# Best Practice Principles for Community Science Engagement Programs

August 2025

# Appendices

Queensland Government

# Appendix A

## Resources for Overall Program Design

This study has identified six core, foundational principles that are fundamental to the success of community science engagement initiatives. Throughout this process, the authors have also identified additional high-level, generic, resources that may be valuable in designing community engagement programs including:

- STEMworks Design Principles – A framework outlining essential elements for designing high-quality STEM education programs.
- Planning for Engagement (Wellcome Trust) – A guide to planning effective science engagement strategies.
- Public Engagement Conversations Guide (NISE Net) – A practical tool for facilitating meaningful science discussions with the public.
- Community Design Principles – A resource focusing on principles that support inclusive, effective community engagement.
- Community Engagement Toolbox – an online toolbox to assess your engagement needs, plan for effective strategies and processes, as well as implement and monitor your engagement efforts.
- Community Engagement 101: Ultimate Beginners guide – offering insights, tools, and actionable plans at every stage of the community engagement lifecycle
- Creating a community engagement strategy: a practical guide – identifying six pillars of effective community engagement strategy (including a ‘deep dive’ on each pillar)

# Appendix B

# Evaluation Frameworks and Evaluation Tools

## Examples of Broadly Applicable Evaluation Frameworks

Online searches of frameworks for evaluating STEM engagement programs provides an extensive list of methodologies, tools, and best practices used to assess program effectiveness. Below is a curated selection of six widely applicable evaluation frameworks and resources—four from Australian contexts and two from international sources.

**1. I want to evaluate a STEM initiative (Australian Government, Department of Education):** A comprehensive guide for evaluating STEM initiatives, offering a step-by-step process to help users decide the purpose of their evaluation, engage the right stakeholders, build evaluation frameworks, address common challenges, gather evidence, draw conclusions, and share results. It also provides a host of customisable templates to simplify design and implementation tasks. https://www.education.gov.au/australian-curriculum/national-stem-education-resources-toolkit/i-want-evaluate-stem-initiative

**2. CSIRO Capability Enhancer:** This co-design initiative supports evidence-based STEM programs by providing training in data collection, evaluation methods, and evidence-informed decision-making. Participants will receive guidance in designing evaluations, developing key questions, and co-creating program logics, indicators, and frameworks to measure impact. The initiative also covers ethical considerations, types of evidence needed for effective program implementation, and tools for data management and learning. https://www.csiro.au/en/education/About-CSIRO-Education/Our-impact/STEM-INSIGHTS/STEM-INSIGHTS-Capability-Enhancer-project

**3. Evaluating STEM Equity Programs – guide to effective program evaluation:** With a focus on underrepresented groups, this resource provides comprehensive guidance for designing, implementing, and assessing science engagement initiatives, emphasising the importance of *evaluation* in understanding program effectiveness. The guide offers a structured approach to measure outcomes and impacts and includes practical tools, such as planning templates, data management plans, and consent form templates to support stakeholders in conducting thorough and ethical evaluations. https://www.unsw.edu.au/content/dam/pdfs/science/general/research-reports/2024-05-women-in-stem/2024-05-National-Evaluation-Guide-Oct-2022.pdf

**4. Best practice guide: Evaluating school-industry STEM partnership:** Although this resource focusses on school partnerships, it nevertheless provides a simple and clear step-by-step approach to designing evaluation approaches that can be readily adapted to broader community outreach programs. It provides key advice across design, implementation, outputs, and outcomes, using real world examples and providing customisable evaluation criteria and templates – assisting stakeholders to assess the effectiveness and impact of their programs. https://www.education.gov.au/download/4713/best-practice-guide-evaluate-school-industry-stem-partnerships/7064/document/pdf

**5. The Queensland Government Program Evaluation Guidelines:** These resources outline a broad set of principles to assist organisation to plan, commission, manage and conduct consistent, transparent and high-quality evaluation. The guidelines are accompanied by separate information sheets that describe specific evaluation topics in more detail, including: Developing a program logic model; Writing an evaluation framework; Performance measurement frameworks; Integrating evidence and evaluation; Economic evaluation; Ethics and Evaluation

**6. User-Friendly Handbook for Mixed Method Evaluations (Frechtling, 1997)**: An excellent introductory resource for designing and carrying out qualitative and quantitative (mixed-methods) evaluations of community engagement programs. Throughout, it provides an example of a hypothetical program (readily adaptable to Australian community engagement programs) that addresses development both broad ideas (such as program goals, evaluation plans etc) and specific issues (such as developing evaluation questions and selecting methods for gathering data). In addition, there are many examples of sample templates/tables/matrices broadly applicable to a wide range of program designs and scenarios. https://www.nsf.gov/pubs/1997/nsf97153/start.htm

**7. Evaluating learning outcomes from citizen science (Phillips et al., 2014):** Although focussing on the context of citizen science, this resource is readily applicable to designing and evaluating community engagement programs in general. In particular, the Appendices provide an impressively comprehensive suite of adaptable templates, worksheets, and guides—including logic model worksheets, consent form templates, design approach templates, and data collection strategies. https://www.birds.cornell.edu/citizenscience/wp-content/uploads/2018/10/USERS-GUIDE_linked.pdf

## Examples of Specific Evaluation Tools and Instruments

The peer-reviewed literature is replete with individual assessment tools such as surveys, questionnaires, quizzes, and templates for both quantitative and qualitive approaches to evaluating community science engagement programs. Many of these examples are included in the Noyce Foundation's ATIS resource (PEAR, 2008):

***Assessment Tools in Informal STEM (ATIS) – Ratings and Reviews***: The ATIS resource is online database with over 90 structured evaluation frameworks and validated assessment tools designed to support the assessment and evaluation of informal STEM learning and engagement programs. It including metrics related to participant engagement, learning outcomes, and program impact, facilitating evidence-based decision-making and continuous improvement in informal STEM education initiatives. See http://www.pearweb.org/atis/dashboard.

The ATIS tool was initiated following recommendations from an extensive review (Hussar et al., 2008) of assessment tools used in informal, community-based, STEM education programs. Since 2008 the database been continuously updated with new tools to allow program coordinators to select the appropriate instrument(s) for their programs according to a variety of criteria including domain, audience and overall purpose of evaluation. Examples of specific assessment tools from the ATIS database (and beyond) for various audiences are presented here:

**1) Primary/Middle School Students**

***The STEM Career Interest Survey (STEM-CIS):*** The STEM Career Interest Survey (STEM-CIS) is a validated tool designed to measure students' interest in STEM careers. It is commonly used in education and research to evaluate the effectiveness of STEM engagement programs and identify factors influencing students' career aspirations.

See Meridith et al (Meredith et al., 2013) for the 44 item survey across four scales (i.e., demography, science technology, mathematics) and Donmez et al (Dönmez & Idin, 2020) for practical implementation.

