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A DEVELOPMENTAL EVALUATION OF THE UNIVERSITY OF SOUTH AUSTRALIA'S STEM SHOWDOWN PROGRAM: REPORT No. 1

C3L

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EFA'S DEVELOPMENTAL EVALUATION APPROACH

EFA's evaluation framework draws from Patton's (2021) developmental evaluation (DE) approach. DE is distinct from traditional evaluation as it supports innovation and adaptation to emergent and dynamic realities in complex environments. Traditional evaluation approaches, on the other hand, advocate for clear, specific, measurable outcomes that are to be achieved through a linear logic model. The programs we evaluate, including university outreach – what the EFA refer to more accurately as 'connect' programs as they are capacity building programs rather than those based on marketing the university – are working with degrees of uncertainty, turbulence, and emergence that traditional evaluation does not account for. As developmental evaluators, we help to surface and 'make sense of emergent problems, strategies, and goals as the social intervention *develops*' (Patton, 2021, p. 24). This enables us to provide timely feedback that can be used to adapt and improve aspects of a program. In future stages of a DE, we can then use evaluation data – for example, survey instruments, interviews, observations, learning artefacts, etc. – to work to identify patterns and new information that can be used in a feedback loop, i.e. a cyclical process whereby the output of a system, action, or decision is used to modify future actions or decisions. Essentially, we use DE to support ongoing real-time decisions about what to change, expand, close out, or further develop in the connect work.

Our DE approach applies a contribution analysis lens to examine how an intervention or program influences practice and outcomes over time. Contribution analysis is designed to test and refine a program's Theory of Change (ToC) by exploring whether, how, and under what condition an intervention is contributing to desired outcomes (Mayne, 2008). Rather than seeking simple attribution ('did it work?'), it builds a plausible, evidence-informed narrative of a program's role in change processes within complex systems such as schools, communities, or higher education settings.

A central feature of our approach to contribution analysis is through the surfacing of tensions (Leonard et al., 2025). In complex educational initiatives, tensions frequently arise between competing priorities or between different actors' expectations and practices. Identifying and analysing these tensions does not imply deficit, rather, it helps us clarify real-world constraints and opportunities shaping implementation.

Through workshops, focused conversations, and review of program documentation, we work collaboratively with stakeholders to map these tensions and analyse how they impact on the intended outcomes. This process allows a ToC to be tested and refined as new insights emerge, creating an evidence-base for adaptive decision-making and continuous improvement. As a result of our approach, we shift our focus from *'Does this program work?'* to *'What elements of the program enable the outcomes to occur?'*

The evaluation methodology as set out above follows a set of six grounding principles. These principles enable evaluation-based collaborations that are responsive to the immediate needs of our partners, while also supporting the generation of important knowledge about what is working and for whom in relation to our student equity groups as defined by the *Australian Universities Accord* (2024) – including people from low socioeconomic backgrounds, Aboriginal and Torres Strait Islander peoples, people from regional and remote areas, people with disabilities, people from non-English speaking backgrounds (also referred to as 'culturally and linguistically diverse'), and women in non-traditional areas of specialisation. It follows that our developmental evaluations are:

1. **Theory-informed –** the evaluative work is informed by the contemporary learning theories and learning sciences, providing all stakeholders with current and relevant research.
2. **Collaborative –** evaluation is designed and scoped in collaboration with relevant stakeholders, ensuring different perspectives are appropriately considered.
3. **Meaningful –** produces knowledge that is relevant, timely and insightful.
4. **Sustainable –** the evaluation incorporates the organisation and system capacity development to ensure the translation of findings into practice is sustainable.
5. **Aligned –** the evaluation process informs organisational priorities and aims in a manner that enables the achievement of the program's goals.
6. **Iterative –** the evaluation design includes early and timely reporting so it can evolve and adjust to changing needs and circumstance.

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STEM Showdown

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INTRODUCTION

This formative evaluation report is intended to inform the ongoing design and development of the University of South Australia's outreach program, STEM Showdown.

Program Overview: STEM Showdown

STEM Showdown is an outreach program delivered in the pre-access student life stage as outlined in *The Student Equity in Higher Education Evaluation Framework* (SEHEEF) (Johnstone et al., 2021). The program is designed to engage Year 5 and 6 school students in Science, Technology, Engineering, and Mathematics (STEM). Students use problem-solving skills to complete their weekly task using one of three delivery models: (1) UniSA staff delivered; (2) hybrid delivery whereby UniSA staff deliver some of the activities with the remainder delivered by the classroom teacher; or (3) classroom teacher delivered (teachers access the course and resources online through a Moodle site). Schools generally begin with the first delivery model before transitioning to the second or third model. The flexibility of the delivery mode also encourages greater participation amongst regional and remote schools. The workshop is designed for delivery across a six-to-ten-week timeframe for schools serving disadvantaged communities. The uptake of this program predominantly occurs in schools which are geographically located in the northern suburbs of Adelaide, South Australia – one of Australia's most socioeconomically and educationally disadvantaged communities – and regional and remote areas such as Whyalla, Pitjantjatjara Yankunytjatjara Lands, and the Riverlands.

