60 recipients in round two
- States reached round 1: the largest states received the most grants in Queensland (13 schools), NSW and Victoria (11 respectively). The greatest amount of funding was directed at NSW, which was allocated over \$500,000 worth of grant money; NT received funding for one project totalling \$50 000.
- States reached round 2: NSW received funding for 18 initiatives amounting to over \$600,000. The next highest amount was QLD (around \$350 000); the state with the next highest number of funded projects was WA (with 10 projects); ACT had 2 projects totalling around \$70 000. While funding per capita or state / territory 'size' is one way to consider equity, there are other ways to consider equity, for example – identifying need through disadvantage or existing STEM approaches / support by state and territory.

	<ul style="list-style-type: none"> • Main participants: As shown in Figure 26, the majority of project activities were directed at teachers (30%) and then students (14%) • Project focus: As shown in Error! Reference source not found.⁷ the main focus for projects was professional learning (22%). Other foci included resources, professional learning and resources, and networking <p><u>Impact</u></p> <ul style="list-style-type: none"> • Reports of teacher confidence and student engagement: All school grant recipients reported that the grant led to an increase in teacher confidence and student engagement and provided anecdotal evidence of this.
<p>Summary of evaluation conclusions (dandolo comments)</p>	<ul style="list-style-type: none"> • Digital Literacy School Grants was implemented as a response to the newly realised Australian Curriculum: Digital Technologies and was therefore timely because schools and teachers needed support with implementation • The initiative reached a large number of teachers and students, although the depth of engagement by these teachers and students is unknown • According to anecdotal evidence provided by school grant recipients, the initiative led to a range of innovative projects and contributed to an increase in teacher confidence and student engagement, although the reliability of this data is uncertain because it is self-reported by grant recipients • Analysis of Round 1 grants based on school ICSEA and funding reveals that more advantaged schools were slightly more likely to receive higher grants. This remains largely consistent for Round 2 grants, for example, the total funding of each grant tended to increase alongside ICSEA score.⁶² • However, grants awarded as a whole tend to spread relatively evenly between a range of low to high ICSEA schools. This changes in Round 2 where there is a higher proportion of schools with lower ICSEA schools awarded grants. • The largest / most populous Australian states received the most funding: QLD, NSW and Victoria, however, size does not necessarily represent need. For example, despite its population size, NT may have additional and specific needs to support

⁶² Please note, the analysis does not include schools for which ICSEA is not available, these could reasonably be understood to be low ICSEA schools.

	<p>underrepresented cohorts or low ICSEA schools, or some states may have stronger STEM outcomes / existing support than others.</p> <ul style="list-style-type: none"> • While there were incentives included in the grants process to encourage scalability and sustainability, the nature of the initiative (114 grants to schools) means that the Department of Education is unlikely to be able to monitor or encourage this. This limits the impact of the grants beyond the grant period
Limitations of the evaluation	<ul style="list-style-type: none"> • The variability in the types of projects that schools used their funding for makes it difficult to develop a uniform framework to assess grant recipients • The evaluation largely relied on self-reported information and anecdotal evidence in acquittal forms • dandolo only had access to acquittal information from the first round of grants funding
Challenges faced by the provider	Information about the challenges faced by individual schools was not collected as part of this evaluation.
Future plans and goals	n/a
Sources	<ul style="list-style-type: none"> • DET website: https://www.education.gov.au/support-science-technology-engineering-and-mathematics • Round one successful projects: https://docs.education.gov.au/system/files/doc/other/digital_literacy_school_grants_round_1_-_successful_projects_alphabetical_order.pdf • Round two successful projects: https://docs.education.gov.au/system/files/doc/other/list_of_schools_020318.pdf • Acquittal forms from school grant recipients • Grant data provided by the Department of Education

Breakdown of Round One Digital Literacy School Grants Projects

Figure 25. Breakdown by state

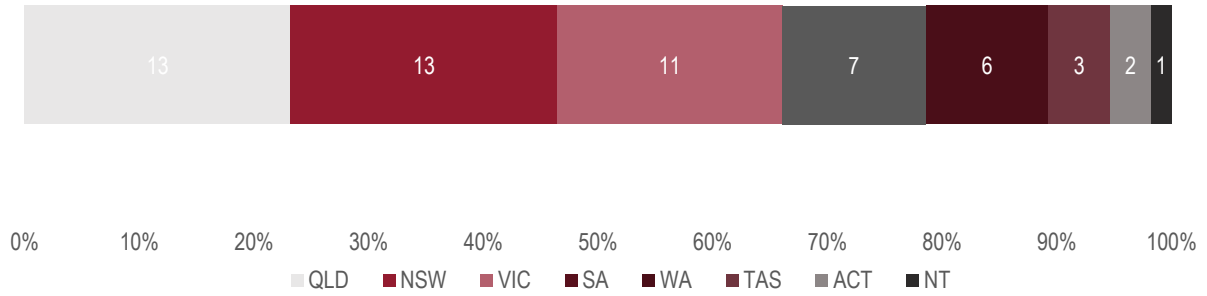


Figure 26. Breakdown by target participant of project

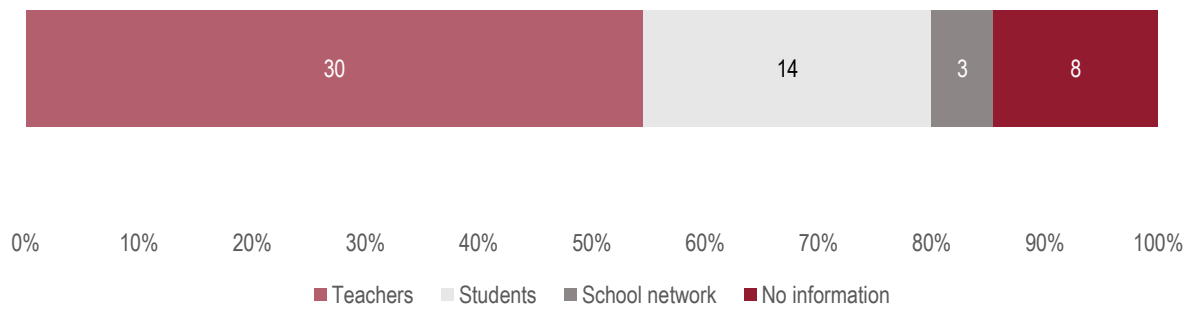
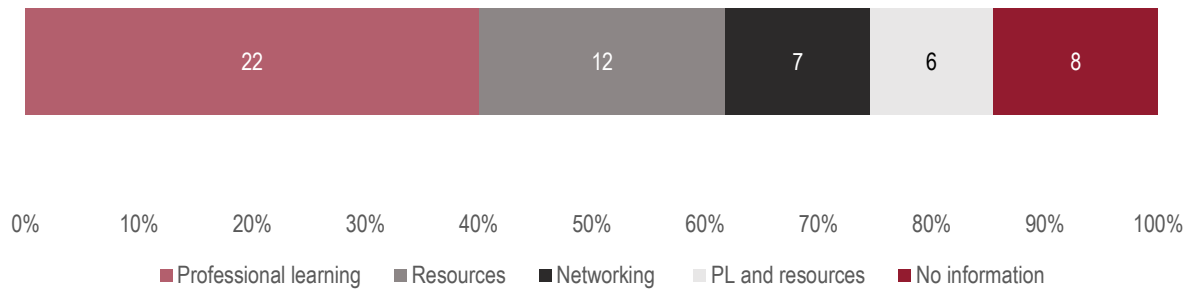


