



An Australian Government Initiative



The STEM Club Research Journey

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Context

CONTEXT

Australia, like other first world countries, depends on the expertise of a science, technology, engineering and mathematics (STEM)-based workforce to generate creative solutions to many of society's problems. Despite the critical role these experts play, policy makers, business leaders, and educators are anxious about the declining interest and take up of STEM-related degrees and careers (Gottfried & Williams, 2013). In light of this, the Australian Government and organisations such as *Inspiring Australia* have been exploring ways in which informal learning environments, such as STEM Clubs, can play a role.



Informal learning environments are defined by Gottfried and Williams (2013) as spaces outside of formal education contexts where educational activities occur in planned, yet flexible learning formats. Informal environments, such as those offered through STEM clubs, provide children and youth with challenging, fun, and interactive STEM learning that inspire and engage students in inquiry and exploration (Moriarty, 2017).

Exposure to STEM in this way has been linked to a “student’s trajectory into or out of STEM-related careers” (Gottfried & Williams, 2013, p.X). Learning within a club environment combines positive learning experiences with social interactions (McCallie, Bell, Lohwater, Falk, Lehr, Lewenstein, Needham, & Wiehe, 2009) as well as leads to increased skill level and intrinsic motivation (Williams & Gottfried, 2013).

At their core, STEM clubs cater for learners with diverse needs or from a range of demographics (e.g. low socio-economic, minority, gender).

They are often initiated by community members, organisations, parents, teachers, schools, industry groups, universities, and government agencies, independently or in collaboration (Moriarty, 2017). The programming provided through STEM club initiatives may focus on specific components (e.g. coding, physics, environmental issues, robotics) or more broadly on capability development (e.g. problem solving, creativity, critical thinking). This approach to STEM education has revealed itself to be catalytic in increasing learners' self-efficacy and self-confidence in STEM (Watermeyer, 2012).

While STEM clubs have a documented impact spanning 20 years, their impact in Queensland is very much in its infancy. Consequently, *Inspiring Australia Queensland* (IAQ) sought to establish an evidence base for the value of STEM clubs in this local context by embarking on a journey to explore the exciting outcomes and opportunities taking place across the state.



To kickstart this process IAQ commissioned a research report and roundtable forum to better understand the role and value of STEM clubs in Queensland.

IAQ Initial Research Findings

IAQ INITIAL RESEARCH FINDINGS

In 2017, IAQ commissioned research into the status of STEM clubs nationally and internationally, which included a summary of the types of STEM clubs as well as success factors and recommendations (Moriarty, 2017). The intention of the overview was to identify the key components of STEM club creation to inform the development of a STEM club network in Queensland.

The following eight recommendations emerged from this research:

1. The establishment of a state-wide network/advisory group;
2. The design and implementation of an evaluation tool;
3. The need to undertake further research on science clubs in Queensland;
4. Continued development of science club models to target support in developing mission statements, principles, management and other resources;
5. To undertake mapping of Queensland science clubs;
6. Further research with a focus on regional, rural and remote STEM clubs;
7. Completion of a comprehensive survey of Queensland science clubs and establish ways IAQ can support operational, pedagogy, funding, evaluations and resourcing of clubs; and
8. Undertake pilot programs with a focus on early years in conjunction with libraries, school/industry, and citizen science in collaboration with schools and universities etc.

Following on from this research, IAQ held a roundtable forum. This event resulted in the production of a document with detailed notes and outcomes that reinforced the research findings and recommendations. As a direct consequence of the round table, **Recommendations 2 and 5** (see p.10) were identified as the next steps of action with IAQ commissioning an expression of interest (EOI) process for undertaking this work with local universities.



This process resulted in the formation of an interdisciplinary team of researchers, educators and innovators with STEM interest and experience from the University of Southern Queensland (USQ).

This collective pitched a project idea that would allow for the creation of an evidence-based evaluation framework, which would be trialled and refined through a pilot project. The USQ team was successful in obtaining

this contract and the beginnings of fruitful partnership with IAQ started to take shape.

Alongside actioning these two recommendations with USQ, IAQ implemented a range of pilot programs to gain practical knowledge about STEM Club models. There were 48 small grant funded projects and sponsorships including:

- **Oakleigh SS Young Innovators STEM Club/STEAM Showcase:** Training and support for parents and volunteers;
- **First Five Forever:** Partnership with State Library of Queensland (SLQ). Small grants to promote STEM activities in library literacy programs; and
- **Kids STEM Convention:** Conference for and developed by 300 high school students.

IAQ – USQ

Research Partnership

IAQ – USQ RESEARCH PARTNERSHIP

Work on the STEM Club evaluation framework began in April 2018 with four stages to follow.