Purpose of the Evaluation

The primary purpose of this evaluation is to construct a clear, testable *Theory of Change* (ToC), which sets out the pathways through which change is anticipated to occur. A theory-based approach to evaluation is particularly useful in education programs because it encourages us to move beyond simply asking whether an initiative 'worked' to instead considering how and why certain components or arrangements might work, for whom, and under what conditions. As Moore et al. (2022, p. 60) explain, theories of change allow evaluators and practitioners 'to hypothesise about the mechanisms that might generate positive changes for the target groups, in which context and why'.

By setting out this logic clearly, the evaluation provides a shared framework for our stakeholders by clarifying the purpose of the program activities, identifying the intended outcomes, and making the assumptions underpinning the work transparent. This is important because when assumptions remain implicit, they cannot be tested or improved. In contrast, a clearly articulated ToC allows us to test whether the program is achieving what it set out to do, adapt the design in response to the evidence in future iterations, and ensure that the program continues to serve equity goals in STEM education.

STEM EDUCATION: AN EQUITY IMPETUS

Broadly speaking, interest in STEM education has gained momentum due to two main agendas. The first is political with the Australian Government prioritising economic and vocational goals, and the second is educational, in terms of what students should know and be capable of in the 21st century (Berry et al., 2025). Over the past decade, the political agenda has been a significant driving force in Australian schools. Set against this agenda, the goal of STEM education is to increase the number of students pursuing post-secondary school studies in STEM disciplines, with the broader aim of expanding the STEM workforce and contributing to national prosperity (Berry et al., 2025; O'Dwyer et al., 2023).

Although the political agenda aligns with Australian universities' goal to widen student participation in STEM related degrees, it is also important to note that an exclusive focus on participation metrics risks obscuring questions of equity and *curricular justice.* Connell (1993) outlines three principles of curricular justice: (1) curriculum should be designed with the interests of the least advantaged in mind; (2) it should promote participation and common schooling, and (3) it should acknowledge the historical production of equality (pp. 43–48). Building on Connell's second principle, Nieto and Bode (2017) argue that curricular justice requires confronting inequality through equal access to education, providing all students with meaningful and high-quality learning that raises achievement, and apprenticing young people to engage critically and productively in a democratic society (p. 6). In this sense, equity extends beyond widening participation to STEM in both schooling and higher education. It requires that students from disadvantaged communities are offered meaningful opportunities to engage with disciplinary knowledge in ways that affirm their identities, recognise their experiences and knowledge, and expand their educational possibilities.

Positioning STEM Showdown within the SEHEEF (Johnstone et al., 2021) highlights the importance of this broader view. In the pre-access stage, equity-focused outreach programs must ensure that students' first encounters with university-designed learning are not only motivating but also inclusive and responsive to diverse cultural, social, and geographical contexts. For instance, the multiple delivery methods – whether delivered directly by UniSA staff, in partnership with teachers, or wholly by classroom teachers accessing Moodle resources – reflect an intentional commitment to equity by reducing barriers for schools in regional and remote areas. Such design choices take on added importance in light of the persistent underrepresentation of students from rural, regional, and remote areas in STEM fields (Education Council, 2018).

At the same time, equity here involves recognising and addressing systemic inequities in who sees themselves as capable of 'doing' STEM. This is particularly evident in Australia's gender gap in STEM: although women represent 47.9% of the overall paid labour force (Workplace Gender Equality Agency, 2022), they comprise only 15% of the STEM-qualified workforce (Australian Government, 2024). Research suggests that these disparities have roots in schooling, where female students across primary, middle and secondary levels consistently report lower self-efficacy in STEM compared to their male peers (Archer et al., 2013; DeWitt et al., 2014). These findings have prompted calls for early interventions with the primary school years ‘now considered a critical time for fostering a positive disposition towards STEM’ (Harnischfeger & Stahl, 2025, p. 2492).

Research consistently highlights that students from low SES backgrounds face significant barriers to accessing and succeeding in STEM education. For instance, Cooper and Berry’s (2020) Australian study of over 4,300 students found that SES has the strongest impact on whether secondary school students study science subjects post-16, with students from low SES backgrounds less likely to engage in these areas. The Education Council’s (2018) *Optimising STEM Industry-School Partnerships* report emphasises this point, noting that encouraging interest in STEM subjects among low SES secondary students is a significant challenge. The report calls for targeted interventions – including those which provide teachers with high quality, discipline specific professional learning – to bridge this gap and provide equitable opportunities for all students.

Aboriginal students also encounter unique challenges in accessing and succeeding in STEM education with recent national data highlighting the depth of this inequity. For instance, in 2023, only one in three Aboriginal Year 6 students and one in four Year 10 students achieved the NAP-Science proficient standard (Gebhardt et al., 2024). These schooling outcomes are reflected in post-school transitions where Aboriginal adults hold university STEM qualifications at far lower rates (approximately 0.5%) than non-Indigenous adults (approximately 5%) (Gebhardt et al., 2024).