Figure 27. Breakdown by Project Focus



Australian Digital Technologies Challenges

Provider	Australian Computing Academy at The University of Sydney
Initiative description and objectives	<p>Australian Digital Technologies Challenges are a series of free online teaching and learning activities including coding, algorithms, data representation and interpretation. They are freely available to all Australian students in years 3 to 12.</p> <p>The activities are a mix of mini Digital Technology Challenges (part of Dive into Code (DiC)), which introduce simple coding concepts for students and provide 1-2 weeks of lesson activities, and full Digital Technology Challenges that provide 4-5 weeks of lesson activities.</p> <p>The resources teach scratch, Blockly, Python, Javascript, Arduino and Microbit. The online challenges provide automated marking and a teacher dashboard.</p> <p>DiC is part of the Australian Digital Technologies Challenges initiative, which aims to introduce simple coding concepts to students and support teachers implementing the coding aspect of Digital Technologies.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Support student learning in the Australian Curriculum Digital Technologies by providing fun computing challenges that are aligned with the curriculum • Provide teachers with computing challenge activities with professional learning and lesson plans that are aligned to the Australian Curriculum: Digital Technologies to support them in their own learning and teaching of ICT • Increase student access to and participation in ICT learning across Australia

	<ul style="list-style-type: none"> The initiative also includes one and two-day professional learning workshops to primary and secondary teachers across Australia
Target audience	Teachers; students
Initiative funding	NISA funding for Australian Digital Technologies Challenges including Dive into Code is \$9,100 000 (exclusive of GST) for the 2016-2019.
Evaluation	<ul style="list-style-type: none"> Beyond dandolo's evaluation, no external evaluation has been completed. However, ACA has designed a framework for an evaluation that will be completed in collaboration with an external evaluator, funded via Australian Government project funding. A final evaluation report is expected in 2020 Internal evaluation activities have been undertaken by the provider
Evaluation purpose	<ul style="list-style-type: none"> The external evaluation will examine the design and implementation of the whole program, including measuring the impact on teacher capacity, students and schools, governance, development and delivery of the program and the value for money/cost effectiveness of the program The purpose of internal evaluation activity is to ascertain the usefulness of the challenges, their implementation and the main issues teachers face on the way to help students to engage with DT courses. This is informing continual refinement of the program and resources as it progresses.
Evaluation framework / methodology	<p><u>Evaluation framework</u></p> <ul style="list-style-type: none"> Overarching questions for the evaluation are: <ul style="list-style-type: none"> ○ Appropriateness ○ Effectiveness ○ Efficiency ○ Governance Design and implementation considerations

	<ul style="list-style-type: none"> • Outputs • Impact of Project deliverables (Challenges, DiC activities and PD workshops) against project objectives, including: <ul style="list-style-type: none"> ○ Quality and effectiveness as judged by teachers ○ Use of the Challenges and DiC activities by students and teachers ○ Increased expertise and confidence of teachers to deliver the DT curriculum <p><u>Methodology</u></p> <p>Gathering and analysing a combination of existing quantitative and qualitative data:</p> <ul style="list-style-type: none"> • Data analysis, e.g. based on Grok System, data from Eventbrite / ASANA • Web analysis e.g. clickthrough data from the ACA website and / or from Grok, social media analysis • Survey data, e.g. based on teacher workshop participation • Reviews of existing documentation / processes e.g. records of conferences and presentations • dandolo completed interviews and a series of online focus groups with stakeholders including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including the Australian Digital Technologies Challenges.
<p>Summary of evaluation conclusions (internal evaluation – Progress Report 6 and dandolo comments)</p>	<ul style="list-style-type: none"> • This initiative is known for its universal focus and wide reach – for example engaging 61,656 students and 3,111 teachers since its inception. • It's also well-regarded for its alignment with curriculum and easy to access student computing challenges.

	<ul style="list-style-type: none"> The internal evaluation affirms this, demonstrating that the Australian Digital Technologies Challenges has exceeded its targets in terms of teacher professional development attendance and teachers' engagement in DT Challenges. Student enrolment and engagement in DT Challenges has yet to reach targets, but is increasing.
Limitations of the evaluation	<ul style="list-style-type: none"> The evaluation planned by the provider will include some input from external evaluator; however, will not be completely independent The internal evaluation does not include any direct measures of the impact on student engagement or achievement Survey data shows teachers thoroughly enjoyed attending workshops but whether such lessons are realised in the classroom has yet to be examined
Challenges faced by the provider	<ul style="list-style-type: none"> Difficulties reaching and communicating with teachers has led to low awareness about the initiative and resources There is no shared database that provides information on which teachers Australian Digital Technologies Challenges and other DT providers are reaching. There has been variable interest and engagement from ICT associations The provider has found it difficult to secure buy-in from principals and senior school leadership, which is important for teacher engagement
Future plans and goals	<ul style="list-style-type: none"> Investigate the possibility of offering PD that is 1-2 hours instead of 1-2 days to increase access and to enable teachers to get a lot more value from the sessions Create a dashboard, which will provide teachers with immediate feedback and student learning analytics Deeper engagement with schools in digital technologies and increase teachers' digital literacy skills, especially in coding

	<ul style="list-style-type: none"> • Revise the champion teacher program and potentially re-launch. • Connect DT challenges to other subjects (for example, Biology)
<p>Sources</p>	<ul style="list-style-type: none"> • Huseynova A. (11 June 2019). <i>Progress Report 6 For National Digital Technologies Challenges for the period of 10 December 2018 – 13 May 2019 (Revision 1)</i>. Australian Computing Academy, University of Sydney. • Australian Computing Academy Website: https://aca.edu.au/projects/dt-challenges/ • Dive into Code website: https://aca.edu.au/resources/#dive-into-code • Interview with the provider

digIT (ICT Summer Schools)

Provider	Australian Mathematics Trust
Initiative description and objectives	<p>digIT provides a six-month invitational program each year that aims to engage students in Digital Technologies and related careers and develop their coding skills, their problem-solving abilities and their algorithmic thinking. It selects Year 9 and 10 students based on:</p> <ul style="list-style-type: none"> • Their performance in the Australian Mathematics Competition and the Computational and Algorithmic Thinking competition or by recommendation from their teachers • Their rural/regional/disadvantaged/indigenous background • Their interest in ICT <p>The 6-month digital technology-based program includes two residential camps – Summer and Winter – accompanied by five months of mentoring in between.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • To identify and select a cohort of 60 students from the targeted group each year • To prepare these students to learn, train, live and work in a digital world through a cycle of engaging, educational activities as set out in this Schedule. • To increase the interest and participation in, and access to, Information and Communication Technologies (ICT) by the targeted students.
Target audience	Students
Initiative funding	NISA funding is \$999,860 (exclusive of GST) for the period of 2016-2020.
Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, no external evaluation has been conducted

	<ul style="list-style-type: none"> Internal evaluation activities have been undertaken to inform evaluation and progress reports – an evaluation report was produced in 2018
Evaluation purpose (internal evaluation – Evaluation Report)	The purpose of the evaluation report is to provide a thematic review of key aspects of the digIT program requiring further development or improvement
Evaluation framework / methodology (internal evaluation – Evaluation Report)	<p><u>Framework</u></p> <p>The evaluation includes information about key challenges, opportunities for improvement, and participant feedback. The report also compares digIT activities and achievements against key performance indicators (KPIs) and outcomes for the report, which are based on the 'Program Logic Model: ICT Summer Schools program (digIT)' model provided to AMT by the Department.⁶³</p> <p><u>Methodology</u></p> <p>Pre and post surveys of participants including students of summer schools and mentors</p> <p>dandolo completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including digIT.</p>
Summary of evaluation conclusions (internal evaluation – Evaluation Report and dandolo comments)	<ul style="list-style-type: none"> Overall, digIT seems to be less well-known with stakeholders compared with other NISA-funded initiatives. Some stakeholders suggested the scale and focus of the initiative is too narrow, with a perception that only two jurisdictions at a time are able to participate. For example, NT is yet to engage with digIT. However, findings for digIT suggest positive outcomes for students, including an increased likelihood of students pursuing STEM subjects in

