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Policy Insights Paper

Building on strength: Advancing STEM education in regional, rural and remote NSW

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We pay respect to Elders both past and present, acknowledging them as the traditional custodians of knowledge for these lands. We celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of Australia.

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Executive summary

Science, technology, engineering and mathematics (STEM) education has been a priority for nearly a decade, yet progress remains uneven. Regional, rural and remote (RRR) schools, which educate nearly a quarter of New South Wales (NSW) students, face persistent gaps in resources, participation and outcomes. This project distils research into actionable policy opportunities that recognise and leverage the unique strengths of non-metropolitan NSW.

STEM sectors, broadly defined to also include information technology and agriculture among others, directly and indirectly contribute to over $300 billion worth of economic activity in Australia per year.[1] The Australian workforce is in the midst of a STEM revolution with STEM occupations growing by 85 per cent between 2000 to 2020, which is more than twice the rate of non-STEM occupations (40 per cent). STEM education is therefore critical to Australian economic growth, prosperity and international competitiveness. Australia currently performs above average in Organisation for Economic Cooperation and Development (OECD) comparisons, but there has been a relative decline over time, which will only be exacerbated if non-metropolitan students are not properly supported.

The aim of this project was to understand the state of non-metropolitan STEM education, including existing strengths, ongoing challenges and opportunities for growth. Evidence was drawn from surveys with education stakeholders (teachers, parents and STEM professionals), expert panellists and desktop research.

The key findings include:

Existing strengths in RRR STEM education	Strengths include improved per-student funding, stronger attainment, rising STEM vocational education and training (VET) completions (+209% since 2019), improved proficiency in primary maths and science, positive attitudes towards STEM and limited influence of both remoteness and parental background on numeracy growth.
Ongoing challenges	Challenges include declining Year 12 completions, lower attendance, stagnating and declining enrolments across all locations, socioeconomic gaps, gender stereotyping, lower scientific literacy levels in Year 6 and decreasing proficiency in secondary maths and science.
Shared stakeholder priorities in supporting STEM in RRR schools	Stakeholders broadly agreed that quality teaching, hands-on and real-world learning, external support and improved resourcing are central to improving STEM learning in RRR NSW. There is a shared view among STEM professionals that personal traits, teachers and secondary school experiences matter more than other factors, such as peers and family, in shaping STEM careers. Stakeholders valued both deep learning in separate subjects and integrated, real-world learning. Balancing the two is critical.
Effective approaches in RRR STEM education	Community-centred, place-based and culturally responsive programs have been shown to be effective for RRR students, practicing teachers and pre-service teachers. NSW already has a solid foundation in place through a variety of initiatives. However, effective cooperative, project- or problem-based and real-world learning often use atypical external support such as guest educators and non-classroom resources. There needs to be a focus on scalable and sustainable practices that can be applied in all settings.

Our policy opportunities are informed by in-depth research and stakeholder engagement. They reflect four key principles within a strengths-based lens (comprising place and community, collaboration, real-world applicability and rigour through evidence). These include opportunities to support partnership hubs, a digital resource suite, teaching and curriculum support, holistic STEM policy, expanded initial teacher education programs, expanding the definition of STEM to encompass broader skills and workforce roles and improving data quality and availability to allow the measuring and sharing of STEM successes.

NSW can lead nationally by showing how evidence-informed, place-responsive STEM policy can reduce longstanding equity gaps and strengthen pathways into future study, work and lifelong learning. With sustained commitment and collaboration across government, school, communities and industry, NSW can continue to build a vibrant, inclusive and high-performing STEM education system for non-metropolitan students.

> “
>
> Our evidence and the existing foundation in NSW point to a shared vision of STEM learning grounded in place and community, collaboration, real-world applicability and rigour through evidence.

Policy opportunities – at a glance

The NSW Government could take the following steps to further strengthen STEM education in RRR settings. Working closely with key stakeholders, this would reflect a multifaceted approach that builds on existing strengths and empowers stronger partnerships across sectors in achievable ways.

1 **Establish new, and support existing STEM education partnership hubs**

Support online and physical hubs that connect schools, government, industry, TAFEs, universities and communities to co-design, deliver and evaluate STEM learning. Create structured early-career teaching mentoring programs, jointly supported by schools and Initial Teacher Education (ITE) providers, with professionalised mentor roles and high-quality professional development opportunities.

2 **Establish a STEM digital resource suite**

Commission freely accessible, curriculum-aligned STEM teaching resources co-designed with RRR stakeholders and based on local contexts. Provide ongoing financial incentives for schools to engage in classroom-based research and make teaching materials, work samples and evaluation artefacts publicly available.

3 **Expand teaching and curriculum supports**

Embed evidence-based pedagogies (cooperative learning, project/problem-based learning and authentic practice) across policy, curriculum, teaching standards and resources. Expand access to high-quality professional development, make minimum STEM professional development engagement mandatory at teacher or school levels, provide workload/time relief for integrated STEM approaches and pilot dedicated STEM blocks to balance disciplinary learning with integrated opportunities.

