Australian Government

Questacon
The National Science and Technology Centre

The STEM Learning Ecosystem: A 2019 Snapshot

Tasmania

Produced by Questacon – The National Science and Technology Centre,
A Division of the Department of Industry, Science and Resources

This report is based on Questacon-commissioned research conducted by ARTD Consultants.

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Key definitions

STEM

STEM education is a term used to refer 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.[1]

STEM learning ecosystem

A STEM learning ecosystem encompasses schools, tertiary institutions, industry programs, community settings such as after-school programs, science centres, and museums, and informal experiences in a variety of environments that together constitute a rich array of learning opportunities for young people[2].

Informal STEM providers

Organisations or groups that provide STEM learning across a multitude of designed settings and experiences outside of the formal classroom.[3]

Formal STEM providers

Organisations or groups that provide STEM learning activities that meet designed curriculum outcomes and are delivered as part of formal schooling from Foundation to Year 12.[4]

Questacon's National Presence Strategy

Questacon's National Presence Strategy aims to contribute to STEM capability nationally, and to support STEM learning ecosystems in specific regions through a place-based, sustained and cooperative approach to STEM engagement. The approach guides all our activities with a focus on STEM leadership, collaboration, connections and capacity-building to achieve an enduring impact.

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[1] Education Council of Australia (2015) National STEM school Education Strategy, 2016-2026, www.educationcouncil.edu.au

[2] Adapted from Traphagen, K. and Traill, S. 2014 *Working paper: How cross-sector collaborations are advancing STEM learning*. The Noyce Foundation. Available from: https://smile.oregonstate.edu/sites/smile.oregonstate.edu/files/stem_ecosystems_report_execsum_140128.pdf (accessed 30/07/2021)

[3] Adapted from Centre for Advancement of Informal Science Education website https://www.informalscience.org/what-informal-stem-learning (accessed 13/12/2021)

[4] Adapted from Department of Education Skills and Employment website https://www.dese.gov.au/australian-curriculum (accessed 13/12/2021)

Executive summary

Questacon, Australia's National Science and Technology Centre, has been inspiring young people, families and educators through engagement with science, technology and innovation for 30 years in our Canberra Centres and around Australia. Questacon has a rich history of bringing innovative STEM experiences to Tasmanian communities and forging relationships with other STEM providers.

We commissioned this study to create a snapshot of the STEM learning ecosystem in Tasmania. The study was also conducted in 2 other focus regions: the Northern Territory and Central Queensland (Gladstone and Rockhampton). The study aimed to:

- build our understanding of the STEM learning ecosystem
- inform our engagement with regional stakeholders
- provide a baseline for a future evaluation of Questacon's National Presence Strategy.

Questacon's National Presence Strategy

Our *National Presence Strategy* (NP Strategy) aims to contribute to STEM capability nationally, and to support STEM learning ecosystems in specific regions through a place-based approach to STEM engagement. It represents a shift in focus for Questacon from delivering primarily one-off inspirational STEM experiences to a model equally focused on sustained, collaborative engagement to achieve an enduring impact.

Under the NP Strategy, Questacon will not only measure success by the uptake or outcomes of its individual programs but will also measure our capacity to support and connect to other providers, experiences and resources in the STEM learning ecosystem.

A learning ecosystem approach acknowledges the multiple contexts for learning in and out of school, online, at home and in daily life. It promotes collaboration and connected learning opportunities and pathways to equip young people and communities for the future.

(Adapted from https:stemecosystems.org)

What we did

The study focused on the collective role of organisations in equipping young people for the future, specifically informal STEM providers and their interaction with formal education.

In Tasmania, we collected a range of data and information using 2019 as a reference year (**TABLE 1**). Limitations of this study included the low response rate to surveys impacting the ability to generalise and disaggregate findings.

TABLE 1 DATA COLLECTED IN TASMANIA

Data source	Areas of inquiry	Data (Response rate)
Informal STEM providers survey	STEM vision, activities, and connections	32 (Unknown)
School survey	STEM capacity, activities and connections	17 (12%,N=137 invited schools)
Stakeholder interviews	Regional STEM priorities, strengths and challenges	15 (83%, N=18 selected interviewees)

Questacon's framework for measuring the STEM learning ecosystem

Questacon drew on mature ecosystem models[5] and research[6] to create a framework for the study design and synthesis. We identified 5 dimensions for STEM provider attributes in a STEM learning ecosystem. Drawing on systems theory[7,8] we then developed a rubric to assess the resilience of a STEM learning ecosystem. Here we have categorised the resilience of a STEM ecosystem as *individual, interactive*, or *interconnected*, as determined by indicators in each dimension (**FIGURE 1**).

FIGURE 1 QUESTACON STEM LEARNING ECOSYSTEM DIMENSIONS AND RUBRIC

Dimension	STEM learning ecosystem resilience scale		
	Individual	**Interactive**	**Interconnected**
Shared vision *Shared goals are developed based on the communities' needs, assets and interests*	**Few STEM providers understand or value** shared goals for STEM	**A moderate number of STEM providers understand and value** shared goals for STEM	**Most STEM providers understand and value** shared goals for STEM
Capacity and resources *STEM professionals and organisations have the resources, practices and tools to contribute to a robust STEM learning ecosystem*	**Limited capacity** and resources across organisations	**Moderate capacity** and resources across organisations	**Strong capacity** and resources across organisations
Diversity and density of STEM learning experiences *STEM learning experiences are accessible, connected and offered in diverse learning environments*	**Limited** range and coverage of experiences to meet diverse community/ region needs	**Moderate** range and coverage of experiences to meet diverse community/ region needs	**Wide** range and coverage of experiences to meet diverse community/ region needs
Relationships *Cross-sector connections are fostered to realise a collective vision of STEM for young people*	**One to one** connections between providers	**One to many** connections between providers	**Many to many** connections between providers
Learning pathways *Diverse, connected learning pathways enable young people to become engaged, knowledgeable and skilled in STEM as they progress through childhood into early adulthood*	**Weak pathway** connections and visibility across learning settings	**Moderate pathway** connections and visibility across learning settings	**Strong pathway** connections and visibility across learning settings

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[5] https://stemecosystems.org/

[6] Traphagen, K. and Traill, S. 2014 *Working paper: How cross-sector collaborations are advancing STEM learning*. The Noyce Foundation. Available from: https://smile.oregonstate.edu/sites/smile.oregonstate.edu/files/stem_ecosystems_report_execsum_140128.pdf (accessed 30/07/2021); Vance S et al 2016 *Designing for Success: Developing a STEM Ecosystem*. University of San Diego; Hannon V et al 2019 Local learning ecosystems: emerging models, Innovation Unit, WISE

[7] Innovation Ecosystem Maturity. I do not believe in comparing different... | by Monika Rozalska-Lilo | CREATORS | Medium

[8] Acaroglu, Leyla 2017 *Tools for systems thinkers: 6 fundamental concepts of systems thinking* available on https://medium.com/disruptive-design/tools-for-systems-thinkers-the-6-fundamental-concepts-of-systems-thinking-379cdac3dc6a (accessed 4/12/2021)

What we found

Overall, the study findings indicated an ‘interactive’ STEM learning ecosystem in Tasmania across all 5 dimensions of *shared vision*, *capacity and resources, diversity and density of STEM-rich experiences*, *relationships* and *learning pathways*.

The Tasmanian Government and other institutions’ STEM policy, strategy and investment plans offered a positive outlook for creating a shared vision for STEM. Both informal providers and schools had mixed views about the presence of a shared vision but identified common areas of strategic focus:

- growing STEM engagement in the community,
- building the STEM capacity of educators and schools, and
- empowering and diversifying STEM learners.

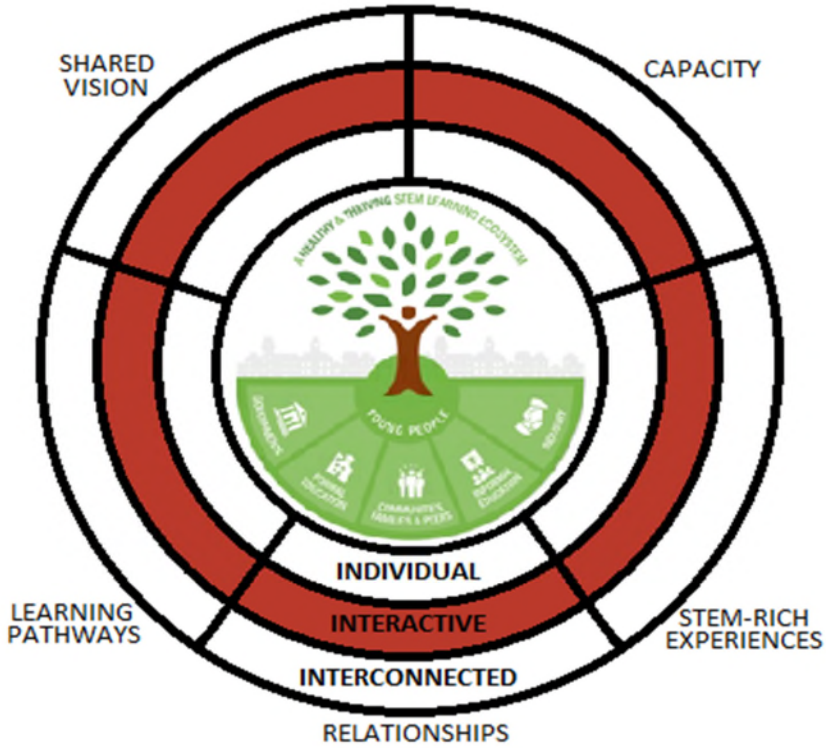
The Study found a high density and diversity of providers and STEM experiences available for schools and communities. Also, a range of initiatives to strengthen STEM pathways However, providers perceived that formal and informal STEM learning could be better connected through greater promotion of opportunities in schools. Equitable reach of STEM opportunities couldn’t be found in this Study. Access for regional and remote communities was a well-recognised issue and efforts were underway to improve coverage of STEM opportunities.

While the sample of schools was small, survey data indicated opportunities to strengthen school and educator STEM capabilities, practices and resources.

Lead STEM organisations reported strong levels of coordination and collaboration. There was appetite for greater coordination and collaboration across other informal providers and schools to realise a shared vision and improve connectivity across the learning ecosystem.

FIGURE 2 outlines the high level synthesised findings for each ecosystem dimension and whether it points to an *individual*, *interactive or interconnected* STEM learning ecosystem.

FIGURE 2 ASSESSMENT OF THE STEM LEARNING ECOSYSTEM IN TASMANIA



SHARED VISION

- Mixed perceptions of a shared vision but stakeholders identified common themes.
- STEM policy and investment settings signalled a positive outlook for growing STEM engagement in Tasmania.

CAPACITY AND RESOURCES

- Sixty-one diverse, informal providers were identified in Tasmania.
- Individuals' passion and commitment underpinned capacity.
- Based on our small sample (N=17), schools had mixed perceptions about school STEM capacity and the support received.

DIVERSITY AND DENSITY OF STEM-RICH EXPERIENCES

- In and out of school experiences were offered across all age cohorts in a range of settings.
- Early childhood and teacher professional learning appeared less catered for.