⁶³ Cited in digIT 2018 Evaluation Report

	<p>later years. However, there are reservations about the initiative's scope and its direct student focus rather than strengthening teacher capability.</p> <ul style="list-style-type: none"> • Findings from the internal evaluation characterise positive successes based on the second digIT program held at Monash University in 2018: • Excellent satisfaction feedback from participants • A continued increase in students' confidence in IT, Mathematics and Science subjects • A continued increase in students reporting likelihood of studying IT, Mathematics and/or Science in Years 11 and 12 and at university, and • Continuing development and delivery of a range of high-quality, interactive activities and experiences designed to help students engage with different types of ICT content areas including algorithmic thinking, coding web design, gaming and robotics. • Survey results from 2018 over most KPIs are comparable to 2017: there were slight decreases (2-6%) in student participants completing the program and student interest/likelihood of studying ICT; an increase (8%) in mentor satisfaction for the 2018 program. These slight differences reflect the variation in student cohort between the first and second programs.
<p>Limitations of the evaluation</p>	<ul style="list-style-type: none"> • No external evaluation has been undertaken. The evaluation was conducted by the provider and is therefore not independent • Final conclusions have not been reached because the internal evaluation is ongoing – the final evaluation report is due in 2020 • The internal evaluation does not include direct measures of student achievement or engagement or information about the resources developed as part the imitative

<p>Challenges faced by the provider</p>	<ul style="list-style-type: none"> • The program has struggled with brand recognition because it moves from state to state each year. This leads to difficulties recruiting teachers, students, schools and finding platforms and organisations to promote the mentor program • Finding suitable excursion locations and safe, secure and appropriate accommodation during school holidays is difficult • Convincing ICT companies to be involved has been challenging because they cannot often deal with large groups and have issues around classified data
<p>Future plans and goals</p>	<ul style="list-style-type: none"> • Developers are considering scaling up the project, but this would put monitoring and management strain on mentor-mentee relationships which take time to foster • Refine and improve the experience for mentors and mentees based on the feedback and learning from previous programs
<p>Sources</p>	<ul style="list-style-type: none"> • Australian Mathematics Trust. (n.d.) <i>Evaluation Report digIT 2018</i> • Interview with provider • Contract between the Australian Government and the Australian Mathematics Trust

Additional school initiatives

Principals as STEM Leaders (PASL)

Provider	Principals as STEM Leaders (PASL)
Initiative description and objectives	<p>The Principals as STEM Leaders project is developing and piloting new approaches to support principals to provide high quality STEM leadership in schools. The project will involve around 200 primary and secondary schools in the government and non-government sectors, covering rural, regional, remote and metropolitan areas. A suite of high-quality professional learning and mentoring resources developed through the project will be made available for all Australian schools to use at the end of the project, alongside a research report detailing key findings.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • To determine best-practice and expand evidence-based approaches that enhance student STEM engagement and outcomes, through the professional development of principals as successful STEM leaders • Develop high quality and accessible resources • Support mentoring model to be made available beyond the life of the project • Evaluate both the impact of the resources and the project overall and share lessons learned to inform future policy and practice
Target audience	Principals
Initiative funding	NISA funding is \$2, 594, 410 (excluding GST) for the period of 2017-2020
Evaluation	In addition to dandolo's evaluation, an external evaluation is built into the project as part of workstream 3. The external evaluator is evaluating PASL

	throughout the life of the project and will provide an evaluation report at the midway point of the project (mid-2019), and at the end of the project.
Evaluation purpose (external evaluation)	The purpose of the monitoring and evaluation workstream of the PASL project is to evaluate the effectiveness of the programs and resources developed and the conduct of the PASL research project.
Evaluation framework / methodology (external evaluation)	<p><u>Evaluation framework</u></p> <p>Not provided</p> <p><u>Methodology</u></p> <p>Interviews and focus groups with PASL team members and principals dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including PASL.</p>
Summary of evaluation conclusions (external evaluation and dandolo comments)	<ul style="list-style-type: none"> • Generally, stakeholders described PASL as having significant potential to positively influence principals to lead school-wide improvements in STEM, particularly given PASL stands out as an initiative specifically targeting principals as an audience. PASL can also serve as an opportunity to develop and share lessons learned from targeting principals as a key mechanism to achieve school-wide change. However, given PASL's later start-date, it's difficult to draw out specific conclusions regarding effectiveness. • Some stakeholders also commented that PASL is an inclusive program with sound objectives, filling a gap in existing STEM offerings. • An external evaluation identified communication among team members as an area for improvement

	<ul style="list-style-type: none"> The providers reported that the first professional learning with principals in NSW went well and resulted in feedback that has been useful for future planning
Limitations of the evaluation	PASL commenced later than the other NISA projects. This limits the period of time the evaluators have had to evaluate the initiative -- the interim evaluation report is due November 2019
Challenges faced by the provider	<ul style="list-style-type: none"> The provider reported that securing ethics approval in multiple jurisdictions was a lengthy process -- this contributed to substantial project delays because the provider was unable to recruit participants Changes in requirements related to data storage and collection created significant additional work for the provider, which they have found time-consuming and difficult to navigate
Future plans and goals	<ul style="list-style-type: none"> Continue with the project and building positive relationships in government and non-government sectors Trial professional learning in a range of different schools, including in far North Queensland Develop case studies to show what diverse schools are doing as a result of the professional learning Develop STEM capability sets for different stakeholders (for example, principals, parents)
Sources	<ul style="list-style-type: none"> Beswick K., Fraser S., Geiger, V., Page, L. (n.d). <i>Principals as STEM Leaders Building the Evidence Base for Improved STEM Learning</i> (Progress Report #2 Period: August 2018-December 2018). A Consortium led by the University of Tasmania Interview with providers Contract between the Australian Government and the University of Tasmania

Science Assist Advisory Service

Provider	Australian Science Teachers Association (ASTA) and Science Education Technicians Australia
Initiative description and objectives	<p>Science ASSIST was an online advisory service for science teachers and laboratory technicians. Developed in 2014, the initiative provided free, online science education resources, focussed on the curriculum and providing technical support for practicals in line with relevant state/territory requirements, and a panel of experts, able to give safety advice and lab management guidelines to teachers and technicians, in line with state and territory requirements.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • To improve the safety of practical work and school laboratories to ensure science teachers and technicians can deliver meaningful, hands-on practicals for students • To be recognised as the national authoritative source of training and advice
Target audience	Teachers; science lab technicians
Initiative funding	NISA funding was \$100,680 (excluding GST) for the period of 2016-17 (this was in addition to substantial previous Australian Government funding)
Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, no external evaluation has been conducted • Internal evaluation activities have been undertaken – a final report was produced for the period of July 2017-30 November 2018

Evaluation purpose (internal evaluation)	<p>The final report from the provider details the outcomes and achievements of the Science ASSIST Advisory Service against the schedule of work and timelines specified in the approved project plan.</p>
Evaluation framework / methodology (internal evaluation – Final Report)	<p><u>Framework</u></p> <p>The final report from the provider details the outcomes and achievements Science Assist against the schedule of work and timelines specified in the approved Project Plan.</p> <p><u>Methodology</u></p> <p>The following data collection activities informed the final report:</p> <ul style="list-style-type: none"> • Usage of Science ASSIST web portal • Analysis of questions and engagement from users, including 2018 user satisfaction surveys (635 completed or partially completed) • Analysis of resource and content developed • Overview of governance arrangements <p>dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Science ASSIST.</p>
Summary of evaluation conclusions (internal evaluation – Final Report and dandolo comments)	<ul style="list-style-type: none"> • Science ASSIST is a lesser-known initiative among stakeholders, but some report positive feedback about the initiative’s specific science content and resource quality. • An internal evaluation suggests that the initiative was ‘well-used’ however, site usage is not particularly strong, for example, 174 questions from users over a 15-month period. Low uptake and usage contributed to decisions about future Australian Government funding. • Internally collected feedback from users suggests that the service was useful – 77% of respondents see Science ASSIST, its services and resources as ‘very to extremely’ valuable. Usage data indicates that