1

In addressing Recommendation 5 (Moriarty, 2017), the team developed and reported on findings from a comprehensive database mapping areas such as:

- STEM club estimated annual funding;
- Primary funding sources;
- Degree of structured content relating to STEM career awareness;
- Club program links to STEM curriculum.

2

Drawing on these insights, a draft evaluation framework was produced with two main components:

- A STEM club evaluation (*Health Check*); and
- An emoji-based participant questionnaire (*How was STEM club today?*).

These tools were designed to be used to review STEM club participants, facilitators, and parent/caregivers' feedback to inform STEM club activities and actions.

3

The framework was piloted in Term 4, 2018 with 48 STEM clubs across Queensland who were recipients of small IAQ grants.

4

Following the pilot, feedback via surveys and interviews was used to refine the evaluation framework. Two key outcomes resulted:

- Development of resources and supporting information linked with the framework to form a STEM club toolkit accessible on the IAQ website, and
- Production of two research-informed journal articles.

Designing the Evaluation Framework



DESIGNING THE EVALUATION FRAMEWORK

The design and implementation of an evaluation framework had two objectives: (i) provide useful feedback to STEM club management and assist them in maintaining club sustainability, and (ii) develop an evidence base that can be utilised to leverage future funding for STEM club programs (Moriarty 2017).

The initial version of the framework was developed in five stages. These stages included:

- 1. Key word search of multiple databases;**
- 2. Analysis of relevant peer reviewed articles;**
- 3. Synthesis of this information into first version of the tool;**
- 4. Evaluation tool refined into second version for testing in the pilot study; and**
- 5. Third and final version of the evaluation tool informed by surveys and interviews with STEM clubs.**

Figure 1 summarises the five stages used in the formation of the STEM club evaluation tool with more detailed explanations of each step detailed below.



Figure 1 *The 5-stage process used to create the STEM club evaluation framework.*

| 1. Literature Search

The focus of the literature review was to identify research that could inform the creation and development of an evaluation tool. A key term search was conducted across multiple data bases with this preliminary sweep resulting in 150 journal articles and conference proceedings (ranging from 2004 to 2018) broadly related to STEM club activities. This initial collection then underwent a process that used exclusion criteria. Articles that were (i) not from peer reviewed journals and/or (ii) focused on curriculum-based STEM activities from formalised educational settings were removed. This left 64 articles for further analysis.

| 2. Review

The abstracts of the remaining 64 articles were systematically examined to identify four focus areas, which became inclusion criteria:

1. The range of STEM club possibilities;
2. Equity and inclusion (e.g. gender-based clubs or clubs directed at low socio-economic groups);
3. Identification of STEM club best practice; and
4. Existing STEM club evaluation models or frameworks.

Literature that did not contain any of the four inclusion criteria were excluded reducing the journal articles in the review process to 38. Nine subsequent articles from cited references were also manually searched and added to the pool of articles, now totalling 47.

3. Synthesis

Each of the 47 articles were analysed to identify the key attributes contributing to best practice in STEM clubs. The synthesis of these key STEM club attributes led to a preliminary version of an evaluation tool composed of five themes. These themes included:

1. Planning activities;
2. Club structures;
3. Club resources;
4. Communication; and
5. Club evaluation processes.

This preliminary draft was reviewed by all team members and refined into a concise, one-page evaluation tool.

4. The Draft Evaluation Tool

The refined evaluation tool, or *Health Check*, was streamlined to three key themes (with sub-themes) representing STEM club best practice as shown below in Figure 2.

Figure 2 *Health Check*.

Club Management	Environment	Evaluation
• Vision	• Context	• Strategies
• Funding	• Activities	• Reviews
• Sustainability	• Partnerships	• Procedures
• Professional Development	• Resources	
• Safety		
• Communication		

This initial design of the evaluation tool was trialled in the STEM club pilot initiative.

5. Trialling the Evaluation Framework

To support the trialling of the evaluation framework, the IAQ pilot program provided small grants to 48 Queensland STEM clubs (Figure 3) for the purchase much needed resources and equipment. Grant recipients were asked to complete the *Health Check* evaluation framework at the beginning and end of Term 4, 2018. Completing the *Health Check* at the start of the pilot was intended to raise the awareness of STEM club management in relation to best practice components that would assist identifying any strengths, weaknesses, and potential gaps in their practice. This knowledge then allowed STEM club participants to examine areas requiring improvement and take action with the second evaluation capturing any changes made. In addition to this, participating STEM clubs were also invited to distribute stakeholder surveys to gauge how the STEM club was experienced by parents, children, and other club activity participants.