Persistent inequities in STEM engagement linked to geography, gender, socioeconomic background and Aboriginal identity highlight the need for STEM outreach programs that are both inclusive and culturally responsive to the communities they serve.

EVALUATION OVERVIEW

Key evaluation questions

The purpose of this developmental evaluation (DE) is to provide a foundation for understanding how the STEM Showdown contributes to equity-focused outcomes in schools. More specifically, the evaluation aims to make explicit the program's underlying ToC, highlight the assumptions that inform it, and begin to map the situational dynamics of the systems in which the program operates. This work is intended to be formative, providing a platform for ongoing empirical inquiry and refinement. As such, this DE has been guided by the following overarching questions:

- *What elements of STEM Showdown hinder and/or enable its outcomes?*
- *What assumptions underpin the STEM Showdown program and how do these inform its intended outcomes?*

Cohorts of interest

The primary cohort of interest in this evaluation are the STEM Outreach Officers as program facilitators and mediators between university and school contexts.

For future evaluative work, cohorts of interest will extend to primary school teachers who are currently, or have previously, engaged with STEM Showdown.

Parameters of the evaluation

This DE is bounded by its focus on the ToC, its assumptions and the tensions which impact upon it. It incorporates qualitative insights drawn from the initial workshop and subsequent conversations with STEM Showdown Outreach Officers. Approved survey and semi-structured interview instruments (see Appendices A to C) provide the basis for further empirical testing and refinement in future phases of the evaluation.

What is not being evaluated

This evaluation does not assess:

- The overall effectiveness or scalability of STEM Showdown as a program;
- Student achievement outcomes in STEM subjects; or
- Comparative effectiveness between the different modes of STEM Showdown delivery.

METHODOLOGY

All educational sites are complex. They are eco-systems in which many actors engage – educators, learners, community members – to achieve numerous and diverse goals. Given this reality, our evaluation approach goes beyond assessing whether an innovation 'worked', and investigates what worked, from whom, and in what contexts. When outcomes fall short, we aim to examine why in order to better refine and improve program design.

Our approach builds upon an increasing body of scholarship in evaluation making use of complexity science to engage with complex problems in public policy domains such as education. This scholarship has shown that most public policy problems are non-linear and do not respond to simple interventions. The problems we are dealing with today behave like an eco-system, so our approach explores the complex interactions, feedback loops, and emergent properties we find in complex systems like STEM Showdown and the schools in which it operates.

Our process involves using contribution analysis to surface tensions that influence how a program operates and what outcomes it can reasonably achieve. Tensions may reflect competing priorities, resource constraints, or differences in expectations between actors. Mapping these dynamics in addition to the program's ToC helps make explicit the assumptions underpinning an initiative and provides evidence for refining its design and delivery.

In July 2025, we conducted an interactive and intensive four-hour workshop with the two Outreach Officers responsible for the design, administration, coordination, mentoring, and delivery of the STEM Showdown program. Guided by an equity agenda, the workshop created a structured space for participants to articulate their understanding of the program, identify its key activities/components and anticipated outcomes, and begin to explore factors influencing program effectiveness. The insights generated have been used to identify current tensions and to make explicit a preliminary Theory of Change (ToC), providing a structured means of bringing together assumptions and intentions that had until now remained largely implicit within the program design. Following the workshop, the evaluation team engaged in further informal conversations and reflective discussions with the Outreach Officers to refine both the modelling and the ToC.

THEORY OF CHANGE: EQUITY BY DESIGN

Our initial stakeholder conversations with the STEM Showdown outreach officers, together with recent literature, have informed the causal links and assumptions in this recommended ToC. Assumptions and evidence that informed this ToC are outlined in detail below.