	<p>Science ASSIST is especially useful for those in independent schools and rural and remote schools.</p> <ul style="list-style-type: none"> • The website was kept up-to-date and monitored with no major concerns.
Limitations of the evaluation	<ul style="list-style-type: none"> • No external evaluation has been undertaken. The evaluation was conducted by the provider and is therefore not independent • The internal evaluation does include any direct measures of the impact on student engagement or achievement
Challenges by the provider	<ul style="list-style-type: none"> • Throughout the entire project period – including four years prior to NISA funding – the Science ASSIST team had to build content quickly, recruit a network of people who could answer questions and procure high-quality resources, whilst also testing this material through workshops • There were some challenges around building a big teacher network because Science Assist has not been able to run many workshops and because there are a lot of science resources competing for teachers' attention • The regulations around laboratories vary across the across the country, which makes it difficult to create general safety rules. Science ASSIST has developed a common set of practices and procedures specifically for schools that have not been adapted from universities or industry like other regulation
Future plans and goals	<ul style="list-style-type: none"> • At the end of 2020, ASTA plans to incorporate Science ASSIST into another ASTA project called STEM-X Academy. STEM X Academy is a five-day residential program for science teachers supported by industry • Science Assist secured funding from CSIRO and other sources to ensure the project continues until 2020
Sources	<ul style="list-style-type: none"> • ASSIST website https://assist.asta.edu.au • Science ASSIST. (n.d.). <i>Science Assist Advisory Service Final Report</i> (1 July 2017 – 30 November 2018)

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| | <ul style="list-style-type: none">• Funding agreement between the Australian Government and Science Assist• Interview with the provider |
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Curious Minds

Provider	Australian Mathematics Trust and Australian Science Innovations
Initiative description and objectives	<p>Curious Minds targets high-potential female students from disadvantaged backgrounds in year 9 and 10. Each year, the program selects a minimum of 54 students, with the aim to include participants from different states and territories. Students partake in summer and winter residential workshops where they attend seminars by STEM experts, practical sessions and group tutorials and participate in mentoring with student mentors from university, industry and Olympiad alumni.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Develop and implement a coherent cycle of educational activities that foster the interest of the target group in STEM learning areas • Identify students from the target group who have significant potential in STEM studies and encourage them in the activities developed under this project • Build participants' skills in critical thinking, logical reasoning and problem solving and strengthen exam techniques. Encourage the participants to take risks, test their limits and create confidence in their abilities • Inspire the participants to continue their STEM studies at the senior secondary level; to increase the number of students from the target groups selected
Target audience	Students
Initiative funding	NISA funding is \$640,000 (excluding GST) for the period of 2018-2020. (building on several previous years of Australian Government funding)

Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, no departmental or external evaluation has been conducted • Internal evaluation activities have been undertaken -- Progress Report 7 for the period of 1 August 2018 to 31 January 2019 was completed in March 2019
Evaluation purpose	<p>The provider is required to produce annual progress reports as part of the contract with Australian Government</p>
Evaluation framework / methodology (internal evaluation – Progress Report 7)	<p><u>Framework</u></p> <p>The internal evaluation report draws on a framework developed with the support of PwC. No more information was provided.</p> <p><u>Methodology</u></p> <p>Before and after camp student surveys and mentor surveys.</p> <p>dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Curious Minds.</p>
Summary of evaluation conclusions (internal evaluation – Progress Report 7 and dandolo comments)	<ul style="list-style-type: none"> • Some stakeholders are familiar with Curious Minds due to its objectives addressing gender diversity, and the initiative has positive brand recognition in this regard. It's considered as a useful 'feeder' program to create a pipeline of girls into STEM. • Initiative findings for Curious Minds also suggest positive outcomes for students, including an increased likelihood of students pursuing STEM subjects in later years. However, there are reservations about the initiative's scope and its direct student focus rather than strengthening teacher capability.

	<ul style="list-style-type: none"> • An internal evaluation suggests the initiative exceeded its target student attendance for its 2018 camp, with 63 students attending (initial target was 54 students). • Most of the student participants not only enjoyed attending the program but grew in confidence and developed STEM career aspirations. This increase in engagement resulted in all participants from the 2015 survey enrolling in STEM subjects in years 11 and 12.
Limitations of the evaluation	<ul style="list-style-type: none"> • No external evaluation has been undertaken. The evaluation was conducted by the provider and is therefore not independent • The internal evaluation does not include direct measures of student achievement or engagement
Challenges faced by the provider	Some of the girls who attend the program do not have the resilience to go deeper into STEM or to complete activities outside of what they are used to in schools.
Future plans and goals	<ul style="list-style-type: none"> • Continue to improve the program and gain a deeper understanding of the impact that such outreach programs can have on students • A PhD Candidate in the Research School of Psychology at the Australian National University (ANU) is conducting an evaluation of the 2018/2019 Curious Minds program as part of her PhD research
Sources	<ul style="list-style-type: none"> • Australian Mathematics Trust and Australian Science Innovations. (March 2019). <i>Curious Minds Progress Report 7 (1 August 2018 to 31 January 2019)</i> • Curious Minds Infographic • Interview with provider

Primary Connections

Provider	Australian Academy of Science
Initiative description and objectives	<p>Primary Connections (PC) is an F-6 implementation support program that provides primary teachers with comprehensive curriculum and professional learning resources that link the teaching of science with the teaching of literacy. It focusses on developing primary students' knowledge, understanding and skill-set in science and literacy, through an inquiry-based approach.</p> <p><u>Objectives of Stage 6 and 7</u></p> <ul style="list-style-type: none"> • Increase the uptake of Primary Connections in schools • Support primary school teachers and final year pre-service primary school teachers to teach science through inquiry • Ensure primary school teachers, pre-service primary teachers and school educators are informed about PC
Target audience	Teachers
Initiative funding	NISA funding is \$1,000,000 (excluding GST) for the period of 2018-2020 (Stage 7). (building on many years of previous Australian Government funding)
Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, the initiative has been evaluated multiple times in previous stages by different evaluators • The University of Technology Sydney (UTS) completed the most recent external evaluation of Stage 6 (2014-2015) in 2018
Evaluation purpose (external evaluation of Stage 6)	<p>The purpose of the UTS' Stage 6 evaluation was to:</p> <ul style="list-style-type: none"> • To assess the program outcomes against Stage 6 objectives, and;

	<ul style="list-style-type: none"> To assess the impact of the program more broadly in order to enable program improvement
<p>Evaluation framework / methodology (external evaluation of Stage 6)</p>	<p><u>Framework</u></p> <p>The research questions addressed are in four streams:</p> <ul style="list-style-type: none"> Appropriateness Efficiency Effectiveness Governance <p><u>Methodology</u></p> <p>This evaluation employed a range of qualitative and quantitative methods, including observations of delivery of professional learning workshops, a literature review, focus group and individual interviews, and surveys with a range of stakeholders.</p> <p>dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Primary Connections.</p>
<p>Summary of evaluation conclusions (external evaluation of Stage 6 and dandolo comments)</p>	<ul style="list-style-type: none"> Primary Connections fills a gap in NISA-funded initiatives as it provides support for the early primary years, as well as engaging pre-service teachers. Some stakeholders describe Primary Connections as having strong professional development offerings, and it is well-received by teachers. Stakeholders also note the positive link between STEM and literacy within the initiative, and the accessibility of its online functions. An external evaluation found that Primary Connections has been widely implemented and has strong brand recognition. Stage 6 has been successful in extending the reach of Primary Connections among regional, rural and remote teachers, primarily in building capacity among