***Children's Attitudes Toward Technology (CATS) (Frantom et al., 2002):*** assesses young students' perceptions, interests, and feelings about technology and its role in their lives. It helps educators and researchers understand how children view technology, influencing curriculum development and fostering positive engagement with STEM fields. See (Frantom et al., 2002) and http://www.pearweb.org/atis/tools/children-s-attitudes-toward-technology-scale-cats

***Science Process Skills Inventory (SPSI):*** Assesses students' proficiency in fundamental and integrated science process skills, such as observation, classification, experimentation, and data interpretation. It helps educators evaluate learners' abilities to apply scientific methods and reasoning in problem-solving and inquiry-based learning. See (Arnold et al., 2013) http://www.pearweb.org/atis/tools/18

***Student Attitudes Toward STEM Survey (S-STEM, Elementary Version):*** The S-STEM includes two surveys: one for upper primary students and another for middle/high school students. Measures young students' confidence, interest, and perceptions of STEM subjects and careers, and 21st Century learning skills. It is well validated and helps educators and researchers assess the impact of STEM programs on student attitudes and aspirations. See (Unfried et al., 2015) and http://www.pearweb.org/atis/tools/77

**2) Secondary School Students**

***Test of scientific literacy skills (TOSLS) (Gormally et al., 2012):*** Assesses students' ability to apply scientific reasoning, evaluate information, and understand research principles. It is used to measure scientific literacy in education and inform curriculum development. See (Gormally et al., 2012) and particularly Appendix B from this study for the 28 question survey.

***Science Motivation Questionnaire II (SMQ-II) (Glynn et al., 2011):*** Assesses five components: intrinsic motivation, self-efficacy, career motivation, self-determination, and grade motivation in science. It is widely used to evaluate how educational experiences influence students' engagement and interest in science. See (Glynn et al., 2011) and here to access the 25 item scale

***Test of science-related attitudes (TOSRA)(Fraser, 1981):*** Well established and widely validated TOSRA uses a 5-point Likert response scale (strongly agree, agree, uncertain, disagree, strongly disagree) which most respondents would likely be familiar with. TOSRA has 70 items across seven sub-scales, including: Social Implications of Science; Normality of Scientists; Attitude to Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science. Each sub-scale has been validated separately. See (Fraser, 1981) and http://www.pearweb.org/atis/tools/13

***My Attitudes Towards Science (MATS) (Hillman et al., 2016) :*** Assesses students' attitudes, beliefs, and interests toward science. Intended for primary and secondary school students, the MATS survey has 40 items across four scales: 1. Attitude towards the subject of science; 2. Desire to become a scientist; 3. Value of science to society; and 4. Perception of scientists. See Appendix 1 in (Hillman et al., 2016).

**3) Teachers**

***Teacher Efficacy and Attitudes Toward STEM Survey (T-STEM):*** Assesses educators' self-efficacy, attitudes, and beliefs regarding teaching STEM. It helps in identifying teachers' confidence in their ability to teach STEM content and their overall attitudes toward STEM education. Click on the following links to request the specific survey items for teachers teaching primary science, secondary science, secondary mathematics, secondary technology, and secondary engineering. A copy of the mathematics T-STEM survey can be found here.

***STEM Teaching Beliefs Instrument (STEBI):*** The Science Teaching Efficacy Belief Instrument (STEBI) is designed to measure science teachers' self-efficacy and outcome expectancy, assessing their beliefs about their ability to teach science and the potential impact of their teaching on student outcomes. It consists of two main scales: the Personal Science Teaching Efficacy Scale (PSTE) and the Science Teaching Outcome Expectancy Scale (STOE).

**An alternative to STEBI-A: validation of the T-STEM science scale (Unfried et al., 2022):** This paper provides a comparison of the STEBI and T-STEM teacher tools described above and includes all questions in each survey. See Table 1 in (Unfried et al., 2022).

**4) Parents**

***Australian Government STEM Influencer parent surveys 2020-2021 and 2022-2023:*** These surveys explore parents' perceptions and attitudes to STEM. Key metrics include: awareness and understanding of STEM; STEM life skills; interest in STEM; importance of STEM, STEM careers; confidence in STEM; gendered differences in STEM. The reports also include the questionnaires provided to parents which can be readily adapted to community science engagement programs targeting parents as influencers of youth choice. See 2020-2021 STEM Influencer Parent Survey and 2022-2023 STEM Influencer Parent Report Survey.

***Parent's perceptions and attitudes to STEM 2022-23***: Presents data on parents' perceptions and attitudes toward STEM education in primary and secondary schools with a focus on equity. See Parent STEM 2022-2023.

***HRDC STEM study Parent survey:*** Parental survey questions across various domains/scale including STEM skills, technology, perceptions of STEM and STEM careers. See HRDC Parent Survey

***STEM Perceptions: Student & Parent Study (Commissioned by Microsoft):*** Presents questions and results of a large-scale parental survey on perceptions of science. The goal of the survey was to gain insight about what can better prepare and inspire students to pursue post-compulsory study in STEM subjects. See Microsoft STEM Parent Survey Results.

***ParentSTEMSCALE:*** Developed as part of an Erasmus+ Strategic Partnership project this survey assesses parents' attitudes toward STEM. See PARENT STEMSCALE.

***Assessing Tools for Measuring the Impact of Programs Promoting STEM Vocations(Herce-Palomares et al., 2022):*** This paper presents the design and validation process of a set of instruments to evaluate the impact of an informal learning initiative to promote Science, Technology, Engineering, and Mathematics (STEM) vocations in students, their families (parents), and teachers. Survey questions for parents, teachers and students can be found in the supplementary section of this paper (click here).

**5) General Program Reviews STEM Engagement**

***National Informal STEM Education Network (NISE – USA):*** NISE provides a range of resources to help program coordinators assess and improve their STEM engagement programs, including: Feedback Survey (DOC); Observation Form (DOC); Participant Interview (DOC); Data Reflection Cheat Sheet (DOC); Team Based Inquiry Guide (PDF); Team-Based Inquiry Workshop (DOC)

# Appendix C

# Capabilities and Capacity

**Skills Matrix**

https://www.effy.ai/blog/%20skill-will-matrix includes templates and a guide on how to create a skills matrix.

https://www.aihr.com/blog/create-skills-matrix-competency-matrix/ detailed guide on what skills matrix are, how to create a skills matrix to improve performance of the team, including defining relevant skills, assessing team members, and ranking proficiency levels using different assessment tools.

https://www.someka.net/blog/how-to-create-skills-matrix/ The guide provides a lot of detail, examples, instructions, and advice to creating and applying a skills matrix.

**Resource Audits**

https://www.mindomo.com/templates/resource-audit-template brief how-to-guide includes a series of prompting questions to help implement resources audits.

https://analyst-zone.com/techniques/resource-audit detailed how-to-guide for resource auditing, including educational videos, and free templates.