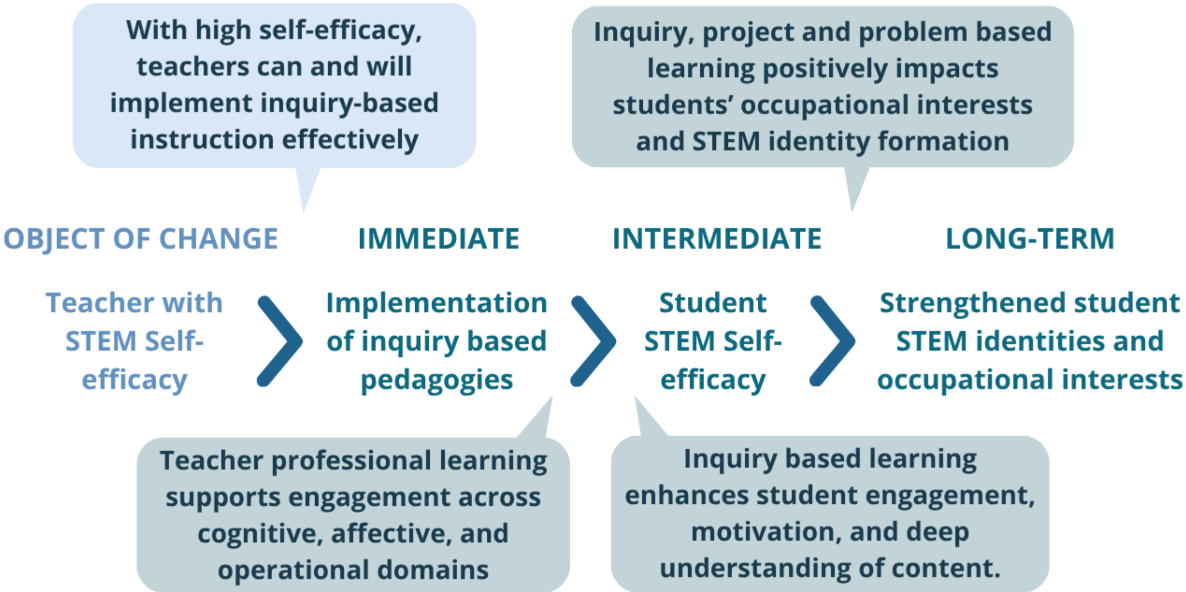

Figure 1: Theory of Change using research informed assumptions

A Theory of Change works when its assumptions are met, allowing the expected outcomes to transpire. These assumptions are represented in the model in the coloured boxes. The Object of Change of STEM Showdown, i.e. teachers' STEM self-efficacy, is an enabler for some of these assumptions, suggesting a strong Theory of Change.

Object of Change: Self-Efficacy for Teaching STEM

Although the program focuses on engaging primary students in STEM learning, it also intends to develop primary school teachers' self-efficacy and capacity to teach in STEM. A growing body of evidence highlights teacher self-efficacy as a key factor in strengthening teacher retention and professional satisfaction, and 'maximising student achievement, particularly in STEM' (Perera et al., 2022).

While teacher self-efficacy was not a deliberate design component of the initial ToC, the program facilitators expressed the importance of supporting teachers' confidence in teaching STEM, demonstrating that it was implicitly included as an intended outcome.

Self-efficacy, as described by Bandura (1977), refers to an individual's competence in specific domains of behaviour. In terms of teaching, self-efficacy involves a teacher's 'belief in their capabilities to teach effectively' (Toma et al., 2024, p. 2). These beliefs together with the emotional responses they evoke (Fowler et al., 2025; Leonard, 2022), play a crucial role in shaping decision-making, influencing both the choices that individuals make and their performance and persistence when faced with challenges. The development of self-efficacy is shaped by four key sources of information (Anderson & Betz, 2001): personal experiences of success, learning vicariously through others, positive emotional engagement, and verbal encouragement.

STEM Showdown provides opportunities for teachers through:

- **Personal experiences of success** – teachers have opportunities to trial STEM activities in their classrooms, building their confidence through direct experience. Successfully implementing these activities can bring them a sense of mastery that can be transferred to future STEM teaching.
- **Learning vicariously through others** – teachers observe live modelling of the STEM activities by university outreach staff (university delivered or hybrid model), so they can watch how STEM activities can be successful in a risk-free environment. This allows teachers to adapt activities to their own practice.
- **Positive emotional engagement** – teachers and students both experience a positive, enjoyable environment. Joyfully experiencing the exploratory-based activities reframes STEM as approachable and engaging, likely reducing teachers' concerns associated with teaching STEM.
- **Verbal encouragement** – teachers receive affirmation and/or guidance from university staff to help reinforce their sense that they are capable of successfully teaching STEM. Professional conversations also allow for feedback or discussion of the learning and work to support teachers' professional development.

Immediate Outcome: Implementation of Inquiry-Based Learning

Teachers within a discipline are more likely to adopt inquiry-based learning (IBL) when they have high self-efficacy (Perera et al., 2022; Toma et al., 2024). For STEM education in particular, this is critical because inquiry-based pedagogies actively engage students in processes that reflect the authentic practices of scientists, including posing questions, testing ideas, analysing evidence and applying solutions to real-world contexts. These pedagogies have been found to cultivate greater student curiosity, engagement, problem-solving and deeper conceptual understanding (Attard et al., 2021).

Research also shows that IBL contributes to a range of positive student outcomes. For example, IBL has been found to stimulate students' interest in STEM subjects and increase capacities to aspire toward STEM-related careers (Ribeirinha et al., 2024). By creating opportunities for students to explore STEM in ways that show how relevant it is in their everyday life and social issues, IBL can also help to disrupt persistent gender stereotypes and broader participation in these historically underrepresented fields (Ribeirinha et al., 2024).

Beyond this, research also shows that linking STEM to students' local environments can make learning more meaningful for diverse groups of students and foster positive attitudes towards STEM learning and careers (Attard et al., 2021). This approach – whether through context-based, place-based or local examples – provides entry points for connecting abstract ideas to tangible, lived experiences. These practices also align closely with an Australian culturally responsive pedagogy (CRP). CRP is 'an educational approach that invites students to bring their home cultures into the classroom', viewing 'cultural difference as an asset' (Morrison et al., 2023, p. 212).