	<p>current users to implement Primary Connections more faithfully and with greater skill and confidence.</p> <ul style="list-style-type: none"> • The research team took the view that <i>Primary Connections</i> should continue much as it is and provided the following recommendations: <ul style="list-style-type: none"> ○ More ongoing professional learning that promotes teacher collaboration, ○ Investigating an online platform that allows teachers to readily select, adapt and build their own program of work ○ Students directly engage with varied learning activities that make the most effective use of digital learning.
Limitations of evaluation	<ul style="list-style-type: none"> • The most recent external evaluation is of Stage 6 only. The stage funded through NISA (Stage 7) has not been externally evaluated • The Stage 6 evaluation does not include direct measures of student achievement or engagement • The UTS evaluation team is conscious that much of the evaluation data about Primary Connections come from those who have chosen to use it rather than those who have chosen not to use it
Challenges faced by provider	<ul style="list-style-type: none"> • Transitioning to the national curriculum and adapting material to align to individual state and territory curricula • Managing the digital transformation – adapting the professional learning for online delivery
Future plans and goals	<ul style="list-style-type: none"> • As recommended by the Stage 6 evaluation report, Primary Connections is exploring how to better take advantage of the digital learning environment. • Increasing interactivity of Primary Connections resources • Providing teachers with greater opportunities to access professional learning by piloting online offerings

	<ul style="list-style-type: none"> • Collaborating with universities to enhance STEM understanding for pre-service teachers
Sources	<ul style="list-style-type: none"> • Aubusson P., Skamp, K., Paul F. Burke, P. F., Pressick-Kilborn K., Ng W., Palmer, T. & Goodall, A. Fergusson, J. (2018). <i>Primary Connections: Linking science with literacy Stage 6 research evaluation final internal report</i> • Interview with provider • Interview with the evaluator • Funding agreement between the Australian Government and the Australian Academy of Science

Science by Doing

Provider	Australian Academy of Science
Initiative description and objectives	<p>Science by Doing is an evidence-based online science program for Years 7 to 10, developed by the Australian Academy of Science (AAS). The program resources are free to all Australian students and teachers and are supported by professional learning modules and a research-based professional learning approach.</p> <p>The aim of the initiative is to improve teaching and student learning outcomes in science within schools, increase student interest and engagement in learning about science and improve the skills and confidence of school teachers to teach science through guided inquiry.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • To ensure an innovative, comprehensive suite of high-quality curriculum units for school students is available and discoverable online to support the teaching of the Australian Curriculum: Science • Teachers and school educators are informed about Science by Doing and its resources
Target audience	Teachers, students
Initiative funding	NISA funding is \$1,000,000 (excluding GST) for the period of 2018-2020 (Stage 5). (building on many years of previous Australian Government funding)
Evaluation	<ul style="list-style-type: none"> • Beyond dandol's evaluation, an external evaluation of Science by Doing (Stage 4) was undertaken by the University of Technology Sydney and completed in 2018

	<ul style="list-style-type: none"> • Stage 5 (funded through NISA) has not been evaluated externally, however, the provider has undertaken internal evaluation activities including collecting website usage and download data
Evaluation purpose (external evaluation of Stage 4)	<p>The purpose of this evaluation was to identify perceptions of Stage 4 of the program, in particular element 4 (revise curriculum units embedding each with a student e-Notebook component) and 5 (implement teacher education with universities)</p>
Evaluation framework / methodology (external evaluation of Stage 4)	<p><u>Framework</u></p> <p>The research questions related to the four research areas for this evaluation:</p> <ul style="list-style-type: none"> • Effectiveness of implementation of Science by Doing • Effectiveness of science teacher educator workshops and resources • Appropriateness • Governance <p><u>Methodology</u></p> <p>The evaluation involved qualitative and quantitative research conducted in approximately six case study schools and with teacher education providers:</p> <ul style="list-style-type: none"> • Effectiveness of implementation of Science by Doing units within schools was determined through surveys of school science teachers and students together with case studies on teachers and students in six schools • Effectiveness of science teacher educator workshops and resources was determined using focus groups and a survey of science teacher educators and science teacher education students. Existing data on Science by Doing held by the Academy of Science was also reviewed to investigate effectiveness • Appropriateness was evaluated using document mapping and interviews, and efficiency evaluated via a document audit and

	<p>discussions with stakeholders. The surveys noted above also obtained information on participant perceptions of appropriateness</p> <ul style="list-style-type: none"> • Governance was evaluated using an audit of existing governance plans, procedures and practices <p>dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Science by Doing.</p>
<p>Summary of evaluation conclusions (external evaluation of Stage 4 and dandolo comments)</p>	<ul style="list-style-type: none"> • Some stakeholders express enthusiastic uptake of Science by Doing by teachers in their jurisdiction, including that modules are widely used for professional learning. However, some stakeholders report that objectives and offerings of the initiative may be unclear to wide range of teachers. • An external evaluation found that Science by Doing is very popular with in-service and pre-service teachers and students. The initiative’s resources were highly valued by in-service teachers because of their flexibility, which enabled teachers to adapt them to suit their needs, and students, who found them engaging and interesting and helpful in building their understanding of science and how scientists work. Professional learning modules were particularly popular with pre-service teachers. • According to the evidence gathered from the high school teachers and students during the evaluation process, the revised curriculum units containing the student e-Notebook have had a very positive impact on their teaching and learning experience. • The evaluation of governance indicates that the Australian Academy of Science, the Department, and the Steering Committee effectively supported and oversaw the delivery of Stage 4.

Limitations of evaluation	<ul style="list-style-type: none"> • There is no independent evaluation of Stage 5 (funded through NISA) • The Stage 4 independent evaluation did not include any direct measures of student engagement or achievement
Challenges faced by provider	<ul style="list-style-type: none"> • As with some other NISA-funded initiatives, Science by Doing must compete with other emerging resources and providers • The e-notebook component of Science by Doing was built using an older code – there is an opportunity to update this • Science by Doing is not currently delivering workshops, which means there is not a lot of active promotion of the initiative • Differences in the technology schools have meant it can sometimes be difficult for students to participate in activities and for teachers to access resources • Many teachers still favour students handwriting in their work, rather than typing. This affects how students use the e-Notebook function of the program
Future plans and goals	<p>The evaluation suggests the initiative could expand its contribution to the evidence base for improving STEM education outcomes in Australia, by using data analytics to track student learning progress.</p>
Sources	<ul style="list-style-type: none"> • UTS. (March 2018). <i>Science by doing Stage 4 Final Report (2016 to 2018)</i> • Interviews with the provider • Interview with the evaluator

reSolve: Maths by Inquiry (reSolve)

Provider	Australian Academy of Science
Initiative description and objectives	<p>reSolve: Maths by Inquiry provides teaching and professional learning resources that aim to transform the teaching and learning of mathematics in Australian schools. The initiative supports an inquiry-based pedagogical approach that links mathematics to real-world situations and focuses on problem-solving and reasoning.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> • Develop and disseminate a suite of innovative, high quality mathematics teaching and learning resources for Foundation to Year 10 school students, teachers and school leaders, incorporating contemporary mathematics pedagogies that are aimed at transforming the teaching and learning of mathematics • Ensure widespread awareness and uptake of the resources and associated pedagogical approaches in schools across Australia
Target audience	Teachers
Initiative funding	NISA funding is \$1,000,000 (excluding GST) for the period of 2018-2020. (building on several previous years of Australian Government funding)
Evaluation	In addition to dandolo's NISA evaluation, an external evaluation of reSolve is being conducted by dandolo. The evaluation commenced in June 2017 and is ongoing.
Evaluation purpose (external evaluation)	The purpose of the evaluation is to evaluate the design and implementation of reSolve and measure its impact on teacher capacity and student outcomes.