# Appendix D

## Sustainability and Scalability

**Scaling Up:**

https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.622

https://ict4me.sri.com/about/downloads/KochPenuelsustainabilitywhitepaper.pdf

https://www.eduporium.com/blog/eduporium-weekly-creating-and-scaling-afterschool-stem-programs/

**Facilitating Sustainability:**

https://www.csiro.au/en/education/about-csiro-education/our-impact/durable-stem-education-programs

# Appendix E

# Strategic Alliances – Collaborations and Partnerships

**Literature-based Partnership Tools**

- A study by Knippenberg et al (Knippenberg et al., 2020) outline a practically implementable seven-step approach for developing interdisciplinary STEM outreach programs that leverage institutional resources and community partnerships. Interestingly (or perhaps not surprisingly) this seven-step approach aligns closely to several of the best practice principles described in this Chapter.
- A paper by Anderson et al (Anderson et al., 2019) includes a useful *Partnership Assessment Tool* in Appendix 2; and Table 3 of the same paper outlines the *Features of an Equitable Partnership*.
- Hardy et al (Hardy et al., 2003) also present a *Strategic Partnership Assessment Tool* with full details on how to implement and evaluate the results from the 42 question survey.

**Australian STEM Partnership Programs and Guides**

- CSIRO "Partner with us" Program –offers opportunities for organisations to collaborate on STEM education initiatives, providing volunteering, sponsorship, and co-designed programs that connect students with real-world science and industry experiences. With a strong focus on impact measurement and sustainability, the program aims to inspire the next generation of problem solvers while fostering diversity and innovation in Australia's STEM workforce.
- Best Practice Guide: Establish School-Industry STEM Partnerships – Produced by the Australian Federal Department of Education this best practice guide provides a framework for building effective collaborations between schools and businesses to enhance STEM education. It outlines the benefits for students, schools, and industry, key partnership models, and seven foundational principles for success, emphasizing shared goals, sustainability, leadership support, and resource commitment.
- STEM school industry Partnership – a guide to establishing STEM School-Industry engagement – Produced by the South Australian Department of Education this guide outlines key principles, benefits, and strategies for engagement, offering practical steps for forming, sustaining, and evaluating partnerships that connect classroom learning with real-world STEM applications.
- Optimising STEM Industry-School Partnerships (Office of the Australian Chief Scientist) – This *Inspiring Australia's Next Generation* report explores how collaborations between schools and industry can enhance STEM education and better prepare students for future careers. It provides insights into national and international trends, challenges in STEM engagement, and strategies for effective partnerships, emphasising the importance of teacher professional learning, real-world problem-solving, and measurable outcomes.

**International STEM Partnership Tools and Guides**

- A Scientist's Guide to Successful Collaboration – from the Union of Concerned Scientists this resource provides advice for creating effective partnerships between scientists and communities to address science-based challenges. It promotes equity and inclusivity, and details best practices for community science engagement
- STEM IN LIBRARIES Community Partnerships Toolkit – provides guidance on building and sustaining effective STEM-focused collaborations between libraries and community organizations. It offers practical strategies, examples, and resources to help libraries develop mutually beneficial partnerships that expand access to high-quality STEM education and programming.
- STEM Learning Ecosystems Partnership Resources – a series of practical guides promoting community-based collaborations that transform STEM education by uniting cross-sector partners—including schools, afterschool programs, colleges, businesses, community organisations, and government agencies—to create immersive STEM learning experiences.
    - Cultivating Cross-Sector Partnerships
    - Recruiting / engaging more business partnerships
    - Building & Maintaining Partnerships with Business & Industry
    - National Standards for Family-School Partnerships: An Implementation Guide
    - Changing Mindsets, Changing Outcomes: A New Paradigm for Teacher-Parent Partnerships

# Appendix F

# Inclusivity and Accessibility Resources

**Diversity, Equity and Inclusivity**

Diversity in STEM (and links therein)

Design for Equity

Inclusive Community Engagement

Free E-Book: Inclusivity and Diversity – Advice for Learning Designers

Toolkit of Resources for Engaging Families and the Community as Partners in Education Part 1: Building an understanding of family and community engagement

Toolkit of Resources for Engaging Families and the Community as Partners in Education Part 1: Building a Cultural Bridge

**First Nations Perspectives**

CSIRO Indigence Science and Engagement

QCAA Aboriginal and Torres Strait Islander Perspectives

Ngarrngga – to know, to hear, to understand

The Yarning Circle

Effective L&T Guide – ATSI

**Programs Targeting Equity Groups**

Curious Minds – Girls in STEM

National Science Youth Forum

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**Women and Girls**

- **Khuda Program for Women in STEM**
  - **Description:** A $100 million initiative funded by tech entrepreneur Robin Khuda, aiming to increase diversity in STEM by encouraging young girls, particularly from western Sydney, to pursue studies and careers in STEM.
  - **Website:** Khuda Women in STEM Program
- **Growing Tall Poppies Program**
  - **Description:** Initiated in 2008, this program offers secondary school students, mainly females, authentic experiences in physical sciences through collaborations with researchers, aiming to increase female participation in physics and related STEM fields.
  - **Website:** Growing Tall Poppies

- **RMIT University's Free Diploma in Information Technology**
    - **Description:** Offers a part-time, online diploma in information technology for women and gender-diverse students in Victoria, supported by government funding to enhance diversity in the IT sector.
    - **Website:** RMIT University
- **STEM Together**
    - **Description:** A CSIRO initiative helping young people in Years 5-10, particularly girls, Aboriginal and Torres Strait Islander students, and those from regional or low-opportunity areas, to build confidence and skills in STEM.
    - **Website:** CSIRO STEM Together
- **Women in STEM and Entrepreneurship (WISE) Grants Program**
    - **Description:** Funds long-term projects aimed at eliminating barriers to women's participation in STEM, including support for First Nations women and those from regional and rural areas.
    - **Website:** WISE grants program
- **Superstars of STEM**
    - **Description:** Raises the profile of diverse women in STEM to inspire the next generation and challenge stereotypes. Provides media training, mentoring, and networking opportunities.
    - **Website:** Science & Technology Australia – Superstars of STEM
- **Elevate: Boosting Diversity in STEM**
    - **Description:** Partners with industry to co-fund university scholarships for women and non-binary individuals, aiming to grow the pool of leaders in STEM fields.
    - **Website:** Australian Academy of Technology and Engineering – Elevate
- **Girls in STEM Toolkit (The GiST)**
    - **Description:** Provides resources to support primary and secondary school-aged girls in exploring STEM education and careers. Includes materials for students, parents, and teachers.
    - **Website:** The GiST
- **STEM Equity Monitor**
    - **Description:** A national data resource tracking girls' and women's participation in STEM, offering insights to inform policy and programs aimed at improving gender equity.
    - **Website:** Department of Industry, Science and Resources – STEM Equity Monitor

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**Aboriginal and Torres Strait Islander Peoples**

- **DeadlyScience**
    - **Description:** Founded by Corey Tutt, DeadlyScience provides STEM resources, including books and telescopes, to remote schools with a high proportion of

Indigenous students, aiming to inspire and support Indigenous youth in pursuing STEM careers.