It is recommended to explicitly include the following outcomes of STEM Showdown:

- ***Recommendation 1:*** *Teachers develop greater confidence and self-efficacy to implement inquiry-based approaches that connect STEM learning to local, real-world contexts.*
- ***Recommendation 2:*** *Teachers implement inquiry-based STEM pedagogies in their classrooms.*

Intermediate Outcome: Student STEM Self-Efficacy

A central intermediate outcome of STEM Showdown is enhancing student STEM self-efficacy – that is, their belief in their own ability to engage with STEM learning tasks and concepts. Holmes et al. (2022) show that place-based and contextualised curricula, where STEM learning is embedded in students' local experiences and communities, enhance engagement, motivation, and confidence in STEM. Beyond this, when teachers are supported to draw on context-relevant challenges, students not only demonstrate increased engagement and deeper conceptual understanding, but also begin to see themselves as capable learners (Perera et al., 2022; Toma et al., 2024).

Supporting students' self-efficacy is likely a to help them persist in STEM pathways. As Bandura (1977) argues, individuals with higher self-efficacy are more likely to attempt challenging tasks, exert greater effort and recover from setbacks. In terms of STEM education, research has consistently shown that students' self-efficacy is strongly associated with persistence and achievement (Britner & Pajares, 2006) and plays a central role in shaping interest and career aspirations (Maltese & Tai, 2011).

It is recommended to retain the following intermediate outcome of STEM Showdown:

- ***Recommendation 3:*** *Students have self-efficacy in participating in STEM activities.*

Long Term Outcome: Strengthened Student STEM Identities

The long-term aspiration of STEM Showdown is to develop positive student STEM identities. STEM identity refers to how 'individuals perceive, position, and align themselves with their conceptions of STEM based on their experiences with STEM' (Cohen et al., 2021, p. 1127). While identity formation is influenced by personal interest or competence, it is also shaped by recognition, representation and opportunities for participation in authentic STEM practices.

STEM identity has been found to play a critical role in students' decisions to persist in STEM pathways (Dou et al., 2019; Vieira et al., 2024; Vincent-Ruz & Schunn, 2018). For instance, Hazari et al. (2010) found that science identity was a strong predictor of students' intentions to pursue science-related degrees, whilst Lockhart et al. (2022) states that a 'science identity' is the 'greatest predictor of STEM persistence' (p. 2). Similarly, Godec et al. (2024) demonstrate that students who can align their developing identities with positive representations of STEM are more likely to aspire toward, and sustain engagement with, STEM careers. These findings indicate that identity is a long-term mediator between classroom experiences and life-course participation in STEM.

It is recommended to retain the following as the driving long-term outcome of STEM Showdown:

- ***Recommendation 4:*** *Students develop strong STEM identities and interests in STEM career.*

STEM SHOWDOWN: TENSIONS AND ENABLERS

Initial tensions and enablers identified through the workshop and subsequent conversations with the Outreach Officers are presented below. These tensions and enablers highlight the key relationships, activities and mediating factors that influence how the program operates in practice. Mapping them has directly informed the Theory of Change by clarifying how activities are expected to interact with contextual factors to generate short, intermediate, and long-term outcomes. The proposed collection of qualitative data in the upcoming STEM Showdown research will enable confirmation and/or advancement of the identified tensions.

Tension and Enabler 1: Teachers' STEM and pedagogical knowledge varies

Teachers' confidence to teach in a discipline, including STEM, is closely tied to their disciplinary knowledge. When STEM content and pedagogical knowledge fall outside their area of specialisation, self-efficacy for teaching it can be low and they may forgo teaching STEM [tension]. To address this, the STEM Showdown facilitators model good practice in real time with the teacher's own students in their own classrooms, which acts as a tool for vicarious experience for the teachers. This in turn increases teachers' STEM self-efficacy [enabler].

Because of this, recommendations are:

- ***Recommendation 5:*** *Explicitly share pedagogical reasoning in real-time with teachers during facilitation*
- ***Recommendation 6:*** *Include the Framework for Engagement with STEM (see Figure 2) and the Inquiry-based Learning Framework (see Appendix C) in handover materials for teachers*

Tension and Enabler 2: Designing STEM learning for all students

Students have different levels of experience and personal interest in STEM, which means the way they engage with an activity can be highly varied [tension]. Likewise, diverse student experiences mean that they may need different supports when experiencing unfamiliar inquiry-based frameworks, creating an equity gap [tension].

The facilitators of the program have deep pedagogical knowledge and lived experience that enables them to support diverse classrooms [enabler]. This demonstrates STEM Showdown's unique capacity to build STEM skills equitably, provided equity frameworks are embedded into the design of activities.