RELATIONSHIPS

- Strong levels of collaboration and joint activity among lead STEM organisations; often around important programs and events.
- Other providers reported few connections.
- Strong appetite to increase communication, coordination and collaboration.

LEARNING PATHWAYS

- STEM pathways programs and initiatives were available through school, the university, industry and informal STEM providers.
- The study couldn't comment on the connectedness of formal pathways. However, pathways between school and informal learning experiences presented challenges for schools and providers.

What next

This snapshot of the STEM learning ecosystem in Tasmania represented a typical year pre-pandemic, and provided a benchmark for understanding, and tracking changes in, the STEM learning environment. While the Study had limitations, participating informal providers, schools and other stakeholders gave valuable data and insights.

There were several emerging opportunities from this Study.

- ❖ Engaging with regional stakeholders in the spirit of sharing and collaboration
    - Confirming indicative findings and exploring the value and potential use of the baseline study for national and regional stakeholders
    - Exploring whether stakeholders consider a STEM learning ecosystem approach useful
    - Discussing the main opportunities and challenges to strengthen the STEM learning ecosystem
    - Facilitating connections and learning between regions.
- ❖ Shaping Questacon's practice and focus
    - Defining outcomes and activities for the next 6 or 12 months
    - Considering how our own practice is contributing to the 5 learning ecosystem dimensions
    - Placing a greater emphasis on understanding specific local needs and interests
    - Working with state and regional authorities and partners
    - Investing in tailored opportunities with multiple touchpoints to deepen engagement and outcomes
    - Sharing practice with other STEM providers.
- ❖ Progressing thinking about learning ecosystem concepts and principles to strengthen practice and outcomes
    - Testing if applying place-based, collaborative practice and a focus on the ecosystem leads to greater impact
    - Promoting the need for further research into STEM learning ecosystem model and its application in Australian settings.

Introduction

Questacon is Australia's National Science and Technology Centre. Questacon's vision is *a better future for all Australians through engagement with science, innovation and technology*. Young people are at the heart of this vision as Australia's future workforce, its future leaders and global citizens. Questacon has been inspiring young people, families and educators through STEM for 30 years, delivering innovative STEM experiences in our Canberra Centres and around Australia. Questacon has a rich history of bringing innovative STEM experiences to Tasmanian communities and forging relationships with other STEM providers.

Questacon has embarked on a new National Presence Strategy (NP Strategy) aimed at working collaboratively to cultivate Australian STEM learning ecosystems; in Tasmania, the Northern Territory, and Central Queensland.

A STEM learning ecosystem encompasses a range of actors and settings - schools, tertiary institutions, industry programs, community settings such as after-school programs, science centres, and museums, and informal experiences in many environments that together constitute a rich array of learning opportunities for young people and communities.[9]

According to the STEM Learning Ecosystems Community of Practice[10], a robust STEM learning ecosystem has the potential to:

- Design and connect STEM learning opportunities in school, out of school, online, at home and in daily life
- Ensure young people have opportunities to engage in STEM learning, including under-represented groups
- Equip all STEM educators to understand the multiple learning contexts of young people and lead them in active, collaborative and rigorous learning
- Ensure parents and families have capacity to support their children's STEM learning and engagement.

Questacon's NP Strategy represents a shift in focus for Questacon from delivering primarily one-off inspirational STEM experiences to a model equally focused on sustained, collaborative engagement to achieve an enduring impact.

The NP Strategy is trialling whether a STEM learning ecosystem approach offers a sound conceptual and practical framework to guide Questacon and other organisations' regional investments in STEM engagement.

ACTORS IN A STEM LEARNING ECOSYSTEM

[9] Adapted from Traphagen, K. and Traill, S. 2014 *Working paper: How cross-sector collaborations are advancing STEM learning*. The Noyce Foundation. Available from: https://smile.oregonstate.edu/sites/smile.oregonstate.edu/files/stem_ecosystems_report_execsum_140128.pdf (accessed 30/07/2021)
[10] https://stemecosystems.org/

Study purpose

Under the NP Strategy, Questacon will not only measure success by the uptake or outcomes of its individual programs but will also measure our capacity to support and connect to other providers, experiences and resources in the learning ecosystem.

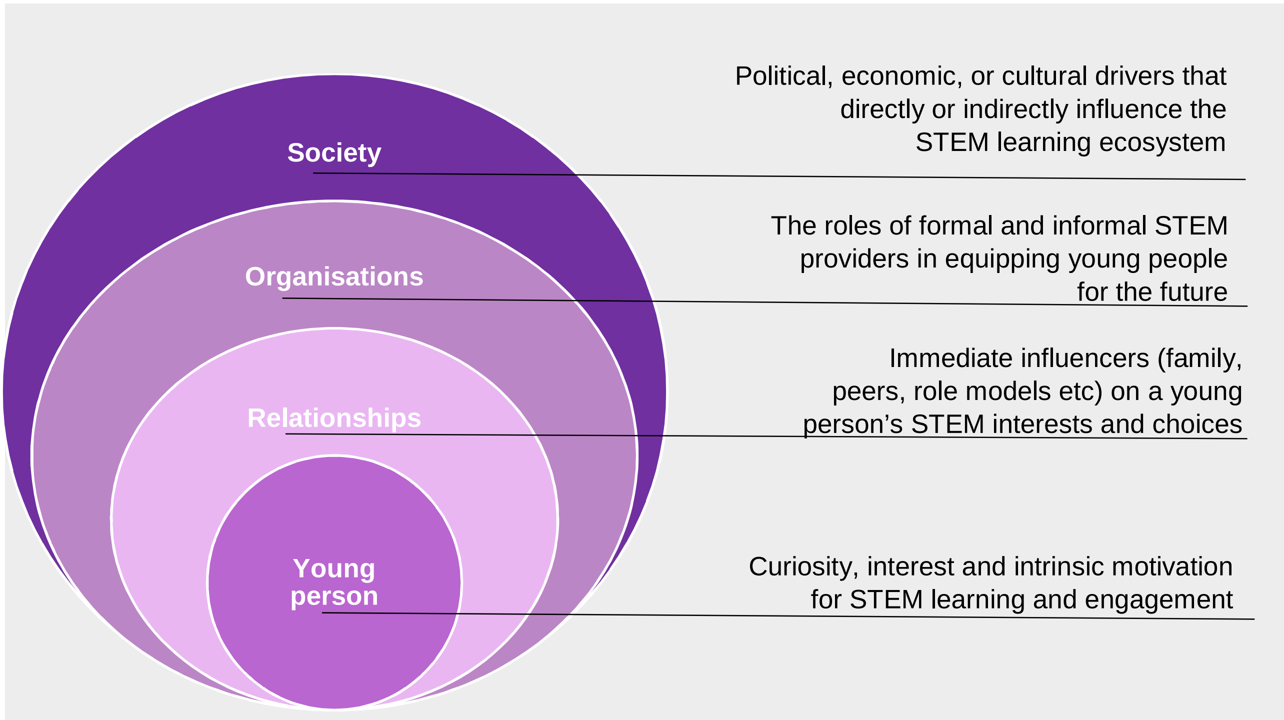
This study was commissioned to inform Questacon's understanding of STEM learning in Tasmania and 2 other focus regions; Northern Territory and Central Queensland. It aimed to:

- Develop our understanding of STEM learning provision and identify how best to contribute to STEM learning and capacity
- Provide a benchmark for a future evaluation of the NP Strategy
- Explore the benefits of applying a learning ecosystem model to strategy implementation and impact measurement.

Applying a learning ecosystem perspective

Building on Bronfenbrenner's ecological model of child development[11], a learning ecosystem model recognises that learning potential is shaped by the interaction between a young person and their environment. The model blurs the traditional boundaries between formal and informal learning and recognises the collective role individuals, organisations and society play in equipping young people for lifelong learning and the future (**FIGURE 3**).[12]

FIGURE 3 APPLYING AN ECOLOGICAL MODEL TO A STEM LEARNING ECOSYSTEM[13]



[11] Bronfenbrenner, Urie. 1979 *The Ecology of Human Development*. Harvard University Press
[12] Hannon, V. *et al*. 2019 *Local learning ecosystems: emerging models*, Innovation Unit, WISE
[13] Meador, Amy et al. (2016). *Comparing 2 National Organization-Level Workplace Health Promotion and Improvement Tools*, 2013-2015. Preventing chronic disease. 13. 10.5888/pcd13.160164.

Baseline study design

This study aimed to explore the strengths and opportunities in the STEM learning ecosystem in Tasmania using 2019 as a baseline reference year.

The study focused on the role of STEM learning providers in creating STEM learning opportunities and pathways for young people and communities. Specifically, the role of informal STEM providers and their interaction with formal education.

Questacon drew on mature learning ecosystem models[14] and research[15] to create a framework for the study design and data analysis (See **FIGURE 4** and **TABLE 2**). We identified 5 dimensions and associated measures for STEM provider attributes in a STEM learning ecosystem:

1. Shared vision
2. Capacity and resources
3. Diversity and density of STEM learning experiences
4. Relationships
5. Learning pathways

Drawing on systems theory[16,17] we then developed a rubric to assess the resilience of STEM providers in the STEM learning ecosystem using the following scale:

- Individual – organisations are internally-driven with limited understanding of, or connections to, the wider learning ecosystem
- Interactive – organisations are informed by their understanding of, and connections to, the wider learning ecosystem
- Interconnected – organisations are functioning as part of a complex and dynamic learning ecosystem.

We synthesised findings against the dimensions and then used the rubric to assess the dynamics of the learning ecosystem at a point in time (**FIGURE 5**). The rubric does not reflect a judgement about the capability of STEM providers in the region. Rather, it aims to measure overall resilience of the STEM learning ecosystem.

[14] https://stemecosystems.org/

[15] Traphagen, K. and Traill, S. 2014 *Working paper: How cross-sector collaborations are advancing STEM learning*. The Noyce Foundation. Available from: https://smile.oregonstate.edu/sites/smile.oregonstate.edu/files/stem_ecosystems_report_execsum_140128.pdf (accessed 30/07/2021); Vance S et al 2016 *Designing for Success: Developing a STEM Ecosystem*. University of San Diego; Hannon V et al 2019 Local learning ecosystems: emerging models, Innovation Unit, WISE

[16] Innovation Ecosystem Maturity. I do not believe in comparing different… | by Monika Rozalska-Lilo | CREATORS | Medium

[17] Acaroglu, Leyla 2017 *Tools for systems thinkers: 6 fundamental concepts of systems thinking* available on https://medium.com/disruptive-design/tools-for-systems-thinkers-the-6-fundamental-concepts-of-systems-thinking-379cdac3dc6a (accessed 4/12/2021)

FIGURE 4 QUESTACON'S STEM LEARNING ECOSYSTEM DIMENSIONS AND RUBRIC

Dimension	STEM learning ecosystem resilience scale		
	Individual	Interactive	Interconnected
Shared vision *Shared goals are developed based on the communities' needs, assets and interests*	**Few STEM providers understand or value** shared goals for STEM	**A moderate number of STEM providers understand and value** shared goals for STEM	**Most STEM providers understand and value** shared goals for STEM
Capacity and resources *STEM professionals and organisations have the resources, practices and tools to contribute to a robust STEM learning ecosystem*	**Limited capacity** and resources across organisations	**Moderate capacity** and resources across organisations	**Strong capacity** and resources across organisations
Diversity and density of STEM learning experiences *STEM learning experiences are accessible, connected and offered in diverse learning environments*	**Limited** range and coverage of experiences to meet diverse community/ region needs	**Moderate** range and coverage of experiences to meet diverse community/ region needs	**Wide** range and coverage of experiences to meet diverse community/ region needs
Relationships *Cross-sector connections are fostered to realise a collective vision of STEM for young people*	**One to one** connections between providers	**One to many** connections between providers	**Many to many** connections between providers
Learning pathways *Diverse, connected learning pathways enable young people to become engaged, knowledgeable and skilled in STEM as they progress through childhood into early adulthood*	**Weak pathway** connections and visibility across learning settings	**Moderate pathway** connections and visibility across learning settings	**Strong pathway** connections and visibility across learning settings

Using the Study for a future NP Strategy evaluation

The synthesised baseline findings will be a point of comparison for a future evaluation to assess:

- Questacon's contribution to STEM learning ecosystem resilience and outcomes
- to what extent Questacon has reoriented its own way of working and relationships towards learning ecosystem principles
- whether an ecosystem approach with sustained and collaborative engagement delivers a more enduring impact.