  - **Website:** Deadly Science

- **Raising Horizons Program**
  - **Description:** Led by Gunggandji Aerospace, this initiative introduces Indigenous students, especially young women, to diverse aviation careers beyond piloting, such as aerodrome management, aviation engineering, and air-traffic control.
  - **Website:** Raising Horizons
- **Adult Future Shapers Program**
  - **Description:** Supports educators, Elders, parents, and community members who assist young Aboriginal and Torres Strait Islander students in building STEM skills, offering resources and recognition for their contributions.
  - **Website:** CSIRO Adult Future Shapers
- **Indigenous STEM Education Project**
  - **Description:** Aims to increase engagement and achievement of Indigenous students in STEM through culturally relevant programs and resources.
  - **Website:** CSIRO
- **National Indigenous Science Education Program (NISEP)**
  - **Description:** Empowers Indigenous secondary students through leadership roles in science education activities, enhancing their engagement and aspirations in STEM.
  - **Website:** Macquarie University
- **Aboriginal Summer School for Excellence in Technology and Science (ASSETS)**
  - **Description:** Offers a nine-day residential program for high-achieving Year 10 Indigenous students, focusing on STEM studies and career pathways.
  - **Website:** CSIRO ASSETS

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**Culturally and Linguistically Diverse (CALD) Communities**

- **Diversity in STEM Program**
  - **Description:** Supports the development of a diverse STEM workforce, including initiatives tailored for culturally and linguistically diverse individuals.
  - **Website:** Department of Industry, Science and Resources
- **Diversity in STEM Review**
  - **Description:** An initiative aimed at identifying and addressing structural and cultural barriers to the participation of women and other underrepresented groups in STEM fields.
  - **Website:** Science & Technology Australia

**People with Disabilities**

- **STEM Inclusion Toolkit**
  - **Description:** Provides resources and strategies to support the inclusion of people with disabilities in STEM education and careers.
  - **Website:** Australian Disability Clearinghouse on Education and Training

**Regional and Remote Communities**

- **Inspiring Australia Network – Regional Science Hubs**
  - **Description:** Establishes networks of local organizations to deliver science engagement activities in regional and remote areas, fostering community participation in STEM. Coordinates a national network of managers to engage regional communities in science, developing new opportunities and improving access for underrepresented groups.
  - **Website:** Department of Industry, Science and Resources; Inspiring Australia Queensland
- **Creative Bytes**
  - **Description**: A free program enhancing STEM and coding education in rural Australian communities, supporting local educators with curricula and guidance.
  - **Website:** Creative Bytes
- **Flying Scientists Program (Queensland)**
  - **Description:** Early to mid-career researchers travel to regional Queensland centres alongside Young Science Ambassadors to deliver community STEM engagement events, addressing the shortage of science-related activities in these areas.
  - **Website:** Flying Scientists
- **Wonder of Science (Queensland)**
  - **Description:** This program builds knowledge, passion, and enthusiasm for science and technology among Queensland's young people, creating aspiration for STEM education and fostering technical innovation.
  - **Website:** Wonder of Science
- **NSW Virtual STEM Academy**
  - **Description:** Delivered virtually through regional studios, this initiative provides STEM enrichment opportunities to students in regional and remote areas of New South Wales, fostering diversity and inclusion through strategic collaborations.
  - **Website:** Virtual STEM Academy

- **STEM Together**
  - **Description:** As mentioned above, this CSIRO initiative also focuses on students from regional and low-opportunity areas, providing greater access to STEM learning opportunities.
  - **Website:** CSIRO STEM Together

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**Low Socioeconomic Status (SES) Backgrounds**

- **In2science**
  - **Description:** Places university STEM students as mentors in low SES secondary schools to inspire and support students' engagement in science and mathematics.
  - **Website:** **In2science**
- **Smith Family's Learning for Life Program**
  - **Description:** Provides educational support and scholarships to disadvantaged students, including initiatives to encourage participation in STEM subjects.
  - **Website:** The Smith Family
- **Maker Projects: Community STEM Engagement Grants**
  - **Description:** Provides grants to organizations delivering STEM programs that engage youth from low SES backgrounds. Grants range from $20,000 to $100,000 and aim to foster creativity and inquiry-based learning, developing STEM skills in students and youth under 18 years through hands-on projects in design, engineering, and programming.
  - **Website:** business.gov.au
- **National Youth Science Forum**
  - **Description:** Receives funding to encourage more young people from diverse backgrounds to pursue STEM education and careers, offering immersive programs and experiences to inspire and support students.
  - **Website:** National Youth Science Forum

# Appendix G

# Inquiry Based Learning (IBL) Resources

**Adaptations of POE (i.e. PEE, P-POE, P-PEE, POEE):** The Predict-Observe-Explain (POE) model emphasises observation, often involving passive viewing of demonstrations, simulations, or phenomena. To encourage more active engagement, program designers might consider adopting variations like PEE (Predict-Explore-Explain), where participants actively engage with materials, conduct experiments, and explore concepts firsthand. This hands-on exploration encourages curiosity, ownership of learning, and resilience, by teaching participants to adapt to unexpected results or failures.

Another adaptation, POEE (Predict-Observe-Explain-Explore), incorporates an active exploration phase after the explain phase, as suggested by Hilario (2015). This phase prompts participants to delve deeper into phenomena by testing/changing variables, evaluating outcomes, and seeking broader explanations.

For even greater participant involvement, planning components can be added to the framework. Variations like P-POE (Plan-Predict-Observe-Explain) and P-PEE (Plan-Predict-Explore-Explain) scaffold opportunities for participants to think critically about experimental design, propose hypotheses, and refine methods. These adaptations encourage deliberate planning and iterative problem-solving, further aligning the framework with inquiry-based learning and social constructivist principles.

By incorporating “Plan” and/or “Explore” components, these adaptations shift the POE framework toward a more active, participant-centred approach – promoting hands-on engagement, critical thinking, and deeper conceptual understanding. However, increasing the complexity of inquiry requires careful consideration of the audience’s needs and capabilities. For example, program designers must evaluate whether participants have the necessary skills and prior knowledge to benefit from more advanced inquiry levels. This balance is critical for ensuring accessibility and achieving desired learning outcomes.

**7 E’s: an Expansion of the 5E’s Model**

The 7E’s instructional model (Eisenkraft, 2003) expands upon the 5E model by adding two additional phases: **Elicit** and **Extend**. These additions enhance its application by

1. overtly addressing participant current understandings; and
2. overtly facilitating transfer of knowledge

**Elicit Phase:** This phase precedes the "Engage" phase and focuses on uncovering participant prior knowledge, preconceptions (including any misconceptions), and initial ideas. It ensures that learning builds on what participants already know, creating stronger connections between existing understanding and constructions of new understandings. Research highlights that overtly addressing misconceptions at the outset improves conceptual change and overall learning outcomes ( (Guerra-Reyes et al., 2024) and references therein).