Because of this, recommendations are:

- ***Recommendation 7:*** *Use the Culturally Responsive Pedagogy (Rigney et al., 2025) resources to explicitly inform the design of future activities*
- ***Recommendation 8:*** *Include links to the Culturally Responsive Pedagogy resources in the handover materials for teachers to adapt STEM activities in their own classrooms*

STEM SHOWDOWN: SUMMARY AND FUTURE OPPORTUNITIES

This developmental evaluation (DE) has provided a detailed Theory of Change (ToC) for STEM Showdown – including, importantly, the underlying assumptions which inform it – along with the initial tensions of the STEM Showdown activity. As the first in a planned series of formative evaluations, this DE provides a foundation for further empirical work aimed at refining the modelling and testing the ToC. The quantitative and qualitative instruments outlined in Appendices A, B, and C, as approved by UniSA's Human Research Ethics Committee (protocol number: 206458), provide a starting point for this work.

Building on the insights gained from this report, the following section highlights potential opportunities for enhancing the program's impact. The opportunities outlined here are not intended to be exhaustive or prescriptive. Rather, they are presented as possible approaches for supporting teachers to move incrementally toward inquiry-based learning models as the next stage of the ToC. Importantly, these suggestions do not call for a re-design of the STEM Showdown program itself, but rather a re-thinking of how the handover or transition from an Outreach Officer delivered mode to teacher-delivery might be most effectively supported.

Tools for Supporting Inquiry Based Pedagogies

Framework for Engagement with STEM

Attard et al.'s (2021, p. 3) *Framework for Engagement with STEM*, or a modified version of it, may be a particularly useful tool for assisting participating STEM Showdown teachers to design, plan for, and reflect on engaging STEM learning experiences. Incidentally, the authors define engagement as 'a deeper student relationship with classroom work, multi-faceted and operating at cognitive, affective, and behavioural levels' (Attard et al., 2021, p. 2). The framework is set out below in Figure 2:

Aspect	Code	Element
Pedagogical Relationships	In an engaging STEM classroom, positive pedagogical relationships exist where these elements occur	
	PK	Pre-existing Knowledge: students' backgrounds and pre-existing knowledge are acknowledged and contribute to the learning of others
	CI	Continuous Interaction: interaction amongst students and between teacher and students is continuous
	PCK	Pedagogical Content Knowledge: the teacher models enthusiasm and an enjoyment of STEM-based content and has a strong Pedagogical Content Knowledge within each of the curriculum areas
	TA	Teacher Awareness: the teacher is aware of each student's STEM-related discipline abilities and learning needs
	CF	Constructive Feedback: feedback to students is constructive, purposeful and timely
Pedagogical Repertoires	Pedagogical repertoires include the following aspects	
	SC	Substantive Conversation: there is substantive conversation about STEM-related concepts and their applications to life
	CT	Challenging Tasks: tasks are positive, provide opportunity for all students to achieve a level of success and are challenging for all
	PC	Provision of Choice: students are provided an element of choice
	ST	Student-centred Technology: Technology is embedded and used to enhance STEM understandings through a student-centred approach to learning
	RT	Relevant Tasks: the relevance of learning within the STEM disciplines is explicitly linked to students' lives outside the classroom and empowers students with the capacity to transform and reform their lives
	VT	Variety of Tasks: STEM-related lessons regularly include a variety of tasks that cater to the diverse needs of learners

Students are engaged with STEM when

- They enjoy STEM-related learning
- They value STEM-related learning and see its relevance in their current and future lives, and
- They see connections between the STEM concepts and practices learned at school and the STEM concepts and practices used beyond the classroom

Figure 2: Attard et al.'s (2021) Framework for Engagement with STEM

Inquiry Based Learning

The program is well positioned to support teachers in choosing inquiry-based learning through the use of an *Education Futures Academy* designed rubric, aligned to the Australian Curriculum. This rubric (see Appendix D) is structured as a continuum ranging from 'prescription' through 'confirmation', 'structured inquiry', 'guided inquiry', and finally 'open inquiry'. Teachers can use the rubric both to design their STEM units and to assess the extent to which their planning and classroom activities reflect inquiry-based pedagogical practices.

Culturally Responsive Pedagogy

A valuable next step could involve directing teachers to Rigney et al.'s (2025) *Culturally Responsive Pedagogy* site: https://culturallyresponsivepedagogy.com.au/ This resource introduces key concepts of culturally responsive teaching and provides a self-paced professional learning package. Teachers can engage with the materials individually or collaboratively in teaching teams to design or re-design units of work, including STEM units and STEM Showdown activities, that then better reflect and respond to the needs of their diverse classrooms. Embedding this resource into a post-Showdown handover process, or package, could support teachers in sustaining inquiry-based and locally contextualised approaches to their STEM teaching.

Final Remarks

As this report represents the first formative evaluation of STEM Showdown, the focus of the initial data collection has been on understanding the environment in which the program operates, developing a testable ToC, and identifying its underlying assumptions. As Mayne (2008) points out, assumptions are one of the three forms of evidence required to validate a ToC, the remaining include observed results and the influencing factors (p. 16). This developmental approach lays the groundwork for future evaluations that will include teachers' and other stakeholders' perspectives. Future stages will also include the implementation of qualitative and quantitative instruments – i.e., a mixed-methods approach – to test the ToC, generate evidence of immediate and intermediate outcomes and inform ongoing program improvement. These instruments are provided in Appendices A, B, and C.