4 **Pursue holistic STEM policy beyond education alone**

Integrating a STEM education lens into RRR policy could strengthen partnerships and reduce duplication by aligning economic and industry initiatives with STEM education goals. Embedding incentives, key performance indicators and evaluation requirements in relevant funding streams could ensure scalable, place-based STEM learning supported by formalised partnerships through TAFEs, universities and industry hubs.

5 **Incorporate non-metropolitan learning more explicitly in initial teacher education programs**

Audit and strengthen how RRR education is embedded in regional Initial Teacher Education programs. In strengthening programs, ensure courses explicitly address non-metropolitan contexts. Where needed, establish collaborative professional learning communities to support graduates in their first two years of teaching and foster cross-institutional research partnerships.

6 **Expand and redefine STEM**

Co-design a shared vision for RRR STEM education that reflects local contexts, broadens definitions of STEM professions and sets system-wide objectives for evaluation and progress. Define priority skills and core approaches (e.g., project/problem-based, real-world learning) and clarify discrete versus integrated STEM. Strengthen pathways by expanding VET STEM growth areas and creating a "STEM VET Opportunity Index" linked to skill shortages. Improve messaging via career-advisor toolkits, community-designed recruitment assets and expanded early childhood STEM access.

7 **Measure and share STEM success**

Consolidate fragmented STEM datasets and publish a location-disaggregated (ASGS) public dashboard combining large-scale indicators with classroom-level evidence as an annual "STEM barometer". Align in-school tracking across maths, science and technology to guide when integrated STEM is appropriate. Make non-metropolitan STEM funding contingent on co-designed evaluations aligned to a shared vision and AERO standards, with external support to reduce school burden. Showcase practice through a "STEM Star Schools" pilot and digital repository, supported by co-finance models.

STEM education in rural, regional and remote settings

Strengthening STEM education has been a national priority for the last decade, following the launch of the *National STEM School Education Strategy 2016-2026*.[2] In this strategy, Australia committed to improving foundational STEM learning and aspirations for young people. This approach includes supporting students, teachers and the education systems, building partnerships with industry and developing an evidence base to identify and promote effective STEM teaching practices.

> STEM means more than just maths and science classes.[3] It's about helping students build practical skills, like problem solving, teamwork, and creative thinking, so they pursue the opportunities and meet the challenges that their futures hold.[4]

The importance of STEM education goes beyond ensuring Australian students receive a well-rounded and comprehensive education. STEM sectors, such as science, information technology, engineering and agriculture, directly and indirectly contribute to over $300 billion worth of economic activity in Australia per year.[5] The Australian workforce is in the midst of a STEM revolution with STEM occupations growing by 85 per cent between 2000 to 2020, which is more than twice the rate of non-STEM occupations (40 per cent). This trend is likely to continue into the future.[6] With relatively low levels of research & development expenditure, Australia must invest in STEM skills to still be at the forefront of innovation and invention.[7]

The most recent review of STEM in NSW schools, published by the NSW Parliamentary Research Service in 2017, warned that dwindling student interest, declining enrolments and suboptimal academic performance in STEM were threats to Australia's capacity to reap the economic benefits of an increased STEM workforce.[8]

During the last decade, expanded curricular support in NSW, an array of national school initiatives, and a plethora of STEM learning resources – including platforms such as Scootle and the now decommissioned STAR Portal – were implemented to meet the objectives laid out in the *National STEM School Education Strategy 2016-2026*.[9] At the same time, national and global research enhanced our shared understanding of what constitutes effective STEM education.[10]

Despite legitimate concerns regarding Australian students' academic achievement and STEM career aspirations, the broader picture is complex – marked by stagnation, successes and persistent inequities that defy a simple deficit narrative.[11]

While Australian students often fall short of high thresholds on international assessments, their performance often exceeds OECD averages, and a majority of learners meet proficiency standards in mathematics and science.[12] In the 2023 *Trends in International Mathematics and Science Study*, Australian primary students showed significant improvements in both mathematics and science outcomes above 1995 and 2019 levels, while Year 8 results stagnated.[13] Similarly, 2024 NSW Higher School Certificate enrolments show over three-quarters (77 per cent) of students studied at least one mathematics subject and 42 per cent studied at least one science subject.[14] Perhaps most importantly, recent national surveys have indicated that many parents, teachers and students in Australia have expressed interest in STEM and hold positive views regarding its importance.[15]

There are clear opportunities to build on the strong foundation in NSW and across Australia. These opportunities extend beyond the traditional focus on improving academic achievement and career pathways in STEM.[16]

The most pressing challenge now is ensuring that future STEM advancements are equitable, as factors such as socioeconomic status, gender and geographic location continue to exert a significant influence on broader student outcomes and trajectories.