**Extend Phase:** Added after "Evaluate," phase, this phase emphasises applying knowledge to new, real-world contexts or interdisciplinary scenarios. It challenges participants to apply their new understandings in novel contexts, fostering critical thinking and problem-solving skills. Extending learning in this way aligns with the goals of developing transferable skills, a key aspect of modern educational priorities.

In summary, this model can support a deeper and more personalised learning experience by emphasising both the diagnostic understanding of learners' preconceptions and the transferability of knowledge across disciplines (Eisenkraft, 2003).

**Descriptive, Comparative and Experimental Investigations (Table G.1)**

**Descriptive Investigations:** involve observing and describing phenomena without manipulating variables. The focus is on collecting detailed, qualitative, or quantitative data about a subject or process as it naturally occurs. The purpose is to explore unknown aspects of a particular phenomenon and provide some fundamental or foundation knowledge on that topic. Examples include observing species diversity or animal behaviour, classifying species, observations made through microscopes and telescopes, and temporal measurements of daily/weekly/annual events to identify trends (e.g. seasonal rainfall trends).

**Comparative Investigations:** involve comparing two or more groups or conditions to identify similarities and differences. Variables are observed but not controlled or manipulated directly. The purpose is to explore relationships or differences between variables but not to specifically control or manipulate them. The variable to be monitored occurs natural or is selected by the investigator. Comparative investigations answer questions about how one group or condition differs from another (e.g. "which …", how different …", how similar …"). Examples include, identifying and comparing boiling points of liquids or solutions, comparing population sizes of a species in different habitats, comparative measurements within population sub-groups (e.g. heights of 10-year-old boys and girls).

**Experimental Investigations:** involve manipulating one or more independent variables to observe their effect on a dependent variable, typically within a controlled environment. The purpose is to answer "why" or "how" questions in determining cause-and-effect relationships. Experimental investigations require a research question and a hypothesis – both with a focus on the variables to manipulated and measured. Examples include pharmaceutical drug trials and any investigation along the lines of "how does X affect Y"

**Table G.1 Descriptive, Comparative and Experimental Investigations**

| | Descriptive Investigations | Comparative Investigations | Experimental Investigations |
|---|---|---|---|
| **Focus** | Observation & description | Comparison of conditions/groups | Cause-and-effect relationships |
| **Example Question** | "What plants live in this part of the rainforest?" | "Which soil type has more worms" | "How does sunlight affect plant growth?" |
| **Hypothesis Type/ Example** | None required | Descriptive hypothesis:<br>"Worms prefer wet soils"<br>Hypothesis as prediction:<br>"I think that …"<br>e.g. I think that wet soils will have more worms"<br>Hypothesis as an explanation:<br>"I think that … because …"<br>e.g. "I think that wet soils will have more worms because worms need to stay moist to breathe through their skin" | Descriptive hypothesis:<br>"Plants thrive in sunlight"<br>Hypothesis as prediction:<br>"If …. then …"<br>e.g. "If a plant is exposed to more sunlight, then it will grow faster than a plant exposed to less sunlight"<br>Hypothesis as an explanation:<br>"I think that … because …"<br>e.g. "I think that plants exposed to a greater amount of sunlight will grow faster because plants require photosynthesis to provide energy for growth." |
| **Fair test required?** | No | No | Yes |
| **Variable Manipulation** | None | None (variables are not deliberately manipulated but differences are observed or measured, e.g. wet vs dry soils) | Independent variable manipulated (e.g. the amount of sunlight)<br>Dependent variable measured or observed (e.g. plant height, plant weight, of leaf area) |
| **Outcome** | Data for understanding phenomena | Insights on similarities/differences | Evidence to support/refute hypotheses relating to cause-effect connections |

*Levels of Inquiry Based Learning*

The IBL frameworks can be adapted for different levels of complexity and learner autonomy, depending on the degree of guidance provided by instructors and the extent to which learners take responsibility for the overall inquiry process.

Table G.2 (Hackling, 2005) outlines varying levels of IBL instruction. These levels differ based on whether the instructor or participants determine key inquiry elements such as the investigation question/problem, the equipment to be used, the design of the experimental procedure, and the conclusions drawn from the activity.

**Table G.2 Levels of Openness of Inquiry-Based Learning Approaches (reproduced from Hackling 2005, after Hegarty-Hazel 1986)**

| Level | Question/Problem | Equipment | Procedure | Answer | Common name |
|---|---|---|---|---|---|
| 0 | Given | Given | Given | Given | Verification |
| 1 | Given | Given | Given | Open | Guided inquiry |
| 2a | Given | Given | Open | Open | Open guided inquiry |
| 2b | Given | Open | Open | Open | Open guided inquiry |
| 3 | Open | Open | Open | Open | Open inquiry |

**Level 0:** At this foundational level, the question/problem is provided to participants, along with the equipment, the experimental procedure and the answer. Participants replicate experiments or activities with predetermined outcomes to verify known principles or concepts. It is primarily used to familiarise learners with experimental procedures and to reinforce already known foundational knowledge. It is generally used to introduce younger learners to experimental settings, building their confidence in basic scientific methods and equipment. The limitations of this approach include minimal opportunities for creativity, critical thinking or exploration.

**Level 1:** At this level, instructors pose a question/problem and provide the equipment and procedure, but participants analyse and interpret the results themselves. This level starts to foster critical thinking by encouraging interpretation and reasoning, and by helping participants to connect observations and data to scientific concepts. A potential limitation of this approach is that participants may feel they lack the freedom and/or ownership of the inquiry process.

**Level 2a:** At this level, the question/problem and equipment are provided, but participants design their own procedures to find answers and interpret results. This level has a greater emphasis on experimentation and starts to develop procedural design and problem-solving skills, as well as and introducing a level of autonomy and creativity. Instructors will need to ensure sufficient guidance is provided to facilitate experimental design.

**Level 2b:** At this level, only the question/problem is provided, and participants choose their equipment, design their procedure, and analyse their results. Cooperative and collaborative learning approaches are often emphasised at this level (Bell et al., 2010; Gillies, 2023; Woods-McConney et al., 2016), thereby incorporating social constructivist principles by leveraging group dynamics and encouraging reflection and learning through social interaction.

**Level 3:** Open Inquiry – this is the highest level of inquiry, where participants independently formulate questions/problems, design experiments, collect and analyse data, and draw conclusions. This level mimics real-world scientific inquiry and develops self-direction, problem-solving, and critical thinking skills. However, it should be noted that this level of IBL demands significant time and resources and participants will typically require increased support to succeed with open-ended inquiry approaches (Ward et al., 2016; Zion & Mendelovici, 2012).

The levels of IBL described above, provide a scaffolded approach, starting with structured guidance and gradually increasing in complexity and autonomy, which reflects the natural progression of how learners gain competence. By understanding and employing the different levels of IBL, program designers can create engagement activities that align with participants' cognitive and developmental stages, while meeting specific educational objectives of their program. This developmental alignment ensures that participants are not only acquiring content knowledge, but also developing problem-solving capabilities, scientific literacy, and critical thinking skills.