And finally, the recommendations in this report are not intended as prescriptive directions. Instead, they are opportunities for STEM Showdown to extend its impact and establish itself as a catalyst for more STEM inquiry-based pedagogical change within schools. By equipping teachers with practical tools such as the *Framework for Engagement with STEM* and the inquiry-based learning rubric and resources for designing culturally responsive pedagogy, the program has the potential to strengthen teacher capacity and embed equity-focused practices into everyday classroom learning. Looking to the Theory of Change as a reminder of the long-term intentions of STEM Showdown, these opportunities represent strategic steps towards achieving the longer-term outcomes of the program; namely, that all students have the opportunity to build strong STEM self-efficacy and identities.

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APPENDICES

Appendix A: Adapted Basic Psychological Needs at Work Survey

This survey is an adaptation of the Basic Psychological Needs at Work Survey (Deci, Ryan, Gagné, Leone, Usunov, & Kornazheva, 2001; Ilardi, Leone, Kasser, & Ryan, 1993; Kasser, Davey, & Ryan, 1992). It is used to better understand a teacher's motivation for teaching a specific subject with respect to how they perceive teaching that subject satisfies their own need for feelings of autonomy, competence and relatedness.

Instructions:

The following questions concern your feelings about your job in the last year when teaching [subject]. Please indicate how true each of the following statements is for you given your experiences at work. Remember that your responses will not be shared with anyone at your school.

Using the scale where 1 is not at all true, and 7 is very true:

1. I feel like I am able to have a lot of input into how [subject] is taught in my class.
2. I really like the people I work with when planning and teaching [subject].
3. I do not feel very competent when I am teaching [subject].
4. People at work tell me I am good at teaching [subject].
5. I feel pressured when teaching [subject].
6. I get along with people involved in planning and teaching [subject].
7. I pretty much keep to myself when I am planning and teaching [subject].
8. I am free to express my ideas and opinions when planning and teaching [subject].
9. I consider the people I work with when teaching [subject] to be my friends.
10. I have been able to learn interesting new skills when teaching [subject]. (New skills may include subject specific skills or wider pedagogical skills).
11. When I am teaching [subject], I have to do what I am told.
12. Most days I feel a sense of accomplishment from teaching [subject].
13. My feelings are taken into consideration at work.
14. When I am planning or teaching [subject] I do not get much of a chance to show how capable I am.
15. People at work care about me.
16. There are not many people at work that I am close to.
17. I feel like I can pretty much be myself at work.
18. The people I work with do not seem to like me much.
19. I often do not feel very capable when I am planning or teaching most subjects.
20. In general, there is not much opportunity for me to decide for myself how to go about my work.
21. In general, people at work are pretty friendly towards me.

Scoring Information

Form three subscale scores by averaging item responses for each subscale after reverse scoring the items that were worded in the negative direction. Specifically, any item that has

(R) after it in the code below should be reverse scored by subtracting the person's response from 8. The subscales are:

Autonomy: 1, 5(R), 8, 11(R), 13, 17, 20(R)

Relatedness: 2, 6, 7(R), 9, 15, 16(R), 18(R), 2

Competence: 3(R), 4, 10, 12, 14(R), 19(R)

Appendix B: Adapted Teacher Self-Efficacy Scale (Short Form)

This survey is an adaptation of the Teacher Self-Efficacy scale (Tschannen-Moran & Hoy, 2001). It is used to better understand a self-efficacy for teaching but has been adapted to the particular subject you are exploring.

The following questions concern your feelings about your job when teaching [subject]. Please indicate how true each of the following statements is for you given your experiences at work. Remember that your responses will not be shared with anyone at your school.

Using the scale detail how much you can do in relation to each question where 1 is nothing, and 9 is a great deal:

1. How much can you control disruptive behaviour in (subject) classes?
2. How much can you motivate students who show low interest in (subject)?
3. How much can you get students to believe they can do well in (subject)?
4. How much can you help your students value learning in (subject)?
5. To what extent can you craft good questions for your students about (subject)?
6. How much can you get children to follow classroom rules during (subject) lessons?
7. How much can you calm a student who is disruptive or noisy during (subject) classes?
8. How well can you establish a classroom management system for (subject) classes?
9. How much can you use a variety of assessment strategies in (subject)?
10. To what extent can you provide an alternative explanation or example when students are confused about (subject)?
11. How much can you assist families in helping their children do well in (subject)?
12. How well can you implement alternative strategies in your (subject) classroom?

Scoring Information

Once all responses are recorded, proceed to calculate the scores for each of the three subscales. These subscales are Efficacy in Student Engagement, Efficacy in Instructional Strategies, and Efficacy in Classroom Management. The items for each subscale are specified as follows: Efficacy in Student Engagement includes items 2, 3, 4, and 11; Efficacy in Instructional Strategies comprises items 5, 9, 10, and 12; Efficacy in Classroom Management consists of items 1, 6, 7, and 8. Calculate the unweighted mean for each subscale by adding the scores of the respective items and then dividing by the number of items in that subscale.