A range of data sources would be used including repeating elements of the baseline study and a synthesis of Questacon data on our reach, engagement and program outcomes.

TABLE 2 MEASURING THE ROLE OF STEM PROVIDERS IN STEM LEARNING ECOSYSTEMS[18]

DIMENSION	Shared Vision	Capacity and Resources	Diversity and density of STEM-rich experiences	Relationships	Learning pathways
OUTCOME	*Shared goals are developed based on the communities' needs, assets and interests*	*STEM professionals and organisations have the resources, practices and tools to contribute to a robust STEM learning ecosystem*	*STEM learning experiences are accessible, connected and offered in diverse learning environments*	*Cross-sector connections are fostered to realise a collective vision of STEM for young people*	*Diverse, connected learning pathways enable young people to become engaged, knowledgeable and skilled in STEM as they progress through childhood into early adulthood*
MEASURES	• Perceptions of a shared vision • Shared strategic focus areas • Government/industry policies, plans and investment	• Number and diversity of informal providers • Provider perceptions of collective capacity to meet informal STEM learning needs • Provider resources (people, time, money) • STEM teaching support, practices and resources in schools	• Range of school and community-based STEM experiences targeting all ages • Equitable reach of experiences • Extra-curricular activities in school • Educator STEM professional learning opportunities • Digital and in-person delivery modes offered	• Type and strength of connections between STEM providers • Cross-sector networks • Participation in formal networks • Informal provider and school attitudes on collaboration	• Formal and informal STEM pathway programs/ initiatives • Connections between school, out-of-school and post-school STEM programs

[18] Traphagen, K. and Traill, S. 2014

Study methods

The study employed a mixed methods design, which included surveys and interviews with STEM providers, teachers and informal STEM educators from government, industry and non-government organisations[19], and a document review. Key data sources are outlined in **TABLE 3**.

TABLE 3 STUDY DATA COLLECTION

Evidence source		Data collected		Response rate
Survey of informal STEM providers		32		Unknown[20]
Survey of schools		17 (total)		12% (N=137 invited schools)
		Catholic	State	
	Primary	3	6	
	Secondary	2	2	
	Combined	3	1	
Stakeholder interviews		15 (total)		83% (N=18 selected invitees)
	Informal providers	11 from 8 providers		
	Formal education stakeholders	4		
Document review		Range of policy/strategy documents		n/a

Study Limitations

Limitations of this study included the low response rate to surveys impacting the ability to generalise and disaggregate findings.

Informal STEM provider survey

A snowballing technique, where the survey is distributed on by people sent the survey, was used to broaden the reach of the survey. It is not possible to know how many providers received an email survey invitation and a response rate cannot be calculated.

While a high number of providers entered the survey (N=32), a much smaller proportion completed the entire survey and hence there was a lot of missing data against individual questions.

Survey completion	N	Percent
<50%	9	28%
50-75%	9	28%
100%	14	44%
TOTAL	32	100%

Schools survey

The response rate from government schools was low (9 of the 100 invited schools), limiting our understanding of their operations, strengths and challenges. A similar number of responses were received from Catholic schools (8 of the 37 invited schools). The analysis does not distinguish between school respondents from different sectors.

[19] Allen, S. and Peterman, K. 2019 "Evaluating informal STEM education issues and challenges in context". In A.C. Fu, A. Kannan and R. J. Shavelson (Eds.) *Evaluation in Informal Science, Technology, Engineering and Mathematics Education. New Directions for Evaluation*, 161, 17-33
[20] Snowballing method was used to distribute the survey so the sample size is unknown.

Key Findings

In Tasmania, we collected a range of data and information using 2019 as a reference year. This snapshot of the STEM learning ecosystem represented a typical year pre-pandemic, and aimed to provide a benchmark for understanding, and tracking changes in, the STEM learning environment.

Limitations of this study included the low response rate to surveys impacting the ability to generalise and disaggregate findings. While the Study had limitations, participating informal providers, schools and other stakeholders gave valuable data and insights.

The following sections are a synthesis of findings organised by the 5 dimensions and associated measures, and highlight the identified strengths, gaps or challenges. We then applied the ecosystem resilience rubric using a scale of *Individual, Interactive,* and *Interconnected*.

FIGURE 5 highlights the key findings for each dimension and overall STEM learning ecosystem.

FIGURE 5 ASSESSMENT OF THE STEM LEARNING ECOSYSTEM DIMENSIONS AND RESILIENCE

SHARED VISION

- Mixed perceptions of a shared vision but stakeholders identified common themes.
- STEM policy and investment settings signalled a positive outlook for growing STEM engagement in Tasmania.

CAPACITY AND RESOURCES

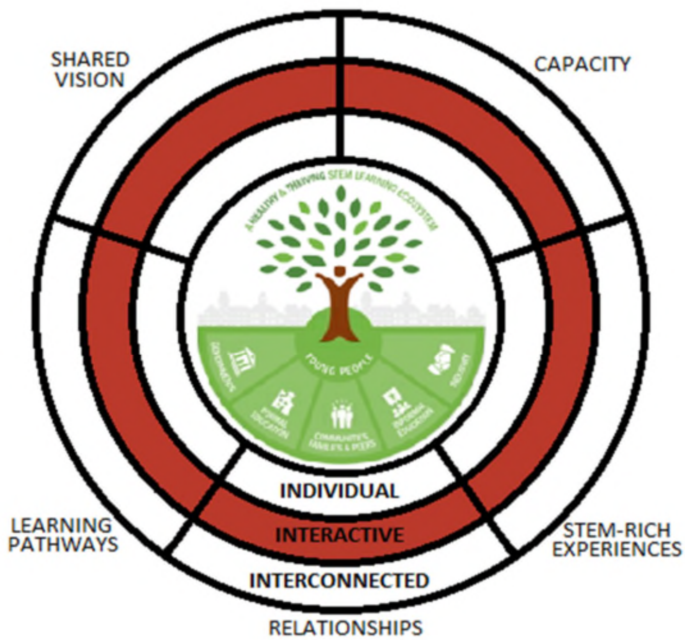
- Sixty-one diverse informal providers were identified in Tasmania.
- Individuals' passion and commitment underpinned capacity.
- Based on our small sample (N=17), schools had mixed perceptions about school STEM capacity and the support received.

DIVERSITY AND DENSITY OF STEM-RICH EXPERIENCES

- In and out of school experiences were offered across all age cohorts in a range of settings.
- Early childhood and teacher professional learning appeared less catered for.

- Strong levels of collaboration and joint activity among lead STEM organisations; often around important programs and events.
- Other providers reported few connections.
- Strong appetite to increase communication, coordination and collaboration.

- STEM pathways programs and initiatives through school, the university, industry and informal STEM providers.
- The study couldn't comment on the connectedness of formal pathways. However, informal providers identified issues connecting schools with informal STEM programs.



RELATIONSHIPS

LEARNING PATHWAYS

Shared Vision

SHARED GOALS ARE DEVELOPED BASED ON THE COMMUNITY'S NEEDS, ASSETS AND INTERESTS

A shared vision encourages buy-in from key actors within the learning ecosystem and the distribution of responsibility for learning among all sectors. Shared visions aimed at young people may include goals such as academic achievement, participation, and/or development of identity, interest, curiosity and passion[22]

KEY BASELINE MEASURES

- Perceptions of a shared vision amongst STEM providers
- Documented STEM policy/ strategy
- Shared strategic areas of focus

KEY FINDINGS

The presence of a shared vision for STEM indicated an 'interactive' ecosystem.

There was not a universal perception of a shared vision across informal providers or schools but stakeholders identified common themes.

The STEM policy and investment plans signalled a positive outlook for a shared vision for STEM in Tasmania.

STRENGTHS

Half of informal STEM providers (50%, N=18) believed there was a shared vision for STEM in the region.

Both informal providers and schools identified similar areas of strategic focus:

- growing STEM engagement in the community
- building the STEM capacity of educators and schools
- empowering and diversifying STEM learners.

'More connected STEM providers and activities' was the top area of focus for informal providers. This suggests providers were positively disposed to working together towards shared goals, though few providers reported success.

IDENTIFIED GAPS OR CHALLENGES

Based on our small sample, less than half of schools (46%, N=13) believed there was a shared vision for STEM in the region. Noting the small sample size of schools, more data is needed to confirm these findings.

Both informal STEM providers and schools reported limited success in achieving strategic areas of focus.

[21] National Research Council 2014. *STEM learning is everywhere: Summary of a convocation on building learning systems.* Washington DC: The National Academies

Shared Vision

Perceptions of shared vision

Half of informal STEM providers (50%, N=18) and less than half of surveyed schools (46%, N=13) believed there was a shared vision for STEM in their region.

While there was not a common perception of a shared vision, aspirational themes discussed by interviewees were to:

- Increase STEM engagement in the community
- Improve the capacity of teachers and schools to provide STEM education and inspiration for students
- Promote opportunities for young people to pursue local STEM-based careers.

STEM providers that perceived there to be a shared vision were typically STEM leaders. The notion of a 'shared vision' was more likely to be focused around specific STEM education initiatives, for example National Science Week.

Documented policy/ strategy

The Tasmanian Government's STEM Framework aims to:

- equip students with knowledge, skills and capabilities
- increase student engagement
- improve retention and progression in STEM fields
- strengthen and optimise parental, business, further education and community partnerships to improve STEM learning outcomes.

The Tasmanian Department of Education recently introduced Principal Education Officers (PEO) for all curriculum areas and levels (Primary, Secondary and Senior Secondary). Within the science area, one of the PEO positions would oversee STEM. A STEM pedagogical framework was planned.

Catholic schools had a STEM Education Officer since 2019, who worked with teachers and schools across all Year levels. Connections were made with STEM education and outreach at the University of Tasmania (UTAS) and other local informal STEM providers to assist a state-wide approach. The role included:

- supporting secondary teachers with projects, and inquiry-based learning projects
- assistance with the development of resources
- facilitating effective communication and cross-learning opportunities between schools.