**LIA Framework (Launch-Inquire-Act)[1] :** Unlike the frameworks the POE and 5E's frameworks, the LIA framework is a new IBL model, introduced in 2024 by the Australian Academy of Science (AAS) via its *Primary Connections* science education program. While the *Primary Connections* program originally adopted the 5E's framework in 2003 (Hackling, 2006), the AAS has seized the opportunity presented by the new *Australian Curriculum (version 9)* to reframe its approach to IBL. The LIA model is significant in the Australian context because it is set to be widely used in Australian schools as part of the new *Primary Connections* rollout in coming years. As such, community science engagement providers may want to incorporate this model into their program designs, given that many school students will already be familiar with it. Be mindful however that it may require the collaboration with STEM education experts to insure veracity of implementation.

The LIA framework (Launch, Inquire, Act) provides a dynamic approach to IBL, designed to align closely with the goals of the Australian Curriculum and the hands-on nature of the Primary Connections program. While maintaining a focus on development of scientific literacy, the LIA approach also empowers teachers to enhance the science capital in their classrooms – encompassing science-related knowledge, attitudes, experiences, and resources—and nurtures the associated development of students' science identities.

In the **Launch** phase, students are asked questions that elicit and explore prior experiences and current understandings, using local and global contexts, intended to spark curiosity and provide a context for their learning. This phase provides opportunities for students to anchor their own experiences and connect their own language and interests to the core scientific concepts they will explore. The launch phase is designed to increase the science capital of the classroom (Godec et al., 2017; Nag Chowdhuri et al., 2022).

The **Inquire** phase lies at the heart of the framework, with students progressively cycling through a 3-stage inquiry cycle of questioning, investigating and integrating. They actively construct and investigate questions, collect and evaluate data, and construct knowledge through further experimentation and research. The repeated inquiry cycles support students to deepen their understanding of the core concepts being explored. This stage also encourages cooperative and

[1] The LIA framework is new. To the authors' knowledge (at the time of writing) it is the only IBL framework that explicitly builds its instructional phases around the concept of "science capital"

collaborative learning approaches, facilitates critical thinking, and builds key inquiry and investigative skills crucial for developing scientific literacy.

The **Act** phase *anchors* understanding of the core concepts and translates learning into action, empowering students to *connect* their new understandings to real-world examples, *design* solutions, and *communicate* their results to relevant audiences. This phase highlights the importance of connecting classroom learning to broader societal and environmental contexts and its potential on future decision making, promoting a sense of responsibility and empowerment among students.

Together, these phases form a cohesive and flexible structure, that goes beyond scientific literacy, increasing the science capital of the student cohort and the science identity of individual students.

Table G.3 shows the relationship between the LIA framework and the 5E's and POE frameworks described above. By and large, the sophistication (and perhaps complexity) of each framework increases from POE, to 5E's, to LIA. The use of one or another of these frameworks in science community engagement will depend on facilitator expertise, the target audience, and the intended outcomes of the program.

**Table G.3 Relationship between IBL frameworks (adapted from (PrimaryConnections, 2024) )**

| LIA | 5E's | POE |
|---|---|---|
| Launch Phase<br>Experience<br>Anchor<br>Elicit<br>Connect | Engage<br>Explore | Predict |
| Inquire Phase<br>Question<br>Investigate<br>Integrate | Explore<br>Explain<br>Elaborate | Predict<br>Observe<br>Explain |
| Act Phase<br>Anchor<br>Connect<br>Design<br>Communicate | Elaborate<br>Evaluate | |

**Note**: The use of one or another of the above IBL frameworks in community science engagement programs will depend on facilitator expertise, the target audience, and the intended outcomes of the program. The levels and complexity IBL approaches are further explored in Appendix E to further assist community science program developers to design IBL experiences for various audiences.

# Appendix H

# Hands-on Experiential Learning Resources

**Scaffolding Experimental investigations**

**1. Orientation (engage phase):** This phase involves introducing the "big ideas" relating to the purpose and context of the investigation with a view to sparking interest, curiosity and, ultimately, active engagement. In practice, the orientation phase of experimental investigations has significant overlap with the "engage' phase of inquiry frameworks such as the 5E's framework.

Ideally participants will identify or choose the problem or phenomenon they wish to explore. The orientation phase lays the ground work for the rest of the investigation process by encouraging question formulation and setting of hypotheses (Bybee et al., 2006).

***Use hooks and/or discrepant events:*** Hooks, such as thought-provoking questions or intriguing visuals, can capture participants' attention and draw them into the investigation. Similarly, presenting discrepant events—unexpected phenomena that challenge existing knowledge—can create cognitive dissonance, motivating participants to resolve their curiosity through active inquiry and exploration.

**2. Generation testable questions and broad hypothesis statements:** Participants propose testable statements and/or tentative explanations based on their prior knowledge and initial research/discussions during the orientation phase. Connecting prior knowledge and current understandings to potential outcomes encourages critical, evidence-based, thinking.

***2.1 Testable questions:*** A testable question is a question that can be answered through experimentation by making observations and/or measurements. It focuses on something specific that can be measured (or observed) when something else is changed or altered in some way – i.e. cause and effect scenarios. Examples of testable questions include:

> "*How does changing the amount of sunlight affect plant growth?*".
>
> *"Does changing the height of a ramp affect how fast a toy car will travel?"*

Testable can be generated and written in multiple ways, however, three fool-proof approaches can be adopted:

How does changing __X__ affect __Y__ ?

Does changing __X__ affect __Y__?

If I change __X__, how will it affect __Y__ ?

The gaps in the above questions are filled by identifying specific variables. In the plant growth example above, "the amount of sunlight" is referred to as the independent variable (the variable that is changed in an experiment) while "plant growth" is referred to as the dependent variable (the variable that is measured or observed). The above generic questions could therefore be expressed as:

How does changing ***(the independent variable)*** affect the ***(dependent variable)*** ?

Does changing ***(the independent variable)*** affect ***(dependent variable)*** ?

If I change ***(the independent variable)***, how will it affect ***(dependent variable)*** ?

A well-designed experiment has only one independent variable and one dependent variable. There are, of course, many other variables that will need to be considered during the experimental design phase (see below). For example, in the plant growth example above, other variables could include soil type, plant type, amount of water etc. Ideally, these potentially confounding variables, would be controlled (kept constant) to ensure that any observed changes in the dependent variable can be confidently attributed to the manipulation of the independent variable. This way, no other variables need be included when drafting the testable question.

***2.2 Hypothesis statements:*** A hypothesis statement is a broad, testable statement or educated guess that describes a phenomenon or relationship based on prior knowledge or observations. There are several ways that participants can be encouraged to articulate hypothesis statements including

*Descriptive hypothesis:* e.g., "Plants thrive in sunlight"

*Hypothesis as prediction*: "If ____ then ____" , e.g. "If a plant is exposed to more sunlight, then it will grow faster than a plant exposed to less sunlight"

*Hypothesis as an explanation:* "I think that ____ because ____" e.g. " I think that plants exposed to a greater amount of sunlight will grow faster because plants require photosynthesis to provide energy for growth."