The final scores reflect the teacher's efficacy in each area, with higher scores indicating stronger efficacy. These results can be used to pinpoint strengths and identify opportunities for professional development and improvement in specific areas of teaching efficacy.

Appendix C: Semi-Structured Interview Questions (Primary School Teachers)

1. What motivated you to participate in the [intervention]?
2. Since being involved in the [intervention], what changes have you noticed with respect to your ability to have input or make decisions about how [subject] is taught?
3. Are there any things you have learned from working with the [intervention] that make you feel better able to teach [subject]?
4. Have you found yourself engaging with other people about how to teach [subject]? Who are they — other teachers, people outside of your school? And what do you talk about?
5. Have you made any changes to the way you seek out new activities or resources for teaching [subject]?
6. What has been your greatest accomplishment when teaching [subject]?

Curriculum outcome	Prescription	Confirmation	Structured Inquiry (Low prior knowledge and experience)	Guided Inquiry (Medium prior knowledge and experience)	Open Inquiry (High prior knowledge and experience, advanced learners)
Questioning and Predicting 1-2: Pose questions to explore observed simple patterns and relationships and make predictions based on experiences (AC9S2I01) 3-4: pose questions to explore observed patterns and relationships and make predictions based on observations (AC9S4I01) 5-6: pose investigable questions to identify patterns and test relationships and make reasoned predictions (AC9S6I01)	*Student engages with a question provided by teacher.*	*Student chooses from a provided, constrained set of questions.*	*Student sharpens or clarifies a question or questions provided by teacher, or other source.*	*Based on discussion with teacher, or others, student poses and refines their own question.*	*Student autonomously poses a question of interest.*
Planning and Conducting 1-2: suggest and follow safe procedures to investigate questions and test predictions (AC9S2I02)	*Student follows a provided plan of investigation.*	*Student follows a plan that offers limited choices in approach, or that the teacher develops*	*Student adapts and refines a plan outline that is provided or*	*Student uses a planning framework to devise and enact a plan.*	*Student autonomously devises and enacts a*

3-4: use provided scaffolds to plan and conduct investigations to answer questions or test predictions, including identifying the elements of fair tests, and considering the safe use of materials and equipment (AC9S4I02) 5-6: plan and conduct repeatable investigations to answer questions including, as appropriate, deciding the variables to be changed, measured and controlled in fair tests; describing potential risks; planning for the safe use of equipment and materials; and identifying required permissions to conduct investigations on (AC9S6I02)		*using guided discussion.*	*developed in class discussion.*		*plan for a chosen investigation.*

Developed from 'ASELL for School – Victorian node's Inquiry Scaffold Tool https://blogs.deakin.edu.au/asell-for-schools-vic/inquiry-scaffold-tool/

Processing, Modelling and Analysing 1-2: sort and order data and information and represent patterns, including with provided	*Student uses provided representations such as tables to record/process data.*	*Student chooses from provided representations to record/process data.*	*Student draws on a structured framework, possibly developed through class discussion, to construct*	*Student draws on a provided outline of possible approaches to develop representations to record/process data.*	*Student autonomously develops representations to appropriately record/process data.*

tables and visual or physical (AC9S2IO4) 3-4: construct and use representations, including tables, simple column graphs and visual or physical models, to organise data and information, show simple relationships and identify (AC9S4IO4) 5-6: construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships (AC9S6IO4)			*representations to record/process data.*		
Evaluating 1-2: compare observations with predictions and others' observations, consider if investigations are fair and identify further questions with guidance (AC9S2IO5) 3-4: compare findings with those of others, consider if investigations were fair, identify questions for	*Fairness/methods of investigation is explained.*	*Student is strongly guided to evaluate fairness/methods of investigation.*	*Student uses structured framework to evaluate fairness/methods of investigation.*	*Student draws on an outline of principles to evaluate the fairness/methods of investigation.*	*Student autonomously evaluates the fairness/methods of investigation.*

further investigation and draw conclusions (AC9S4IO5) 5-6: compare methods and findings with those of others, recognise possible sources of error, pose questions for further investigation and select evidence to draw reasoned conclusions (AC9S6IO5)					
Communicating 1-2: write and create texts to communicate observations, findings and ideas, using everyday and scientific vocabulary (AC9S2IO6) 3-4: write and create texts to communicate findings and ideas for identified purposes and audiences, using scientific vocabulary and digital tools as appropriate (AC9S4IO6) 5-6: write and create texts to communicate ideas and findings for specific purposes and audiences, including selection of	*Student is directed how to communicate.*	*Student is given steps and procedures to frame communication.*	*Student communicates/argues using a structured framework.*	*Student is provided broad guidelines for arguing/* *communicating.*	*Student autonomously develops argumentation/* *communication of ideas.*

language features, using digital tools as appropriate (AC9S6IO6)					