<p>Evaluation framework / methodology (external evaluation)</p>	<p><u>Framework</u></p> <ul style="list-style-type: none"> • Design: Were design decisions and processes evidence based? • Implementation: Has reSolve been implemented as intended? • Outputs: What outputs were produced and used? • What indicators are there that reSolve is meeting/not meeting its objectives? • Lenses for analysis: <ul style="list-style-type: none"> ○ Delivery of state objectives ○ Segmentation ○ Potential for change <p><u>Methodology</u></p> <p>For the external evaluation dandolo conducted, a mixed methods approach using:</p> <ul style="list-style-type: none"> • Interviews with Departmental stakeholders • Online questionnaires • Focus groups to canvas views on rollout progress • School visits for observation and interviews • Qualitative and quantitative data (e.g. web portal access data, survey data) • Surveys for teachers and champions <p>For this project, dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including reSolve.</p>
<p>Summary of evaluation conclusions (external)</p>	<ul style="list-style-type: none"> • Stakeholder perspectives from this round of consultation align strongly with findings from dandolo’s separate, external evaluation. For example, stakeholders speak highly of reSolve’s resources and its

<p>evaluation and dandol comments)</p>	<p>specific focus on increasing teacher capability. Stakeholders also applaud the ‘champions’ model and networking opportunities it creates.</p> <p>An overview of findings from dandolo’s separate evaluation is provided below:</p> <p><u>reSolve resources</u></p> <p>High quality resources</p> <ul style="list-style-type: none"> reSolve resources continue to be highly regarded and valued by school leaders, Champions and teachers – but there is unmet demand for more resources <p>Awareness</p> <ul style="list-style-type: none"> Only a minority of champions are networking outside of their own schools – those that are rely on pre-existing relationships or expect reSolve to provide them with opportunities to network <p>Uptake/use</p> <ul style="list-style-type: none"> Most website users are repeat users and resources for upper primary levels are particularly popular Key success factors in schools with continued use include familiarity with inquiry, school leadership support and having several inquiry-enthusiasts in the school <p>Impact</p> <ul style="list-style-type: none"> User reports indicate positive impacts on teachers’ knowledge, attitudes and actions. reSolve is particularly beneficial to students attending schools in remote areas or with high proportions of Indigenous students Users have identified a range of additional support needed to realise an impact on wider behaviour change <p><u>Professional Learning Modules (PLMs):</u></p>
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	<p>High quality resources</p> <ul style="list-style-type: none"> • Champions identified that the PLMs are very good and that they find the concepts within the PLMs important and useful in their own teaching practice <p>Awareness</p> <ul style="list-style-type: none"> • Teachers have not heard about the PLMs • Teachers get their professional learning from many other sources despite being users of reSolve and proactively searching for professional learning opportunities • The value of the PLMs is not well understood <p>Uptake/use</p> <ul style="list-style-type: none"> • Time is a barrier to using the PLMs • Champions have used the PLMs as part of their champion training, and use the PLMs for their own improvement • Online delivery of PLMs is likely to support uptake and use by school staff in regional and rural areas <p>Impact</p> <ul style="list-style-type: none"> • PLMs help users reflect on their teaching practice and encourage them to think about and use new frameworks • PLMs used with others (e.g. in a teacher team setting) sparked engaging conversations but did not generate substantial uptake of reSolve resources or PLMs by other staff
<p>Limitations of the evaluation</p>	<ul style="list-style-type: none"> • Schools volunteering for observations may have created selection bias – schools participating in the evaluation and school observations were using reSolve because most of them were already convinced of the value of inquiry-based learning, which is not necessarily illustrative of the general teaching population’s view.

	<ul style="list-style-type: none"> • There was limited exposure to reSolve's use at secondary schools – all schools visited and most Champions in the focus group were from primary schools (primary schools over-represented in samples)
Challenges faced by the provider	The biggest challenges facing reSolve are uptake barriers – including attitudes towards, and awareness of, the program.
Future plans and goals	<ul style="list-style-type: none"> • Developing more resources including learning professions • Reviewing the champion program to make improvements
Sources	<ul style="list-style-type: none"> • dandolopartners. (February 2019). <i>Evaluation of the Maths by Inquiry Program: Second Progress Report</i> • Contract between the Department and the Australian Academic of Science • Interview with provider • Interview with evaluator

Early learning initiatives

The Early Learning STEM Australia (ELSA)

Provider	University of Canberra (UoC)
Initiative description and objectives	<p>The ELSA Pilot introduces STEM practices and concepts through a play-based digital learning environment using mobile applications (apps) on tablet devices. Additional materials support the STEM practices and concepts included in the apps. The University of Canberra was selected in late 2016 to develop the materials and to pilot them in 100 preschool services from the beginning of 2018 (this has since been extended for a second pilot year in 2019). Six ELSA apps have been developed, comprising four apps for children, one for educators and one for families.</p> <p><u>Objectives:</u></p> <ul style="list-style-type: none"> • Embed the constructive use of technology in preschool programs through the presentation of STEM-focussed practices and learning experiences in a play-based digital environment • Provide meaningful opportunities for preschool children to explore a play-based digital learning environment that is rich in STEM practices, concepts and learning experiences • Engage effectively with the early learning sector to raise awareness of the importance of STEM practices and learning in preschool programs; and • Support early childhood educators to understand the multiple points of connection between STEM practices and concepts
Target audience	Early childhood educators; children; families
Initiative funding	NISA funding is \$8,289,237 (excluding GST) for the period 2016-2020. This includes the extended 2019 ELSA pilot and evaluation.

<p>Evaluation</p>	<ul style="list-style-type: none"> • Beyond dandolo’s evaluation, an internal evaluation is being conducted by the provider. The final 2018 report was released 5 June 2019 • An external evaluation is being conducted by Australian Council for Educational Research (ACER). The 2018 final report was provided to the Department on 31 May 2019 • Both the ELSA Pilot and evaluation by ACER have been extended for a second year in 2019, and the evaluation activity and reporting for 2019 is still in progress. <p>We’ve described the approach for the internal and external evaluation below, but beyond this, dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including ELSA.</p>	
	<p>Internal evaluation</p>	<p>External evaluation</p>
<p>Evaluation purpose</p>	<p>The report evaluated the design, development and delivery of the ELSA pilot in 2018 against the initiative’s four objectives.</p>	<p>The purpose of ACER’s evaluation is to:</p> <ul style="list-style-type: none"> • Review literature related to STEM in the early years and the use of apps • Review the design and delivery of the materials • Analyse data on educators’ and families’ participation in the ELSA Pilot • Analyse children’s engagement with and application of STEM practices

		<ul style="list-style-type: none"> • Produce a cost effectiveness analysis, with a focus on program sustainability
Evaluation framework / methodology	<p><u>Framework</u></p> <p>The structure of the evaluation follows the four objectives in the contract.</p> <p><u>Methodology</u></p> <p>UoC used a mixed-methods approach to evaluation, with data drawn from surveys, usage data of the apps, a literature review, and personal accounts from educators. This report includes both qualitative and quantitative analysis.</p>	<p><u>Framework and methodology</u></p> <ul style="list-style-type: none"> • A review of literature relating to STEM learning in the early years using tablet apps, and of apps developed to support STEM learning in the early years • Analysis of the design, development and delivery of the apps and related materials, as they relate to research reviewed in the literature review and compatibility with the EYLF and AC • Data collected on pilot participation and its effect on educators' confidence and competence, and families' perceptions of their children's confidence, competence and interest in STEM; to be collected through surveys, observation, interviews, focus groups and case studies • Children's engagement with STEM practices, to be collected through app data (to be supplied by UoC) and observations during case study visits