More broadly, the Tasmanian Regional Development Australia priorities for 2021-22 were focused on innovation and industry diversification to promote economic growth around land, water, energy and renewables, and transport. Related workforce diversification, education, and job pathways were also planned. While STEM was not an identified priority, many of the development initiatives needed a STEM trained and capable workforce[22].

Significant construction, refurbishment, and relocation of academic and STEM-related infrastructure was planned or underway to further develop STEM industry and educational capabilities in Tasmania.

[22] Regional Development Australia Available from https://www.rda.gov.au/sites/default/files/documents/priorities-matrix.pdf

Under the 10-year Hobart City Deal (2019), the Antarctic and Science Precinct at Macquarie Point had total funding commitments of over $595 million to upgrade Australia's research station network and support infrastructure. As part of the Launceston City Deal, the Northern Transformation Program aimed to fund a university precinct close to the Launceston CBD to build participation, research and development, and industry connections.

Further Tasmanian Government STEM investments included:

- $3.5 million for refurbishing the Science and Mathematics hub at Hellyer College in Burnie allowing students aged 16-19 to undertake real-world experiments and simulations.
- $400 million capital investment to construct a new purpose-built STEM facility for tertiary education, research and training in the Hobart CBD to increase the appeal of studying STEM in Tasmania for local, interstate and international students.

The Financial Security for Women Action Plan 2018-2021 aimed to increase women's participation in Science, Technology, Engineering, Mathematics, and Medicine (STEMM). Eleven cross-government actions outlined in the plan included:

- establishing STEM learning pathways for girls in schools
- encouraging Tasmanian women in STEM leadership and ambassadorial roles
- supporting women and girls in regional areas interested in STEM pathways to participate in male-dominated fields.

Shared areas of focus

Informal STEM providers and schools were asked to report their strategic STEM areas of focus from a pre-defined list of survey items. The extent of success was asked to those who indicated the statement was a moderate to major focus for their organisation or group. (**FIGURE 6** and **FIGURE 7**).

Informal providers and schools shared the priority of, '*Growing STEM engagement in the region*'. Around half of providers and schools reported success in this focus area.

'More connected STEM providers and activities' was a top priority for informal providers and for around half of schools, but few reported success in this area.

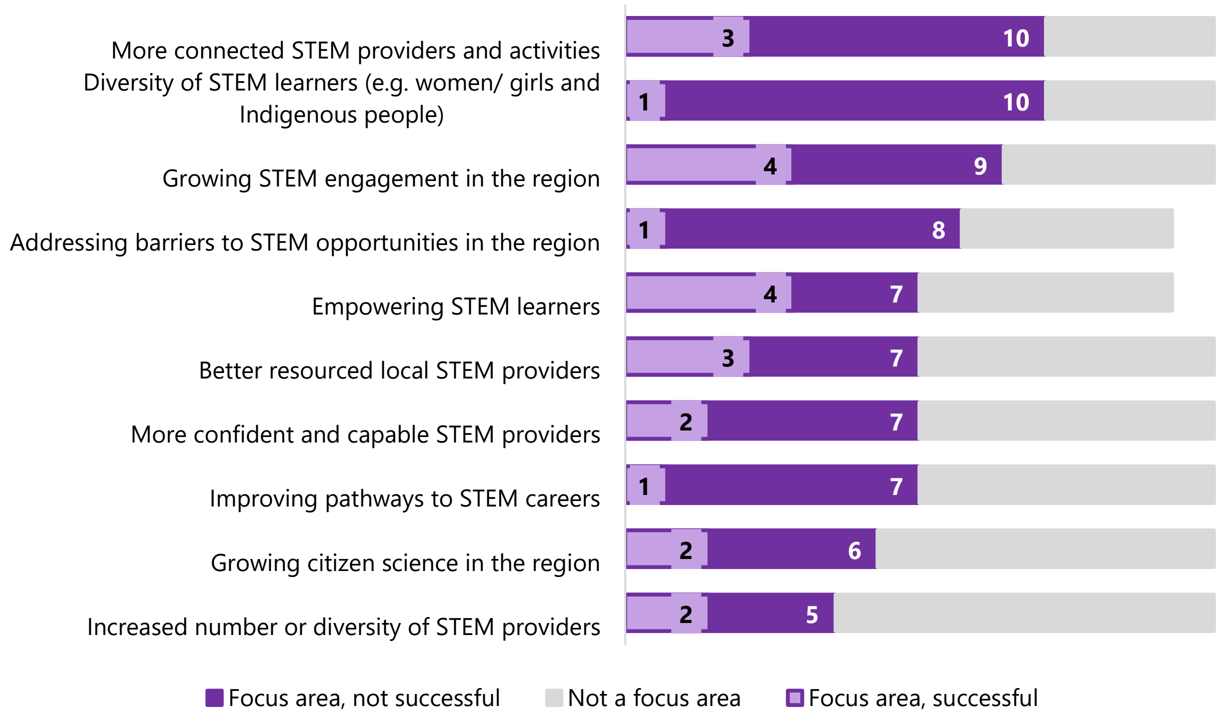
'*Improving pathways to STEM careers'* was the lowest priority for school respondents. Informal providers reported limited success in this area.

An identified priority for schools was '*building the capacity of STEM educators*'. Other study data suggests that increasing teacher access to professional learning was an identified need.

'*Addressing barriers to STEM'* was a priority for informal providers. One of 8providers reported success, suggesting a potential area of strategic focus.

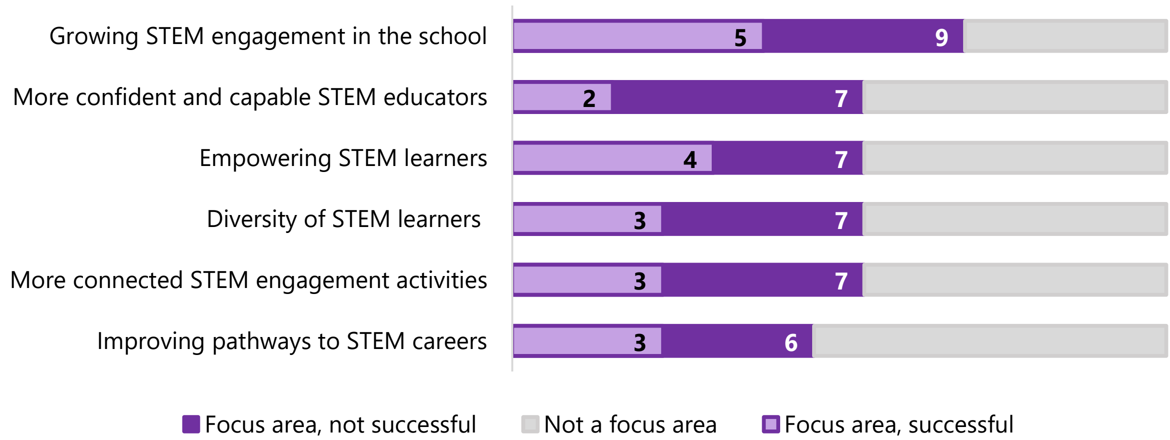
Overall, providers did not rate themselves as successful against listed focus areas. '*Empowering STEM learners'* was the only focus area where more than half of providers and schools reported success.

FIGURE 6 INFORMAL PROVIDER STEM FOCUS AREAS IN 2019, AND LEVEL OF SUCCESS



Notes: N=14. "Addressing barriers to STEM opportunities in the region" and "Empowering STEM learners" had N=13 responses. Source: Informal STEM provider survey, 2020.

FIGURE 7 SCHOOLS STEM FOCUS AREAS IN 2019, AND LEVEL OF SUCCESS



Notes: N=13. Source: School STEM survey, 2020.

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Capacity and Resources

COLLECTIVE CAPACITY AND RESOURCES ARE ABLE TO MEET COMMUNITY NEEDS

STEM professionals and organisations have the organisational and technical resources, practices and tools to support a robust STEM learning ecosystem

KEY BASELINE MEASURES

- Number and diversity of informal providers
- Provider resources
- Provider organisational strengths
- STEM teaching support, practices and materials in schools

KEY FINDINGS

Collective capacity and resources indicated an 'interactive' ecosystem in Tasmania.

Sixty-one diverse informal providers were identified with a presence in Tasmania suggesting strong collective capacity for informal STEM engagement and education.

Our small sample of schools (N=17), had mixed perceptions about school STEM capacity and the support received.

STRENGTHS

A diversity of informal STEM providers were identified across government, industry, education, cultural institutions and non-government organisations.

Scientific and community organisations, researchers and professionals working in related scientific, environmental and technology fields were contributing to informal STEM education.

The passion and commitment of individuals had created a positive culture and momentum for STEM education and engagement.

IDENTIFIED GAPS OR CHALLENGES

Informal providers identified that resource constraints, funding, time and people, affected the reach, sustainability and cost-effectiveness of STEM programs.

Schools were mixed in their perceptions about STEM capacity and support, noting that the small sample size meant findings could not be generalised. Identified capacity needs included building educator STEM capability and increasing access to quality STEM teaching resources.

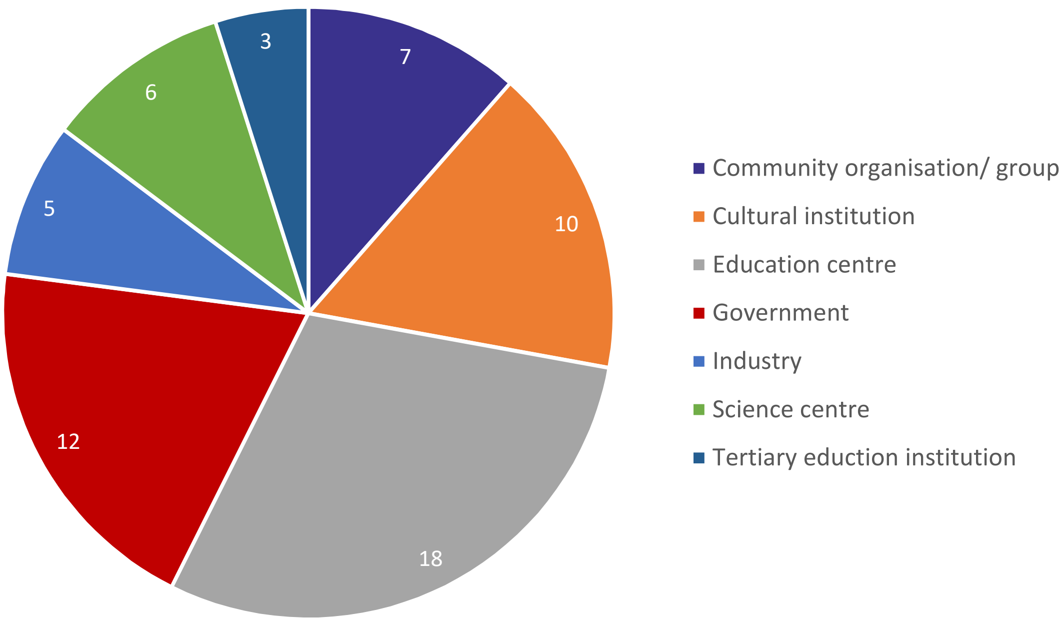
Capacity and Resources

Number and diversity of informal providers

The study identified 61 informal STEM providers operating in Tasmania (**FIGURE 8**). The providers comprised education centres, government, cultural institutions, community groups, science centres, industry, and tertiary institutions. Government, education centres and cultural institutions made up most providers offering informal STEM engagement opportunities.