In general, hypothesis statements should be kept broad enough to allow for exploration and flexibility during the experimental investigations, yet specific enough to provide clear direction for designing experiments and collecting data. More specific predictions about the outcome of an experiment can be made after the experimental design phase (see below).

**3. Experimentation:** This phase can be broken into several sub-phases, including, Experimental Design (fair tests), Prediction, Observations and Data Collection, and Data Interpretation.

***3.1 Experimental Design/Fair Test*** **–** participants design, and plan experiments to test their hypotheses. Ideally, they identify variables and controls, and materials, and outline procedures, ensuring the experiment is structured for reliability and reproducibility. Identifying potential risks and/or ethical concerns could also be included.

Young participants in community science engagement programs may already be familiar with the concept of a "fair test" – being a compulsory component of the *Australian Curriculum: Science* in upper primary and junior secondary school. A fair test is an experiment where only one variable is changed, one variable is measured, while all other factors are kept the same (controlled variables). This ensures that the results are due to the variable being tested, not other factors.

**C**ows **M**o**O** **S**oftly is a useful mnemonic where the bold/underline letters that represents the three key elements in designing a fair test: **Change, Measure** or **Observe, and Same**. It emphasises the importance of changing only one variable (independent variable), measuring or observing the outcome (dependent variable), and keeping all other variables constant (controlled variables) to ensure the test is fair and the results are reliable. This approach helps participants to isolate the effect of the independent variable on the dependent variable, reducing the risk of confounding factors influencing the outcome.

The use of a variables grid is a good way to assist participants in designing fair tests and ensuring that no confounding variables interfere with the results, allowing for accurate identification of cause-and-effect relationships. Variables grid template.

***3.2 Prediction*** **–** participants make informed guesses about the expected outcomes of their experiment. These predictions are directly tied to their hypothesis, encouraging them to think critically about the relationships between variables and anticipate potential findings.

Prediction statements share similarities with hypothesis statements, but they are more specific and directly tied to how the independent variable is altered and how the dependent variable is observed or measured. For instance, in the plant growth example, the hypothesis might state, *"Plants grow better in sunlight"* (descriptive) or *"If a plant receives more sunlight, then it will grow faster than a plant with less sunlight"* (predictive). In contrast, a prediction would be more detailed and linked to the experimental setup, such as: *"If a plant receives 50% less sunlight over two weeks, its height increase will be half that of the control plant."*

***3.3 Observations and Data Collection*** **–** participants actively conduct their experiment, recording detailed observations and collecting data. This stage has a focus on precision and accuracy in both measurements and documentation.

***3.4 Data Interpretation and evidence-based claims*** **–** participants analyse the collected data to identify patterns, trends, or anomalies. They compare their findings against the initial hypothesis and predictions, reflecting on the results to make *evidence-based claims*. An evidence-based claim is a conclusion drawn from the data collected during the experiment, supported by measurable evidence. In the context of the plant growth experiment, an example of an evidence-based claim might be: *"Plants exposed to 50% less sunlight grew an average of 2 cm less than the control plants, confirming that reduced sunlight negatively impacts growth."*

**4. Drawing conclusions:** participants synthesise thoughts and ideas from their data analysis to form evidence-based conclusions. They evaluate whether the results support their initial hypothesis, discuss alternative explanations for unexpected outcomes, and reflect on the broader significance of their findings. This phase involves critical thinking through deductive reasoning, helping participants bridge the gap between their artificially controlled experimental results and real-world phenomena.

**5. Making evaluations:** Participants assess the overall investigation process, considering the validity and reliability of their methods and results. They identify limitations, suggest improvements, and evaluate the impact of their findings within their own relevant context. This is a reflective process (improving metacognitive skills) that builds a deeper understanding of both scientific concepts and the overall investigative process – thereby addressing scientific literacy.

**Hooks and Discrepant events**

A useful resources for illustrating highlighting the rationale and practical implementation of classroom hooks and discrepant events can be found here: Hooks, Lines and Sinkers and here Discrepant Teaching Events. Examples can be found here and here.

**Testable Questions:**

Examples of testable questions include:

> "*How does changing the amount of sunlight affect plant growth?*".
>
> *"Does changing the height of a ramp affect how fast a toy car will travel?"*

Testable questions can be generated and written in multiple ways, however, three fool-proof approaches can be adopted:

How does changing __X__ affect __Y__ ?

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If I change __X__, how will it affect __Y__ ?

The gaps in the above questions are filled by identifying specific variables. In the plant growth example above, “the amount of sunlight” is referred to as the independent variable (the variable that is changed in an experiment) while “plant growth” is referred to as the dependent variable (the variable that is measured or observed). The above generic questions could therefore be expressed as:

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If I change ***(the independent variable)***, how will it affect ***(dependent variable)*** ?

A well-designed experiment has only one independent variable and one dependent variable. There are, of course, many other variables that will need to be considered during the experimental design phase (see below). For example, in the plant growth example above, other variables could include soil type, plant type, amount of water etc. Ideally, these potentially confounding variables, would be controlled (kept constant) to ensure that any observed changes in the dependent variable can be confidently attributed to the manipulation of the independent variable. This way, no other variables need be included when drafting the testable question.

An exhaustive list of testable questions that can be adapted to multiple contexts can be found here (testable question pdf).

**Hypothesis statements**

A hypothesis statement is a broad, testable statement or educated guess that describes a phenomenon or relationship based on prior knowledge or observations. There are several ways that participants can be encouraged to articulate hypothesis statements including

*Descriptive hypothesis:* e.g., “Plants thrive in sunlight”

*Hypothesis as prediction*: “If ____ then ____” , e.g. “If a plant is exposed to more sunlight, then it will grow faster than a plant exposed to less sunlight”

*Hypothesis as an explanation:* “I think that ____ because ____” e.g. “ I think that plants exposed to a greater amount of sunlight will grow faster because plants require photosynthesis to provide energy for growth.”

In general, hypothesis statements should be kept broad enough to allow for exploration and flexibility during the experimental investigations, yet specific enough to provide clear direction for designing experiments and collecting data. More specific predictions about the outcome of an experiment can be made after the experimental design phase (see below).