		<ul style="list-style-type: none"> • Post-pilot performance activities of a sample of participating children attending case study preschools • A cost effectiveness analysis that focuses on how the program can be extended beyond the pilot period, with financial consideration of program sustainability and improvements
<p>Summary of evaluation conclusions</p>	<ul style="list-style-type: none"> • The analysis of 2018 ELSA data indicates the 2018 Pilot was a success, with high levels of engagement and enthusiasm shown by educators and children • UoC has achieved its four objectives • UoC ensured that the Early Years Learning Framework (EYLF) was embedded in every aspect of the ELSA program with links to Australian Curriculum • ELSA's 'practice' stance on STEM enabled it to address a diverse range of learning opportunities within the curriculum • The expertise of the pedagogical team behind the 	<ul style="list-style-type: none"> • ELSA apps fill a gap by taking an integrated approach to STEM, focusing on process rather than content • The apps are strongly linked to the Early Years Learning Framework (EYLF), although links to the Australian Curriculum and Foundation to Year 2 could be strengthened. All apps aligned to the EYLF STEM outcomes, with a gap in the Statistics and Probability strand of mathematics • Educator confidence has increased as result of their participation in the pilot, although there was little growth in confidence of digital skills and using digital technology • Some educators used the Community of Practice, but

	<p>project included a range of academics contributing to its success</p> <ul style="list-style-type: none"> • ELSA actively engaged females, Indigenous Australians and people with disabilities and adopted an inclusive pedagogy to reach students from diverse backgrounds 	<p>educators tended to use their own networks to communicate</p> <ul style="list-style-type: none"> • Families reported increased time on STEM and greater interest • The initiative met its objectives • The evaluation recommends a moderate increase in funding would be a good investment
Additional dandolo comments	<ul style="list-style-type: none"> • Stakeholder comments regarding ELSA were divided. Some stakeholders thought ELSA was successful at promoting STEM thinking and STEM skills, and gave children an opportunity to creatively engage with a range of media. They also said ELSA is appropriately aligned with the EYLF. However, some stakeholders report that ELSA had not appropriately engaged with the early childhood sector, and the initiative was developed with limited experience in early childhood education, and pedagogical knowledge. Similarly, that the ELSA initiative does not use early childhood language. • In terms of parent and family engagement, ELSA fills a gap in extending children’s learning into the home to support families to engage with STEM concepts. 	
Evaluation limitations (external evaluation)	<ul style="list-style-type: none"> • ELSA focuses on developing STEM skills, but no valid measure currently exists of STEM skills. As a result, it was difficult for the evaluator to measure these skills • There was a low response rate from pre-schools participating • Both the evaluator and provider conducted evaluations leading to some overlap and data collection activities overwhelming centres • 2019 evaluation is still in progress 	

Challenges faced by provider	<ul style="list-style-type: none"> • Managing government compliance requirements around IT security • The provider expressed concerns about the expertise of the evaluator in early childhood • Lack of IT infrastructure, for example, there are a range of devices in preschools and cost of tablets; app won't work on some older iPads; issue of constant upgrades; limited availability of devices • Communicating with, and high turnover of, rural and remote educators
Future plans and goals	<ul style="list-style-type: none"> • Providers want to expand and upscale their initiative immediately. They believe they will not need to rely on Australian Government funding going forward because of interest in their initiative (from both national and international organisations/governments) • A deed of variation to contract was signed for an extension of the pilot in 2019, which includes undertaking more data analytics and developing learning progressions
Sources	<ul style="list-style-type: none"> • ACER. (22 August 2018). <i>Evaluation of the Early Learning STEM Australia Pilot: 2018 Final Report</i> • University of Canberra. (4 June 2019). <i>Early Learning STEM Australia Pilot Final Report 2018</i> • Interview with provider • Interview with evaluator

Let's Count

Provider	The Smith Family
Initiative description	<p>Let's Count is an early mathematics program for children aged three to five, which is aligned to the Early Years Learning Framework (EYLF). The program supports educators and parents to work collaboratively to develop the mathematics skills of the children in their care by noticing, exploring, and talking about mathematics using everyday activities. It works on the premise that if educators and parents have a positive opinion of mathematics then this will more likely result in children also having a favourable mathematical experience. In particular, the program aims to support children from disadvantaged backgrounds develop their mathematics knowledge and skills.</p> <p>The professional learning associated with Let's Count is offered for educators through face-to-face workshops. In 2018, The Smith Family developed and piloted Let's Count Online as a complementary professional learning approach.</p>
Target audience	Early childhood educators; parents; families
Initiative funding	NISA funding is \$4,000,000 (excluding GST) for the period of 2016-2020.
Evaluation	<ul style="list-style-type: none"> • Beyond dandolo's evaluation, an external evaluation of Let's Count Online was conducted by the Smith Family by Monash University. The final report was published in June 2019. This evaluation relates to the period of NISA funding. • An external longitudinal evaluation of Let's Count was conducted by Professor Bob Perry and Associate Professor Ann Gervasoni before the NISA funding period. The final report was published in 2015 by Charles Sturt University.

<p>Evaluation purpose (external evaluation by Monash University)</p>	<p>The purpose of the Let's Count Online evaluation was to determine the effectiveness of the Let's Count Online platform for professional learning. The evaluation also aimed to gain insights that could be used to improve the program.</p>
<p>Evaluation framework / methodology (external evaluation by Monash University)</p>	<p><u>Framework</u></p> <ol style="list-style-type: none"> 1. Do educators who complete the Let's Count Online course have enhanced dispositions, skills and confidence towards: <ul style="list-style-type: none"> • Engaging and supporting families with mathematical learning and the concepts and principles of the Let's Count program? • Developing a continuity of mathematical learning between the early childhood setting and homes? • Engaging children with mathematical learning and mathematical concepts? • Confidently and professionally approaching mathematical pedagogical practice? • Recognising the importance of mathematical language? 2. Do the educators who participate in Let's Count Online develop similar dispositions, skills, and levels of confidence from those who participated in the face to face model, as evidenced by the Let's Count Longitudinal Evaluation. 3. How can Let's Count Online be improved to more effectively deliver the Let's Count professional learning program using an e-learning platform? <p><u>Methodology</u></p> <p>The evaluation adopted a mixed-methods approach using qualitative and quantitative methods. Data was collected in the following ways:</p> <ul style="list-style-type: none"> • Online surveys – one prior to commencing the program and one two weeks after completion • Phone interviews - twice with seven case study participants

	<p>dandolo also completed interviews and a series of online focus groups with stakeholders, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Let's Count.</p>
<p>Summary of evaluation conclusions (external evaluation by Monash University and dandolo comments)</p>	<ul style="list-style-type: none"> • Stakeholders spoke highly of Let's Count, particularly early childhood stakeholders. They were impressed with the initiative's research-based approach, evidence-base and alignment with the EYLF. • Stakeholders also commented on the transparency of the Let's Count advisory board, which has resulted in greater sector engagement and anecdotally, greater impact. • Let's Count also aims to fill a gap in supporting parents to develop the mathematics skills of the children in their care by noticing, exploring, and talking about mathematics using everyday activities. • Findings based on the Let's Count Online evaluation suggest that the e-learning platform was successful for delivering professional learning for educators associated with the Let's Count program • The participants in the evaluation were very positive about Let's Count Online, and many appreciated the chance to access the professional learning when opportunities for the face-to-face workshops were not available in their region • There were some important differences noted when comparing the Let's Count Online evaluation findings with those of the Let's Count Longitudinal Evaluation which explored the impact of the Let's Count face-to-face course.
<p>Evaluation limitations (external evaluation by Monash University)</p>	<ul style="list-style-type: none"> • The most recent external evaluation that covers the period of the NISA funding evaluates the online component of the Let's Count program only • The evaluation does not include direct measures of child engagement and achievement