The array of local, state and national providers were offering a wide range of informal STEM learning opportunities in Tasmania catering to a multitude of STEM interests, age groups, and learning modes and formats. Many surveyed STEM providers (83%) agreed national and interstate programs were a valuable resource.

FIGURE 8 NATIONAL, STATE AND LOCAL PROVIDERS OFFERING INFORMAL STEM ENGAGEMENT OPPORTUNITIES IN TASMANIA IN 2019, BY PROVIDER TYPE



Notes: N=61. Providers only counted once. Sources: Names of STEM providers come from (a) respondents to the Baseline Informal STEM Providers Engagement Survey 2020, (b) STEM providers listed in the Baseline Informal STEM Providers Engagement Survey 2020, (c) STEM providers nominated by respondents in the Baseline Informal STEM Providers Engagement Survey 2020, (d) STEM providers identified during interviews with informal STEM providers, and (e) STEM providers listed as offering incursions or excursions in the Baseline Schools STEM Engagement Survey 2020.

Informal provider organisational strengths

Informal STEM providers offered a diversity of experiences to meet the interests of young people at different learning stages.

Stakeholders highlighted the range of scientific and community organisations, researchers and professionals working in related scientific, environmental and technology fields who were contributing to informal STEM education. Further, Tasmania's rare, diverse and accessible natural environment and proximity, offered an inspiring backdrop for STEM.

Stakeholders commented on the presence of passionate individuals willing to invest time and commitment to promote and champion STEM and build a collaborative culture across the informal STEM community.

Provider resources (people, time, money)

Informal providers commented often on resource constraints (funding and people). This limited the reach and range of informal STEM providers' activities and their capacity to offer programs with sufficient regularity. Key issues identified by providers were:

- Lack of funding or reduced resourcing to support events and programs. Programs often faced funding cliffs impacting the sustainability and cost-effectiveness of STEM programs in the long-term.
- Limited capacity of STEM professionals/experts/educators to contribute to community events or collaborative networks given the relatively small pool.
- A perceived lack of resources in schools, particularly secondary schools, to engage in STEM events and programs.
- The cost of insurance for community groups making and running programs was expensive, '*It's killing clubs and regional organisations*' [community group provider].

STEM teaching support, practices and resources in schools

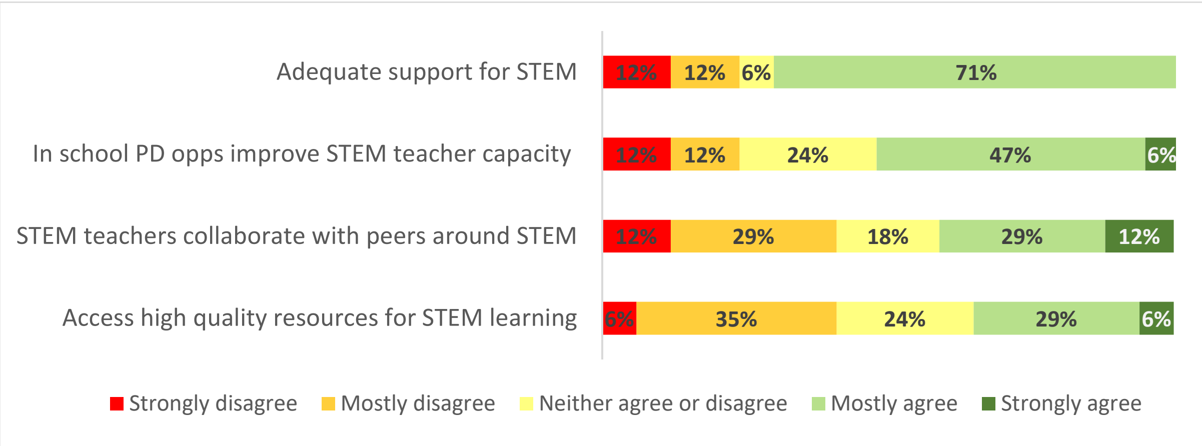
Overall, a small number of schools (n=17) responded to the survey. Around half of the surveyed schools were positive in rating their school's STEM capacity. Though, the small sample size meant findings could not be generalised to all schools in the state.

Most respondents (71%) felt that they had adequate support for STEM in their school (**FIGURE 9**).

35% of respondents felt that they could access high quality resources to use for STEM learning with students. While the respondent sample was small, it does indicate that schools may benefit from high quality STEM teaching resources.

Just over half (53%) of respondents agreed that there were opportunities for professional development to improve STEM teacher capacity in their school and 41% worked with peers around STEM practice (**FIGURE 9**). Identified challenges included the timing of professional learning, and the cost of relief teachers during school hours. The Tasmanian Department of Education had taken professional development to schools (reducing the need for travel) holding sessions after teaching hours to increase teacher access.

FIGURE 9 STEM RESOURCES AND SUPPORTS IN SCHOOLS

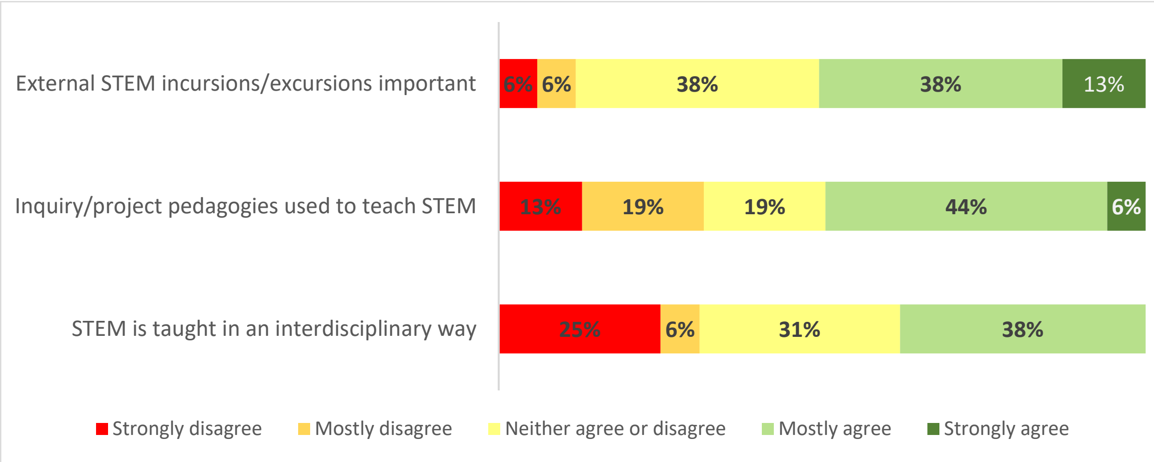


Notes: N=17 Source: Baseline Schools STEM Engagement Survey 2020

Sixteen schools responded to questions regarding STEM learning practices in schools. Approximately half of respondents felt that external STEM incursions or excursions were important for students (51%). Thirty-eight percent were teaching STEM in an interdisciplinary (or cross-curricular) way and half were using inquiry-based or project-based pedagogies to teach STEM (**FIGURE 10**). These innovative teaching techniques can enhance STEM engagement and understanding, promote innovative thinking, and build 21st century skills that better prepare students for the future world of work[23,24,25].

About half of respondents (56%) felt STEM subjects were in demand by students at their school. Based on teacher perceptions, this could be an indicator of student interest in STEM or the quality of STEM teaching or other STEM opportunities in schools.

FIGURE 10 STEM LEARNING PRACTICES IN SCHOOLS



Notes: N=16 Source: Baseline Schools STEM Engagement Survey 2020

[23] Regional Australia Institute & National Broadband Network (2016). The future of work: setting kids up for success. Canberra, Regional Australia Institute.

[24] Foundation for Young Australians (2017). The New Basics: Big data reveals the skills young people need for the New Work Order. (pp.7)

[25] Office of the Chief Scientist (2015). Transforming STEM teaching in Australian primary schools: everybody's business. Canberra, Department of Industry, Innovation and Science.

Diversity and density of STEM-rich experiences

Ideally, there are "multiple access points that reflect the range of perspectives, backgrounds, and strengths of the diverse people who inhabit the learning ecosystem."[26]

KEY BASELINE MEASURES

- Range of school STEM incursion, excursions, and extra-curricular activities
- Range of community-based STEM experiences
- Equitable reach of STEM experiences
- Educator STEM professional opportunities

KEY FINDINGS

The diversity and density of STEM-rich experiences indicated an 'interactive' ecosystem.

Tasmania offered a wide and diverse range of school and community-based STEM experiences for young people and the community.

STRENGTHS

In and out of school experiences were offered across all age cohorts in a range of settings.

Data from providers and schools identified 29 diverse informal providers delivering school incursions and excursions.

Thirteen surveyed informal STEM providers delivered 42 distinct community-based STEM activities in 2019 reaching over 100,000 people.

Based on our small sample (N=13), more than half of schools received a STEM incursion (63%), or excursion (54%), in a typical year. A sizeable 73% of surveyed schools reported offering extracurricular STEM activities. Note, these findings in no way represent all Tasmanian schools.

IDENTIFIED GAPS OR CHALLENGES

Early childhood seemed to be less catered for across identified informal STEM programs and activities.

Building educator STEM capability was an identified priority in Tasmania. However, based on our sample (N=13), 38% of schools received professional learning for teachers in 2019.

Equitable reach of STEM opportunities to regional and remote communities was a well-recognised problem.

Digital or virtual offerings were uncommon.

[26] Bevan, B., Garibay, C. and Menezes, S. 2018 *What is a STEM learning ecosystem?* Available from: https://www.informalscience.org/sites/default/files/BP-7-STEM-Learning-Ecosystem.pdf

Density and diversity of STEM-rich experiences

Range of school STEM incursions, excursions[27] and extra-curricular activities

Twenty-nine informal STEM providers delivered school-based activities in 2019 (

FIGURE 11). All school stages were catered for with secondary schools most frequently targeted by activities (20 providers offering 44 distinct activities). Eighteen providers offered 37 activities to primary schools and 11 providers offered 18 activities for foundation/prep students.

Activities ranged from an annual event, for example the Festival of Bright Ideas to activities offered multiple times, for example, museum excursions. The number of participants per activity ranged from less than 10 to several thousand.