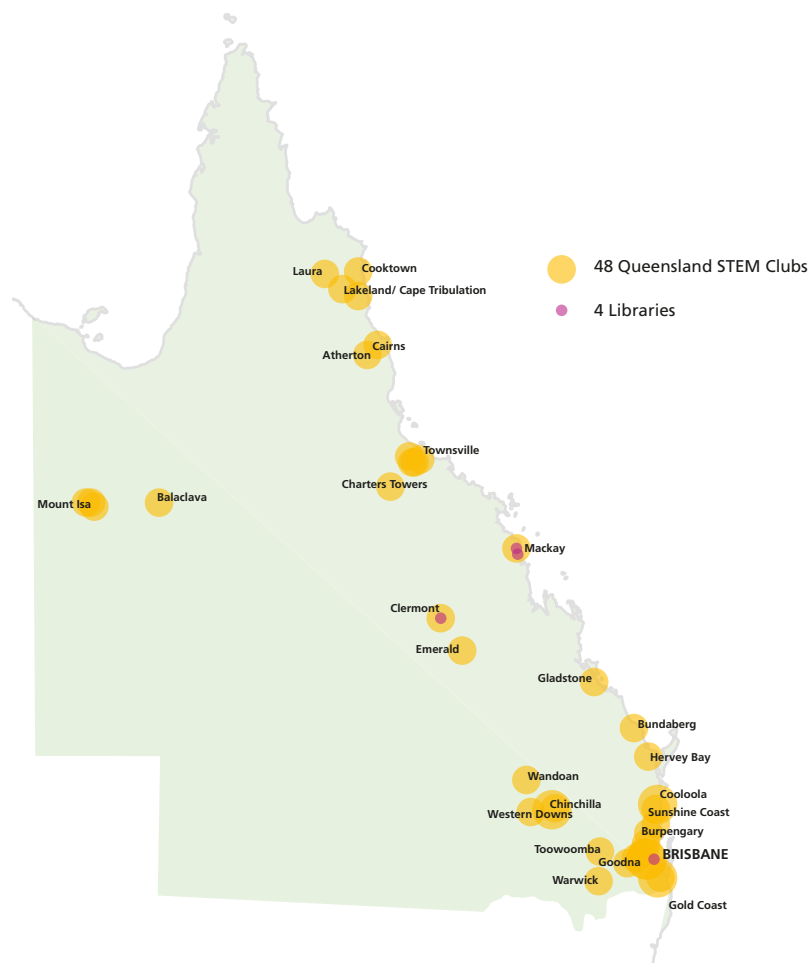


Figure 3 Queensland grant recipients

Refining the Framework



REFINING THE FRAMEWORK

A sample of participants representing all types of organisations involved in the pilot were invited to participate in an interview to discuss their experiences of using the draft framework. In total, nine participants from school and libraries were interviewed. Additionally, all pilot participants were invited to complete an online questionnaire about the draft framework and their experience of using it. In total, 31 responses were recorded. In analysing the data and presenting the findings, the team considered how many responses were recorded for each question and based percentages on this. Survey respondents included a fairly even spread of participants from public primary schools, public and private secondary schools, private education providers, libraries, and not-for-profit businesses. Responses were also received from a distance education provider, a multi campus private school, a secondary special assistance school, and a university.

Insights from the survey responses

Almost 90% of questionnaire participants found the *Health Check* they completed at the start of the pilot useful, a sentiment that was echoed by interview participants. Participants were asked if they completed the *Health Check* again at the end of the pilot. Of the 29 participants who responded to this question, 13 had completed it again (approximately 45%) and of those, all participants found the process of working through the checklist again useful. A further 12 participants (approximately 41%) indicated they had not completed the *Health Check* again at the close of the pilot but that they intended to do so, further indicating the usefulness of the tool. A quarter of participants indicated that some refinements to the *Health Check* were necessary, however, when asked what could be improved, a majority of the feedback focused on the second part of the framework, the emoji-based questionnaire. There was, however, the suggestion that repetition could be removed and a section on participant management be added.

More than 80% of questionnaire participants found the emoji-based participant questionnaire provided them with useful information. Roughly a quarter of respondents felt the questionnaire needed some refinements, with the majority of feedback centring on providing prompts and space for participants to provide more reflective comments about their experience of STEM club. Many of these participants felt that qualitative style questions would elicit useful information that would help them to both interpret the emoji responses and identify how they could improve participants' experience. Some participants also expressed some frustration or concern that all of the participant responses to the emoji-based questionnaire were positive and questioned the utility of a tool that does not elicit constructive or critical feedback. Some participants indicated the emoji-based questionnaire was not age appropriate for teenagers. It was also suggested that a targeted survey tool for parents might be useful. Participants indicated that using the emoji-based questionnaire in every session may not be necessary and doing so might make it a less effective tool.