# Appendix I

# Resources for Engaging Scientists in Community Science Programs

**Online Training Resources for Scientists:**

Alan Alda Centre for Communicating Science Professional Development Virtual Programs (online x 4) – https://www.aldacenter.org/professional-development/index.php#view-Virtual_Programs

Portal to the Public Network – https://popnet.instituteforlearninginnovation.org/

Australian National Centre for the Public Awareness of Science – Professional Short Courses and Workshops https://cpas.anu.edu.au/study/professional-short-courses-workshops

Community Engagement: Collaborating for Change – https://online.umich.edu/courses/community-engagement-collaborating-for-change/

Future Science Talks (x7) – https://www.futuresciencetalks.com.au/training-courses

Designing Effective Science Communication – https://www.coursera.org/learn/designing-effective-science-communication

The Softer Side of Science Communication – https://www.coursera.org/learn/the-softer-side-of-science-communication

Science Communication – https://www.edx.org/learn/journalism/israelx-science-communication

# Appendix J

# Resources to Influence the Influencers

**Engaging Parents and Families:**

Family Engagement: A Guide to Tools, Strategies and Resources
https://www.afterschoolalliance.org/documents/TASC%20-%20Family%20Engagement%20Resource%20Guide.pdf

Engaging Parents Through Better Communication Systems
https://scholar.harvard.edu/files/mkraft/files/kraft_2017_engaging_parents_through_better_communication_systems_el.pdf

Toolkit of Resources for Engaging Families and the Community as Partners in Education Part 1: Building an understanding of family and community engagement.
https://ies.ed.gov/sites/default/files/migrated/rel/regions/pacific/pdf/REL_2016148.pdf

Toolkit of Resources for Engaging Families and the Community as Partners in Education Part 1: Building a Cultural Bridge https://files.eric.ed.gov/fulltext/ED569111.pdf

A Parents Role in STEM Education https://www.carnegie.org/our-work/article/parents-role-stem-education/

Identifying Barriers: Creating Solutions to Improve Family Engagement
https://files.eric.ed.gov/fulltext/EJ1124003.pdf

The Case for Strong Family and Community Engagement in Schools
https://www.gse.harvard.edu/ideas/usable-knowledge/23/03/case-strong-family-and-community-engagement-schools

5 Culturally Responsive Family Engagement Strategies https://www.edutopia.org/article/5-culturally-responsive-family-engagement-strategies

Field-based science for families https://learninginplaces.org/for-families/

**STEM Careers Platforms:**

Exploring STEM career platforms can significantly enhance students' understanding of opportunities in STEM.

**Careers with STEM**: This platform provides free magazines, quizzes, videos, and job kits to help high school students, undergraduates, graduates, careers advisors, teachers, and parents discover various STEM careers and study paths. https://careerswithstem.com.au/careers-with-stem-about/

**STEMCAREERS.com.au**: A dedicated platform offering STEM job listings across Australia, career resources, and programs designed to help individuals gain the skills and experience needed for success in STEM careers. https://www.stemcareers.com.au/

**STEM Career Wheel by Careers Foundation**: This resource helps individuals explore STEM career pathways by matching their interests and passions with relevant Australian jobs, offering insights into various STEM fields and the skills required. https://www.careersfoundation.com.au/pathways

**Career In STEM® Explorer** –This platform offers a comprehensive suite of digital resources designed to empower middle and high school students to discover STEM careers. It provides interactive tools, career profiles, and 'try-it' activities that allow students to explore various STEM fields at their own pace. https://www.careerinstem.com/

**Myfuture** – provides resources to explore career pathways and tools to develop self-knowledge to help with career decision-making. https://myfuture.edu.au/

**STEM Sports® – Career Exploration Activities –** STEM Sports® offers hands-on exploration activities that introduce students to various STEM career paths. These activities are flexible and can be tailored to student interests, making them a valuable tool for facilitators aiming to ignite a passion for STEM in their students. https://stemsports.com/career-exploration-activities-for-stem-students/

**Mindflight7 – Virtual Reality Career Exploration –** Mindflight7 is an Australian startup bringing virtual reality (VR) into classrooms to enhance interactive education. Using VR headsets, students can immerse themselves in various environments, from historical events to scientific explorations, providing a tactile experience that makes complex concepts easier to understand and more engaging. https://www.mindflight7.com.au/

**Teacher Professional Learning:**

5 Ways To Make Teacher Professional Development Effective (& 7 Powerful Resources) – https://www.prodigygame.com/main-en/blog/teacher-professional-development/

Enabling High Quality Professional Learning A practical guide for leaders – https://www.aitsl.edu.au/docs/default-source/hqpl/enabling-high-quality-professional-learning---practical-guide.pdf

Improving Teacher Professional Learning – https://www.aitsl.edu.au/teach/improve-practice/improving-teacher-professional-learning

6 Tips for Designing Engaging Professional Development Sessions – https://literacypages.wordpress.com/2017/09/15/6-tips-for-designing-engaging-professional-development-sessions/

**Miscellaneous**

CSIRO STEM Professionals in Schools program https://www.csiro.au/en/education/programs/stem-professionals-in-schools-program

Kids teaching Kids https://earthwatch.org.au/education/school-programs/kids-teaching-kids and https://www.ryde.nsw.gov.au/files/assets/public/v/1/environment/reen/kids-teaching-kids-program.pdf

Suzie the Scientist Early Reader Series https://www.suziethescientist.com.au/home/

Millie the Mathematician Early Reader Series https://milliethemathematician.com.au/home/

In addition, the three Australin Government YouthInsight reports (YouthInsight, 2022(a), 2022(b), 2023) have excellent evaluation tools (e.g. mixed methods questionnaires) that can be adapted for community engagement programs engaging parents, teachers and children.

# Appendix K

## Informal Learning Places, Programs and Training Opportunities

**Places**

Museums, Science Centres, Planetariums, Observatories, Aquariums

**Programs**

Science on the GO!

**Additional Resources:**

*Preparing informal science educators: Perspectives from science communication and education (Patrick 2017)*

This book provides a diverse look at various aspects of preparing informal science educators. The volume is divided into five topics: Defining Informal Science Education, Professional Development, Designing Programs, Zone of Reflexivity: The Space Between Formal and Informal Educators, and Public Communication. The authors have written chapters for practitioners, researchers and those who are interested in assessment and evaluation, formal and informal educator preparation, gender equity, place-based education, professional development, program design, reflective practice, and science communication

Check out these programs for learning opportunities: https://www.chiefscientist.qld.gov.au/stem-education/learning-opportunities

# Appendix L

# Leveraging Local Assets

**Culturally Responsive Engagement Approaches for First Nations Peoples**

CSIRO Indigence Science and Engagement

QCAA Aboriginal and Torres Strait Islander Perspectives

Ngarrngga – to know, to hear, to understand

The Yarning Circle

Effective L&T Guide – ATSI

**First Nations Notion of 'Country'**

- AIATSIS – Australian Institute of Aboriginal and Torres Strait Islander Studieshttps://aiatsis.gov.au
- Return to Country – NITV and SBS Indigenous https://www.sbs.com.au/nitv/return-to-country
- Common Ground First Nations: What Is Country? https://www.commonground.org.au/learn/what-is-country
- Aboriginal Carbon Foundation – Caring for Country https://aboriginalcarbonfoundation.com

The Department of the Environment, Tourism, Science and Innovation acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Owners and custodians of the land.

We recognise their connection to land, sea and community, and pay our respects to Elders past and present.

Queensland Government