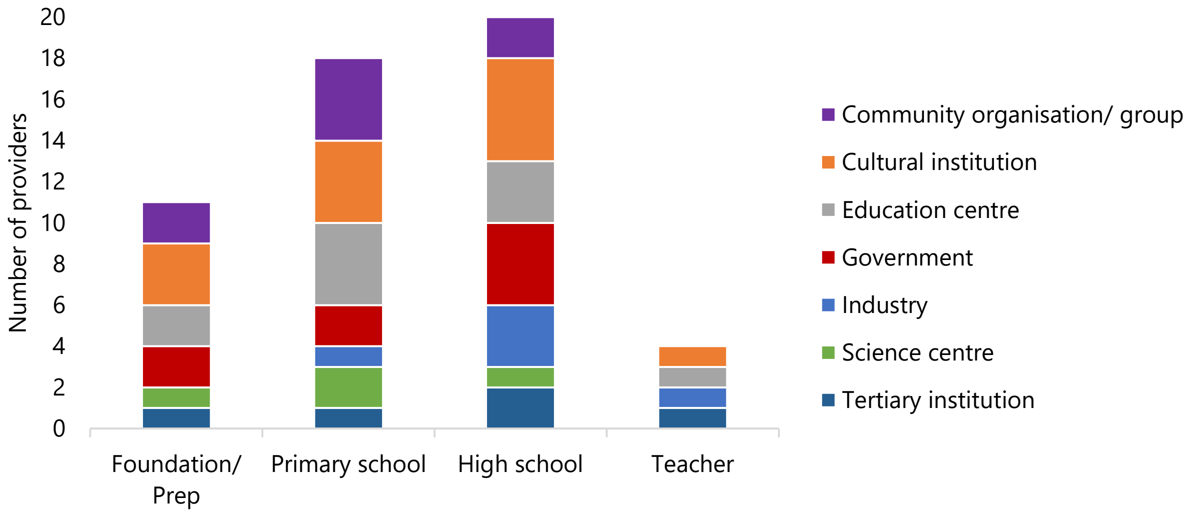
Young Tassie Scientists is a program in Tasmania that is funded by National Science Week grants. UTAS students are funded to go to local schools and present for 30 minutes about their work. They offer this to all school levels, K to 12. In 2019 they estimated reaching 12,000 participants.

Most incursions in primary school were for students in Years 5 and 6, and in high school, for junior years (Years 7 to 8) (School survey). Excursions occurred across all year groups; more frequently for Years 3 to 6 in primary school and Years 9 to 10 in high school.

A sizable 73% (N=16) of schools reported offering extra-curricular activities. 63% (N=16) had a STEM incursion and 54% (N=13) a STEM excursion in a typical year, noting the sample size was in no way representative. About half of respondents felt that external STEM incursions or excursions were important for students (51%).

[27] An incursion can be defined as an outside organisation visiting a school to deliver education during school hours (including virtual delivery) and an excursion can include students visiting a workplace, museum, university, or specialised educational centre. Source: Department of Education, Skills and Employment 2021 *Different kinds of STEM education initiatives*. Available from: https://www.dese.gov.au/australian-curriculum/national-stem-education-resources-toolkit/i-want-know-about-stem-education/different-kinds-stem-education-initiatives/ (accessed 16/09/2021)

FIGURE 11 INFORMAL STEM ACTIVITIES IN SCHOOLS IN 2019 BY TARGET GROUPS AND PROVIDER TYPE



Notes: N=29 providers Source: Baseline Schools STEM Engagement Survey 2020; Baseline Informal STEM Providers Engagement Survey 2020

Range of community-based STEM experiences targeting all ages

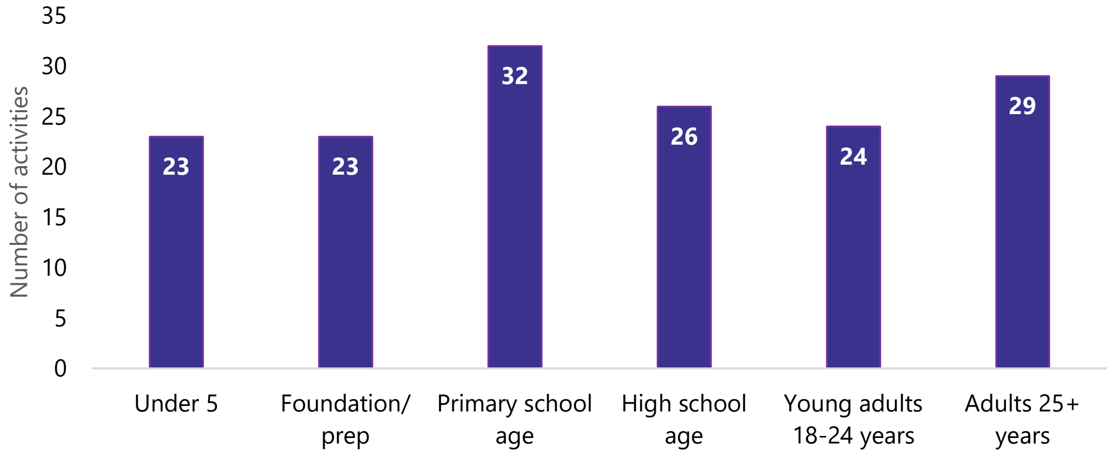
Thirteen informal STEM providers delivered a total of 42 distinct activities in 2019. Most activities were in Hobart or Launceston. All age groups were catered for (**FIGURE 12**).

In 2019, community STEM activities were attended by over 111,000 people. Activities included clubs, after school programs, competitions, field days, presentations, events, and festivals.

Four STEM-based festivals held in 2019 (Festival of Bright Ideas, Beaker Street, Science in the Park and Tasmanian Craft Fair) reached 33,500 people, and museum and gallery events reached an estimated 67,000 people.

The annual Beaker Street two-night festival held at Tasmanian Museum and Art Gallery each year for adults 18 years and over. It offers a combination of guest speakers and workshops to do 'hands on science' and has scientists placed around the museum talking to members of the public.

FIGURE 12 TARGET AGE GROUPS OF COMMUNITY STEM PROGRAMS IN 2019



Notes: N=13 providers, 42 activities. Activities may target more than one age group. Source: Baseline Informal STEM Providers Engagement Survey 2020.

Equitable reach of experiences

The inequitable reach of STEM opportunities to regional and remote communities was a well-recognised issue and efforts were underway to improve reach. Problems included the lack of STEM learning infrastructure in regional areas and lack of funded transport to attend learning opportunities.

Unreliable internet was a problem in some areas. One informal STEM provider routinely offered virtual STEM experiences and three other providers delivered one activity each. Few schools reported receiving virtual STEM experiences.

The location of activities was not collected. Most providers were in the major urban centres of Hobart and, to a lesser extent, Launceston. Interviews indicated that providers aimed to reach non-metro schools, but coverage was difficult to achieve.

Educator STEM professional learning opportunities

The reach of formal STEM professional learning offered to teachers was difficult to assess on the available evidence. Five out of 13 schools (38%) indicated that their teachers had attended formal STEM professional learning in 2019.

Two surveyed informal STEM providers indicated that they delivered professional learning activities to 210 teachers over 8 occasions in 2019.

STEM professional learning providers identified through the study included: UTAS, Department of Education, Catholic Education Tasmania, Science Teachers Association (national and state), the Professional Learning Institute, CSIRO and Questacon

Relationships

CROSS-SECTOR CONNECTIONS ARE FOSTERED TO REALISE A COLLECTIVE GOAL FOR STEM

Connections and collaboration across providers enable sharing of knowledge, practice, capacity and resources to enhance STEM learning provision and outcomes. Connected providers can also more effectively provide the stepping stones for young people navigating the STEM learning ecosystem through traditional schooling, out of school learning, and future study/careers[28]

KEY BASELINE MEASURES

- Type and strength of connections between STEM providers
- Informal provider and school attitudes on collaboration
- Cross-sector connections
- Formal networks

KEY FINDINGS

STEM provider relationships indicated an 'interactive' ecosystem.

Strong levels of collaboration and joint activity among lead STEM organisations around important programs and events.

Other providers had low awareness and limited connections. Most providers wanted to increase their level of collaboration and communication.

STRENGTHS

Key institutions had a central role in coordinating efforts and sharing information.

The formal STEM networks for informal providers were supported by active leadership and a resourced coordination function.

The schools STEM network was well-attended by schools and education institutions at all levels.

IDENTIFIED GAPS OR CHALLENGES

There were notable differences between well-connected and less-connected providers in the ecosystem. Smaller organisations had low awareness of the work of other providers.

Surveyed providers had less awareness of education centres, industry and science centre providers.

Schools did not find it easy to work together, particularly between different types of schools that is, primary and secondary.

[28] Morrison, J. and Fisher, W. P. (2018) Connecting learning opportunities in STEM education: Ecosystem collaborations across schools, museums, libraries, employers and communities. Journal of Physics: Conference Series, 1065. Available from: https://iopscience.iop.org/article/10.1088/1742-6596/1065/2/022009

Relationships

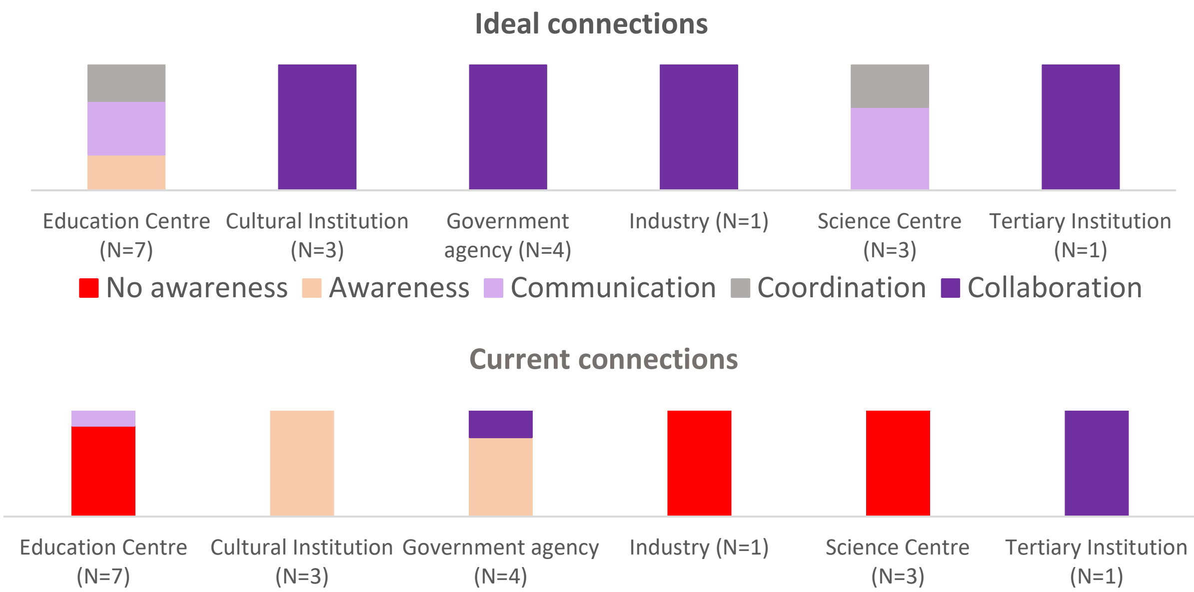
Type and strength of connections between STEM providers

Informal provider survey respondents rated their current and ideal level of connection with 19 informal provider organisations that had been identified and listed in the survey. Responses were made against a scale of: '*No awareness*', '*Awareness*', '*Communication*', '*Coordination*' and '*Collaboration*'.

FIGURE 13 presents the most common type of connection (the mode) reported by informal providers (N=15). Listed providers are de-identified and shown by type. Most respondents reported an 'awareness' of cultural institutions and government STEM providers and less awareness of education centres, industry and science centre providers. Substantial collaboration was reported with the university and one government agency. Interviewees confirmed that it was difficult for smaller informal STEM providers to engage with other providers.

Most respondents reported an appetite to improve their connectedness with other providers through communication, coordination or collaboration.