The participants were asked whether they would use the evaluation framework, including participant questionnaire and the *Health Check* again in the future. Approximately 59% of respondents indicated they would, and a further 38% indicated they might use it again. Participants were asked to tell us why they would use it again. Comments included:

Provides valued guidance and a checklist to ensure we remain on target and the questionnaire provides valuable data for future planning and purchasing of resources relevant to our students.

It's a great structure to check off against.

“

The evaluation
framework is a
fantastic document
that can be used to
improve our STEM club.

”

Insights from the interviews

In addition to the findings from the survey, interview participants indicated that the *Health Check* prompted them to think about aspects of managing their club that they had not previously considered, including resourcing, sustainability, creating a vision for their STEM club, and establishing partnerships. Completing the *Health Check* not only prompted them to reflect on these aspects of club management, but to take action.

Some sample comments include:

[D]ue to your framework, your *Health Check* that came in... we came up with a... vision that we believe in giving all to the opportunity to experience more of the jobs today... We didn't have that before. So we're going to put that statement on all of our classrooms now because that's the reason why we do it.

I mean when I went through and looked through this evaluation framework, I went wow, I never even thought of that. I feel like having a plan, it's pretty cool.

| What happened as a result of these findings?

As a result of these findings, revisions were made to the draft evaluation framework and questionnaire. Changes made to the emoji-based participant questionnaire *How was STEM club today?* included the additions to the original survey that asks participants ‘how’ or ‘why’ questions related to the existing questions, to provide opportunities for reflective responses. *The How was STEM club today?* questionnaire remains part of the final evaluation framework, for use as a quick pulse check.

Two additional questionnaires have been developed for older students and parents using a more traditional Likert scale survey tool along with qualitative questions. Minor refinements were also made to the *Health Check* to remove repetition and to add a section on participant management.



Where to from here?

The initial eight Inspiring Australia Queensland research recommendations listed on page 7 aimed to inform the development of a STEM club network in Queensland. To date, the following three recommendations have been accomplished:

- Recommendation 4: Research into the state and nature of STEM clubs in Queensland;
- Recommendation 7: A comprehensive survey of STEM clubs including the trialling and refinement of an evaluation tool that supports a best practice framework for the operation and establishment of quality Queensland STEM clubs; and
- Recommendation 8: Delivery of focused early years STEM programs through a collaboration of libraries, school/industry, and citizen science projects with schools and universities.

The following recommendations are still in progress under the Inspiring Australia program.

- Recommendation 1: Establishment of a state-wide STEM Club network and advisory group;
- Recommendation 4: Development of STEM Club mission statements, principles, management and resource creation; and
- Recommendation 6: Research into regional, rural and remote STEM clubs.

Future work on refining and funding STEM club facilitator professional development, the development of learning and teaching resources, and the creation of club operational models have also been identified as key priority areas. The valuable STEM club resources generated as part of the research partnership between IAQ and USQ will go some way to supporting the creation, operation and resourcing of existing and future clubs.

SUMMARY

Overall, the research partnership between IAQ and USQ has been a productive and rewarding venture that has resulted in several products, including an effective evaluation framework, a comprehensive database, a toolkit of practical STEM club resources, and two peer-reviewed publications. The evidence collected and the resources developed throughout this project will assist in the progression and expansion of this emerging STEM field.



Visit the Inspiring Queensland STEM clubs website to access the STEM Clubs Toolkit and the Evaluation Framework: inspiringqld.com.au/stem-clubs

Reference List

- Gottfried, M. A., & Williams, D. (2013). STEM club participation and STEM schooling outcomes. [math club; science club; STEM]. *Education Policy Analysis Archives*, 21doi:10.14507/epaa.v21n79.2013 Retrieved from <https://epaa.asu.edu/ojs/article/view/1361>
- McCallie, E., Bell, L., Lohwater, T., Falk, J., Lehr, J., Lewenstein, B., Needham, C., Wiehe, B. (2009). *Many experts, many audiences: Public engagement with science and informal science education*. Washington DC: A. C. I. G. Report. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=https://www.google.com.au/&httpsredir=1&article=1011&context=eth_fac
- Moriarty, J. (2017). *Science clubs: A starting point* Inspiring Australia Queensland.
- Watermeyer, R. (2012). Confirming the legitimacy of female participation in science, technology, engineering and mathematics (STEM): evaluation of a UK STEM initiative for girls. *British Journal of Sociology of Education*, 33(5), pp. 679-700. doi:10.1080/01425692.2012.678751 Retrieved from <https://doi.org/10.1080/01425692.2012.678751>

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