Challenges faced by provider	Finding a balance between expanding the initiative to reach more people and ensuring that the initiative serves participants from disadvantaged backgrounds.
Future plans and goals	The provider would like to make the program more broadly available in disadvantaged communities and is exploring fundraising to make this possible. They are considering funding from state governments in South Australia and Victoria to embed the program in childcare centres.
Sources	<ul style="list-style-type: none"> • Gervasoni, G., MacDonald, A., Perry, B., Roch, A. (23 May 2019). <i>The Smith Family Let's Count Online Evaluation: Final report</i> • Interview with provider

Little Scientists

Provider	FROEBEL Australia Limited
Initiative description and objectives	<p>The Little Scientists program is designed to facilitate children’s natural curiosity for science, technology, engineering and mathematics (STEM) in the early years through child-appropriate, fun and playful experiments and inquiry-based learning. The initiative uses a train-the-trainer approach to deliver professional development to early childhood educators. Local network partners (for example, education departments, independent catholic schools, universities, outreach programs) in each state and territory appoint a trainer from their community or organisation to carry out the Little Scientist workshops to early childhood educators. NISA funding was used to expand the program in Australia, to a national audience. This included adapting eight of their German modules to use in Australia.</p> <p><u>Objectives (children)</u></p> <ul style="list-style-type: none"> • Develop enthusiasm, curiosity and interest in research • Practice research-based approach and expand problem-solving competencies; • Comprehend basic scientific, mathematical and technical concepts • Experience self-efficacy and personal competence • Learning and learning methodologies • Social competency • Language competence • Gender equality <p><u>Objectives (educators)</u></p> <ul style="list-style-type: none"> • Develop enthusiasm about researching together • Apply a research approach and critical analysis • Deepen knowledge about scientific, mathematical and technical relationships

	<ul style="list-style-type: none"> • Expand range of educational classroom strategies • Self-confidence as a learning coach • Enhance appreciation of one's professional role and self-perception
Target audience	Early childhood educators
Initiative funding	NISA funding is \$4,000,000 (excluding GST) for the period of 2016-2019.
Evaluation	Beyond dandolo's evaluation, an external evaluation was undertaken by Charles Sturt University. The evaluation research team comprised of early childhood and primary teacher educators and researchers, Dr Amy MacDonald, Associate Professor Lena Danaia, Dr Shukla Sikder, and Dr Carmen Huser. The evaluators completed their final report in March 2019.
Evaluation purpose (external evaluation)	<p>The purpose of the evaluation is to ascertain the efficacy of the Little Scientists program. The program was examined in relation to its impact upon:</p> <ol style="list-style-type: none"> 1. The educators 2. The context of the early childhood setting, including its culture 3. The children within the setting <p>The evaluation was approached as a developmental evaluation which involved providing ongoing feedback to the Little Scientist team for them to reflect on and improve their program based on the evaluators' findings. This feedback was provided via two interim reports and a final report.</p>
Evaluation framework / methodology (external evaluation)	<p><u>Framework</u></p> <p>Impact on early childhood educators:</p> <ul style="list-style-type: none"> • Exploration of educators' perceptions of him/herself as a STEM educator • Assessment of educator confidence in leading STEM activities

- Evidence of educator understanding of underlying concepts in STEM education

Exploring cultural change in early childhood settings:

- Review of example lessons and program change
- Analysis of documentation of learning in STEM education
- Exploration of educator reflections on changes in staff perceptions of STEM and practices in relation to STEM

Children's engagement in STEM learning:

- Competency, including language development, vocabulary, and social skills in STEM contexts
- Confidence in exploring STEM related topics in their everyday world
- Curiosity and desire to explore, investigate and research in STEM
- Perceptions of the Little Scientists program and their STEM learning

Methodology

- Phase 1: Content analysis involves conceptual mapping of the program against the Early Years Learning Framework (EYLF), the National Quality Standard (NQS), the Australian Professional Standards for Teachers (APST), and the Australian Curriculum
- Phase 2: Online surveys of educators (pre and post survey on teacher confidence and beliefs), partner organisations and trainers
- Phase 3: Professional Learning Networks (PLNs), which involved face-to-face meetings and online discussions where participants shared their evidence of changes to practice and children
- Phase 4: Context analysis of reach of the program

dandolo also completed interviews with stakeholders and a series of online focus groups, including STEM organisations and representatives from state and territory departments of education. Stakeholders were asked to provide feedback on individual NISA initiatives, including Little Scientists.

<p>Summary of evaluation conclusions (external evaluation and dandolo comments)</p>	<ul style="list-style-type: none"> • Stakeholders spoke highly of Little Scientists, and it was regularly characterised as a ‘stand out’ NISA-funded initiative. • Stakeholders were impressed with the initiative’s research-based approach, evidence-base and alignment with the EYLF. • Stakeholders regarded the professional development as engaging and valuable, including being relevant for those attending from remote or regional communities. Professional development is practical and hands-on. • Stakeholders also commented on the transparency of the Little Scientists’ advisory board, which has resulted in greater sector engagement and anecdotally, greater impact. • An external evaluation aligns with these stakeholder perceptions. Data collected over two years of the program indicates that the Little Scientists program is favourably received by the participants. Strengths include the focus on the everyday nature of STEM, and the ability to integrate the Little Scientists activities into a range of early childhood education and care settings. Participation in the Little Scientists workshops appears to have a positive impact upon educators’ confidence and practices, and in turn impacts positively upon children’s STEM learning opportunities. • Evaluators examined whether Little Scientists appealed to pre-service teacher. They recommend that if Little Scientists is looking to impact pre-service teachers, they will need a different communication and engagement strategy that looks at making the initiative more obviously relevant, reducing cost and the time commitment for pre-service teachers.
<p>Limitations of evaluation</p>	<p>The evaluation does not include direct measures of child engagement and achievement. The evaluators chose to rely on educators who could provide examples about how kids are engaging with the program instead</p>

Challenges faced by provider	<ul style="list-style-type: none"> • Costs and finding casual replacement educators are barriers for participants who want to attend the professional learning • Finding trainers who have knowledge and skills in both early childhood and STEM • Australian Government requirements around IT security impacted the initiative. It was time-consuming and challenging for the provider to develop their own online booking system. In addition, the evaluators were required to use a government provided platform (instead of Facebook) to collect data for the evaluation. As a result, participants were more hesitant and less engaged, which hindered the evaluation activities • Managing the diversity in skills and experience in some educators who participated in the professional learning. Some had little interest in teaching STEM while other educators had a lot of experience
Future plans and goals	<p>The provider has submitted a proposal to the Department of Education for on-going funding.</p>
Sources	<ul style="list-style-type: none"> • Charles Sturt University. (March 2019). <i>Little Scientists Evaluation - Final Report</i> • Interview with provider • Interview with evaluator

Appendix 3: State and territory STEM strategies

- New South Wales — [Future of Learning initiative](#) includes research projects and STEM resources
- Victoria — [STEM in the Education State](#) (released 2016, with updated initiatives in 2018)
- Queensland — [A Strategy for STEM in Queensland State Schools](#)
- Western Australia — [Future jobs, future skills – Driving STEM skills in Western Australia](#)
- South Australia — [STEM learning strategy 2017 to 2020](#)
- Tasmania — [STEM Framework](#) within Department of Education
- Australian Capital Territory — has adopted the National STEM School Education Strategy
- Northern Territory — [STEM in the Territory Strategy 2018-2022](#)