FIGURE 13 CURRENT VS IDEAL LEVELS OF CONNECTIONS BETWEEN INFORMAL STEM PROVIDERS (N=12)



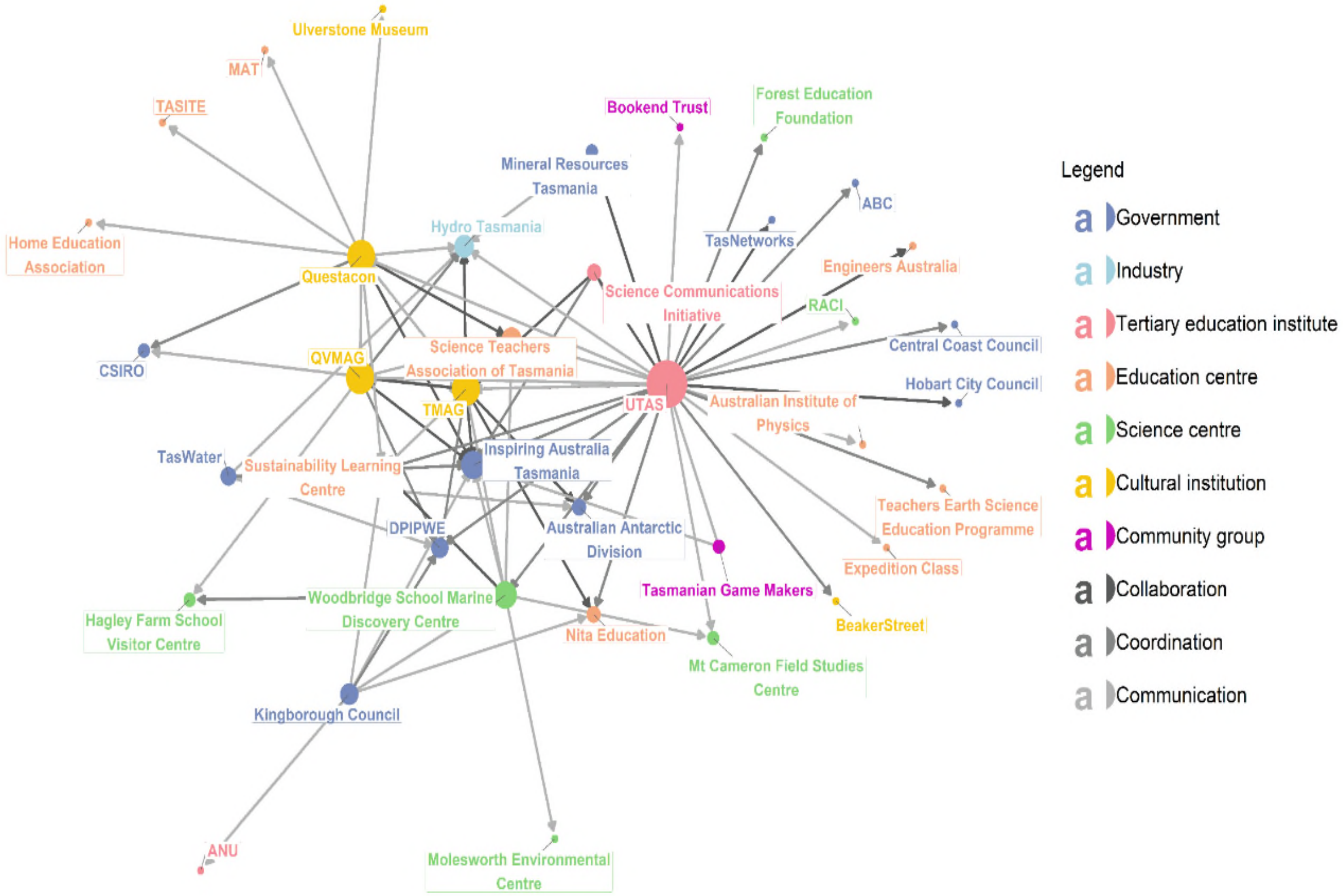
NOTES: Informal providers (N=15) rated their current and ideal levels of connectedness with other providers against a list of 19 informal provider organisations using a scale of: 'No awareness', 'Awareness', 'Communication', 'Coordination' and 'Collaboration'. The most common type of connection (the mode) is shown with providers de-identified and shown by type. Source: Baseline Informal STEM Providers Engagement Survey 2020.

Cross-sector networks

Organisations that were already connected through communication, coordination or collaboration, are presented in a Network Map (**FIGURE 14**). The Network Map shows a small number of organisations, cultural and tertiary institutions and education centres were central nodes, with multiple spokes connecting other providers. Interviews confirmed the central role of these providers in collaboration, coordination and information sharing.

Apart from these well-connected nodes, most providers reported a single connection with other providers. This shows notable differences between well-connected and less-connected providers in the ecosystem.

FIGURE 14 MAP OF TASMANIAN STEM LEARNING ECOSYSTEM CONNECTEDNESS LEVELS



Source: Baseline Informal STEM Providers Engagement Survey 2020.

NOTES ON NETWORK MAPS

The map of the Tasmanian learning ecosystem shows whether providers work together at all (a line drawn between providers) and the nature of that connection. The direction of the arrow has a meaning. It indicates that the provider (from where the arrow originates) has nominated the other provider as an organisation it works with. The darker the connecting line the stronger the working relationship (see the definitions below). The black line denotes that the providers collaborate; the medium grey line that activities have been coordinated and the light grey line that the two organisations share information. The larger the dot, the more connections a provider has with other STEM providers.

Key to provider name abbreviations

- ANU = Australian National University
- DPIPWE = Department of Primary Industries, Parks, Water and Environment
- MAT = Mathematical Association of Tasmania
- QVMAG = Queen Victoria Museum and Art Gallery
- RACI = Royal Australian Chemical Institute
- TASITE = Tasmanian Society for Information Technology in Education
- TMAG = Tasmanian Museum and Art Gallery
- UTAS = University of Tasmania

Definitions of provider types

Providers chose the relevant classification

- Government = government agency includes local councils
- Industry = economic or commercial activity. The survey listed 9 industry types e.g. mining and power generation.
- Tertiary education institution = university, TAFE or private Vocational Education and Training Provider.
- Education centre = site that offers education activities (does not include schools).
- Science centre = site that offers education activities, with a science focus.
- Cultural institution = a museum or library or other site for the exhibition or promotion of culture.
- Community group = includes not for profit, volunteer groups, sporting groups, catchment groups, specialist interest groups and Aboriginal Land Councils.

Definitions of types of connectedness

Providers chose the relevant type of connectedness

- Collaboration = where the provider jointly plans and delivers key aspects of their work with the other organisation.
- Coordination = where the provider works together by modifying planning and other delivery to take into account methods, materials and timing of the work of the other organisation.
- Communication = where the provider actively shares information with the other organisation.

Formal networks

Informal providers and schools were participating in a small number of STEM networks, many with a specific purpose for example, National Science Week. Twelve respondents belonged to a local STEM network or hub and 9 respondents belonged to a state or national network or hub.

The local STEM networks, supported by government funding or grants, had active leadership and coordinators to support their functions.

An active STEM network for STEM teachers and coordinators involved primary, secondary, senior secondary, university and industry representatives. The network was well-attended, and offered STEM teaching practice advice and resources (see Appendix 1 for more information on STEM networks).

Informal provider and school attitudes on collaboration

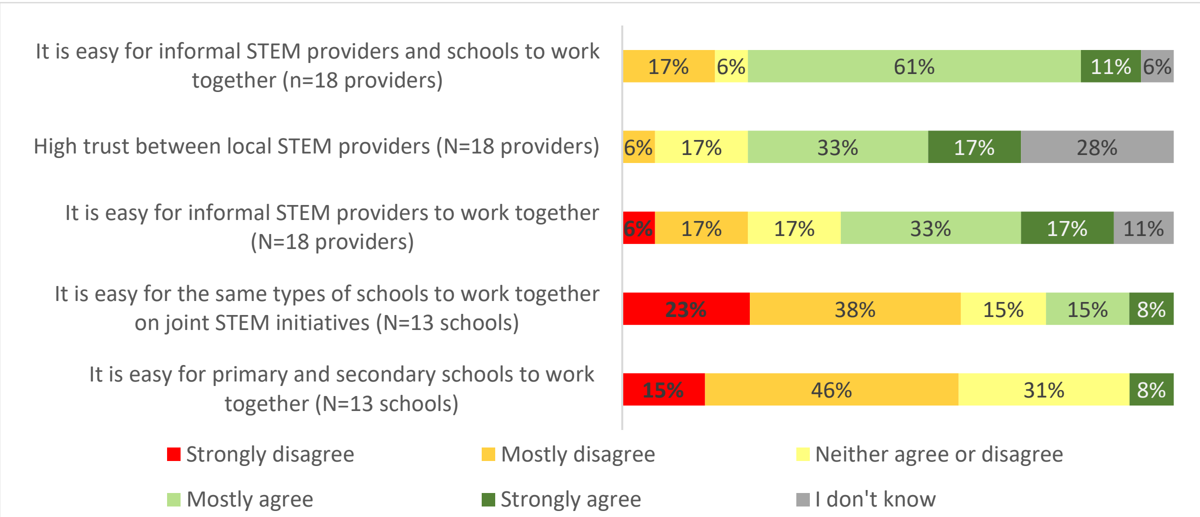
Of the 18 informal providers responding, 50% reported that there was a '*high degree of trust between local STEM providers*' (**FIGURE 15**).

Half of the respondents (50%) said that '*it is easy for informal STEM providers to work together*'. Thirty-three percent (N=18) of providers believed '*local networks can demonstrate outcomes of collective work';* suggesting an individual rather than collective mindset. Interviews suggested that most providers were acting in well-defined boundaries and had limited scope (resources) for expanding what they do.

More informal STEM providers (72%, N=18) reported that '*it is easy for informal STEM providers and schools to work together*'.

The majority of school respondents reported that it was not easy for schools to work together on joint STEM initiatives, particularly primary and secondary schools working together (**FIGURE 15**). Interviewees concurred that collaboration across school types and year levels was not easy to achieve, particularly in regional areas. One interviewee commented that it was only when her teaching role was expanded from dedicated classroom teacher to a coordinator role that she had capacity to undertake additional STEM activities.

FIGURE 15 STEM PROVIDER AND SCHOOL PERSPECTIVES ON WORKING TOGETHER



Source: Baseline Schools STEM Engagement Survey 2020 and Informal STEM Providers Engagement Survey 2020.

Learning Pathways

DESIGNED PATHWAYS ENABLE YOUNG PEOPLE TO BECOME ENGAGED, KNOWLEDGEABLE AND SKILLED IN STEM AS THEY PROGRESS THROUGH CHILDHOOD INTO ADOLESCENCE AND EARLY ADULTHOOD

A focus on learning pathways reflects a shared responsibility to broker the knowledge, tools, support and connections that a young person needs to navigate the STEM learning ecosystem and potentially progress into a STEM career [29]

KEY BASELINE MEASURES

- STEM pathways programs/ initiatives
- Connections between school, out-of-school and post-school STEM

KEY FINDINGS

STEM learning pathways indicated an 'interactive' ecosystem.

STEM pathways programs and initiatives existed through schools, university, government, and informal STEM providers.

Unclear level of connection between school, out-of-school and post-school STEM programs.

STRENGTHS

The Study identified several initiatives to strengthen STEM pathways offered through schools, post-school institutions, and informal learning settings.

Policy and investment plans (see *Shared Vision*) should create higher demands for a STEM-trained and capable workforce, and increase STEM pathways.

Tertiary institutions had a significant role in offering diverse STEM formal educational pathways and informal initiatives for young people.

IDENTIFIED GAPS OR CHALLENGES

This study did not gather sufficient information to identify the challenges in navigating STEM pathways.

Pathways between school and informal learning experiences presented challenges for schools and providers.

[29] Tan, E., Calabrese Barton, A., Kang, H. and O'Neill, T. 2013 "Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science", *Journal of Research in Science Teaching*, 50 (10): 1143-1179

Learning Pathways

STEM pathways programs/ initiatives

A list of known STEM pathway programs offered in Australian secondary schools was listed in the survey. Most surveyed secondary schools (5 of 7 schools) offered at least one STEM pathway program. The most common programs were the '*Trade Centres Program*' and mentoring programs for STEM students (**TABLE 4**).

Other school-focused initiatives identified in the Study included:

- Career expos (especially for schools in Hobart) to highlight student career opportunities in local sectors and institutions
- Packages of learning, for example Advanced Manufacturing was piloted at schools located near relevant industries
- Informal STEM pathway programs, for example Curious Minds, a 6month hands-on mentoring program to help ignite girls' passion in STEM.

Around half of surveyed schools identified STEM career pathways as a current focus area for their school (noting many were primary schools) and the majority felt it should be a greater focus.

TABLE 4 STEM PATHWAY PROGRAMS IN SECONDARY SCHOOLS

STEM pathway opportunities	Offered	Not	Unsure	Total
Mentoring programs for STEM students	3	3	1	7
Trade Training Centres Program[30]	3	3	1	7
Vocational education and training programs	2	3	2	7
School apprenticeships or traineeships in STEM industries	2	4	1	7
Pathways in Technology (P-TECH) Program[31]	0	4	3	7
CareerTrackers Indigenous Internship Program[32]	0	4	3	7

Source: Baseline Schools STEM Engagement Survey 2020.

UTAS is the main source of tertiary STEM education and STEM outreach in Tasmania. UTAS reported strong relationships with maritime research (Australian Maritime College in Launceston); Antarctic research (with the Australian Antarctic Division and International Antarctic Policy Organisation); renewable energy, and space (with the Australian Space Agency).

[30] Trade Training Programs in Schools is a national program to help students successfully move to further education, training or work.
[31] Australian Government pilot study at 13 sites where an innovative model of education-industry collaboration provides students studying for their Senior Secondary Certificate with an industry supported pathway to a STEM related diploma, advanced diploma or associate degree
[32] CareerTrackers is a national program that creates paid internship opportunities for Indigenous students.

Other important UTAS STEM pathways initiatives included:

- STEM Outreach, which included a position jointly funded by UTAS and Inspiring Australia
- Partnerships with government and industry to run STEM programs and events for students (e.g., Science and Engineering Challenge, Open Days, Young Tassie Scientists, and the Festival of Bright Ideas)
- Partnerships with industry (over 12 companies), and government (Inspiring Australia) to offer scholarships for women and students in engineering
- The Peter Underwood Centre, which works with young people in lower socio-economic areas to provide access to technology
- Partnerships with: Engineers Australia; Tasmanian Minerals, Manufacturing and Energy Council; and the State government, to promote Advantage Tasmania.

University College is an alternative pathway to university. It is designed as a bridge between pre-vocational subjects and university, where students do not need an Australian Tertiary Admissions Rank (ATAR). TAFE and apprenticeships offer other STEM education pathways.

> *"We will promote Tasmania as a STEM State. We will help transform our State by growing STEM literacy and the community's understanding of its vital importance. We will collaborate with industry, business and government to translate that knowledge into practical and productive outcomes, and we will engage with industry to ensure that our graduates are well equipped for the higher-value jobs of the future, in key fields such as engineering, the sciences, and data and technology."*
>
> *(UTAS Strategic Plan 2019-2024)*

Connections between school, out-of-school and post-school STEM programs

This study couldn't find out whether formal STEM pathways were well-connected or visible across Tasmania.

However, informal providers raised issues with pathways between schools and informal STEM opportunities. Key issues included:

- Difficulties setting up connections with local schools
- Lack of information on schools' STEM needs and interests.

Providers wanted better and more frequent engagement with schools about STEM learning needs and opportunities.

Conclusion

This study aimed to conduct a rapid assessment of the STEM learning ecosystem in Tasmania and trialled a framework for measuring a STEM learning ecosystem.

The study focused on the collective role of organisations in equipping young people for the future, informal STEM providers and their interaction with formal education. We identified 5 outcome dimensions and associated measures for optimising STEM learning in a robust STEM learning ecosystem. We then developed a rubric to assess the robustness and resilience of the learning ecosystem using a scale of *Individual; Interactive; Interconnected*.

What we found

Overall, the study findings indicated an 'interactive' STEM learning ecosystem in Tasmania across all 5 dimensions of *shared vision*, *capacity and resources, diversity and density of STEM-rich experiences*, *relationships* and *learning pathways*.

The Tasmanian Government and other institutions' STEM policy, strategy and investment plans offered a positive outlook for creating a shared vision for STEM. Both informal providers and schools had mixed views about the presence of a shared vision but identified common areas of strategic focus:

- growing STEM engagement in the community,
- building the STEM capacity of educators and schools, and
- empowering and diversifying STEM learners.

The Study found a high density and diversity of providers and STEM experiences available for schools and communities. Also, a range of initiatives to strengthen STEM pathways However, providers perceived that formal and informal STEM learning could be better connected through greater promotion of opportunities in schools. Equitable reach of STEM opportunities couldn't be found in this Study. Access for regional and remote communities was a well-recognised issue and efforts were underway to improve coverage of STEM opportunities.

While the sample of schools was small, survey data indicated opportunities to strengthen school and educator STEM capabilities, practices and resources.

Lead STEM organisations reported strong levels of coordination and collaboration. There was appetite for greater coordination and collaboration across other informal providers and schools to realise a shared vision and improve connectivity across the learning ecosystem.

What next

This snapshot of the STEM learning ecosystem in Tasmania represented a typical year pre-pandemic, and provided a benchmark for understanding, and tracking changes in, the STEM learning environment. While the Study had limitations, participating informal providers, schools and other stakeholders gave valuable data and insights.

There were several emerging opportunities from this Study.

❖ Engaging with regional stakeholders in the spirit of sharing and collaboration

- Confirming indicative findings and exploring the value and potential use of the baseline for national and regional stakeholders
- Exploring whether stakeholders consider a STEM learning ecosystem approach useful

  - Discussing the main opportunities and challenges to strengthen the STEM learning ecosystem
  - Facilitating connections and learning between regions
- Shaping Questacon’s practice and focus
  - Defining outcomes and activities for the next 6 or 12 months
  - Considering how our own practice is contributing to the 5 learning ecosystem dimensions
  - Placing a greater emphasis on understanding specific local needs and interests
  - Working with regional authorities and partners
  - Investing in tailored opportunities with multiple touchpoints to deepen engagement and outcomes
  - Sharing practice with other STEM providers
- Progressing thinking about learning ecosystem concepts and principles to strengthen practice and outcomes
  - Testing if applying place-based, collaborative practice and a focus on the ecosystem leads to greater impact
  - Promoting the need for further research into STEM learning ecosystem theory and application

APPENDIX 1 STEM PROVIDERS AND NETWORKS IN TASMANIA

Organisation	Classification
Bookend Trust	Community organisation/ group
Devil Robotics	Community organisation/ group
First Robotics	Community organisation/ group
Metal Minds Robotics Incorporated	Community organisation/ group
Robot Man	Community organisation/ group
Tasmanian Game Makers	Community organisation/ group
Science Communications Initiative	Community organisation/ group
Beaker Street	Cultural institution
Bonorong Wildlife Sanctuary	Cultural institution
Eric Thomas Galley Museum	Cultural institution
LINC	Cultural institution
Queen Victoria Museum and Art Gallery	Cultural institution
Questacon	Cultural institution
Scottsdale Library	Cultural institution
Tasmanian Museum and Art Gallery	Cultural institution
Ulverstone Museum	Cultural institution
Festival of Bright Ideas	Cultural institution
Australian Institute of Physics	Education centre
Children's University Tasmania	Education centre
Coder College Pty Ltd	Education centre
Elizabeth College	Education centre
Engineers Australia	Education centre
Expedition Class	Education centre
Home Education Association	Education centre
Launceston College	Education centre
Mathematical Association of Tasmania	Education centre

Australian Maths Trust	Education centre
NITA Education	Education centre
Science Teachers Association of Tasmania	Education centre
St James Catholic College	Education centre
St Patrick's College Launceston	Education centre
Sustainability Learning Centre	Education centre
Tasmanian Society for Information Technology in Education	Education centre
Teachers Earth Science Education Programme	Education centre
Department of Education Tasmania Learning Events	Education centre
ABC	Government
ANSTO virtual classroom	Government
Australian Antarctic Division	Government
Central Coast Council	Government
CSIRO Education	Government
Department of Primary Industry	Government
Hobart City Council	Government
Inspiring Australia Tasmania	Government
Kingborough Council	Government
Mineral Resources Tasmania	Government
TasNetworks	Government
Forensic Science Service Tasmania	Government
Hydro Tasmania	Industry
Marinova Pty Ltd	Industry
TasICT	Industry
TasWater	Industry
Fiomarine Industries	Industry
Forest Education Foundation	Science centre
Hagley Farm School Visitor Centre	Science centre
Molesworth Environmental Centre	Science centre

Mt Cameron Field Studies Centre	Science centre
Royal Australian Chemical Institute	Science centre
Woodbridge Marine Discovery Centre	Science centre
Australian National University	Tertiary education institution
University of Newcastle	Tertiary education institution
University of Tasmania	Tertiary education institution

Note: Names of STEM providers come from (a) the names of organisations who responded to the Informal STEM Provider Survey (b) STEM providers listed as options in the Informal STEM Provider Survey, and (c) STEM providers nominated by respondents in the Informal STEM Provider Survey and the School Survey, 2020.

STEM networks and hubs

Inspiring Australia

Inspiring Australia, a national initiative, works with UTAS and the state government to coordinate major STEM events in the annual calendar for Tasmania including National Science Week, and the Festival of Bright Ideas. Each of these could be seen as their own network, involving and bringing together many groups, organisations and individuals.

Teacher Associations

Teacher Associations provide important networks for sharing information and professional learning and support. The most frequently mentioned by respondents were the Science Teachers Association of Tasmania, Australian Science Teachers Association and the Catholic Teachers STEM Network. The Catholic Education Officer was also part of an informal email group of STEM educators around the country, who share what STEM activities are occurring in their jurisdiction and what approaches are being used.

Science in the Pub

Science in the Pub is a national network that is active in Tasmania. In Hobart they have monthly science presentations from different scientists/ specialists from around Australia.

Education centres and Science centres

Education centres and science centres, such as the Sustainability Learning Centre (SLC) and the Woodbridge Marine Discovery Centre, are informal STEM providers providing a physical location for STEM activities for different groups, including students and the public.

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