Australian Bureau of Statistics data from 2024 shows that 287,216 NSW students (23 per cent) were enrolled in non-metropolitan schools, with 1,094,340 (27 per cent) nationwide.[17] Globally, 45 per cent of the population are living in rural areas with developing economies. Issues such as poor teacher retention, reliance on inexperienced and 'out-of-field' teachers and less tailored curricula have been associated with poor education and employment outcomes in non-metropolitan communities.[18] In his *Independent Review of Regional, Rural and Remote Education in Australia*, Emeritus Professor John Halsey drew on research that estimated the cost of entrenched metropolitan and non-metropolitan education divides as having lifetime fiscal and social cost impacts of $412,000 per person.[19]

Non-metropolitan (i.e., inner regional, outer regional, remote and very remote) students, schools and communities have been largely overlooked in Australia's national STEM agenda.[20] Geographic location is seldom explicitly addressed in national policy, initiatives and the broader discourse. In fact, none of the 12 nationally endorsed STEM learning initiatives specifically target STEM learning in non-metropolitan settings.[21] More broadly, a synthesis of Australian STEM programs showed that only 17.4 per cent explicitly targeted non-metropolitan learners.[22] This is a substantial gap in STEM education policy.

NSW has taken steps to address this issue through a variety of initiatives, such as the Academies of STEM Excellence established through the STEM Industry School Partnerships in 2018, and the NSW Virtual STEM Academy (NSWVA) launched in 2021, but more work remains.[23]

Recent research has begun shifting toward a paradigm that acknowledges, but does not define, non-metropolitan communities by their challenges. Instead, it advocates for strengths-based, community-oriented approaches to research, practice and policy, replacing outdated deficit framing and metro-normativity.[24] Encouragingly, these moves toward meaningful, positive outcomes are now increasingly reflected in the policies and practices of the NSW Department of Education.[25]

Taken together, and to continue these efforts, the STEM agenda should be incorporated into wider efforts to bridge the economic divide between metropolitan and non-metropolitan areas, particularly as RRR communities often have foundational STEM industries in agriculture, production and mineral extraction.[26] The opportunities for strengthening STEM in non-metropolitan NSW strongly align with the federal Albanese Government's commitment to revitalise regional Australia as well as the NSW Minns Government's commitments to improved student outcomes, which include the establishment of a $400 million Education Future Fund.[27]

Now is the time to develop an evidence-based policy that enhances Australia's strong foundation in STEM education by including our often overlooked but vitally important RRR communities.

NSW rural, regional and remote STEM education: strengths and challenges

This research set out to understand the state of STEM education in non-metropolitan NSW, examining existing strengths, persistent challenges and opportunities for growth.

Over two-years (2023-2025), a comprehensive body of evidence were compiled and analysed, including surveys of NSW RRR STEM education stakeholders (n=399), insights from expert panellists (n=7), large scale reports and datasets (n=17) and an extensive review of academic literature and public documents (n=539). Together, these sources provide a deep understanding of STEM education in RRR NSW. In the following pages, we share insights to lay the foundation for a strengths-based policy agenda for RRR STEM education in NSW.

Existing strengths

Publicly available data from the Australian Bureau of Statistics, the Australian Curriculum, Assessment and Research Authority (including NAPLAN and My School data), the Australian Council for Educational Research, the STEM Equity Monitor and National Centre for Vocational Education Research's VET in Schools data were analysed.[28] Below is a brief summary of the existing strengths and achievements in the NSW and Australian STEM education landscape.

Across education broadly, not just STEM, there have been considerable achievements for Australian education in reaching educational outcomes:

- **Funding catching up**: Between 2009 and 2022, NSW net recurrent income per student grew by almost 78 per cent, with the largest gains in regional and remote areas, where increases ranged from 87.6 per cent to 119.7 per cent. Although this growth is well above general inflation trends over this period, per capita measures may obscure wider resource limitations due to lower overall populations.[29] While a positive trend, improvements in net recurrent income per student should not be interpreted as contradicting established understandings of relative economic and educational disadvantage in RRR communities.[30]
- **Educational attainment amongst young adults is increasing**: The percentage of young adults (aged 20-24) in NSW who have attained a Year 12 or equivalent or Australian Qualifications Framework Certificate III or above increased between 2004 and 2023 by 5.5 per cent. Census data from 2006 and 2016 show increases in attainment in outer regional NSW by 9.4 per cent and remote NSW by 8.5 per cent.

For STEM specifically, there have been significant achievements:

- **The RRR gap is closing in Year 4 science and mathematics**: Over the past two decades, data from the *Trends in International Mathematics and Science Study* indicate that Australian RRR students have made notable progress in primary school science and mathematics. Since 2007, Year 4 mathematics achievement scores have increased significantly in both regional (+12 points) and remote (+23 points) areas. In the same period, science achievement scores increased even more dramatically, with gains of +23 points in regional areas and +46 points in remote areas.
- **STEM VET program completions are growing rapidly in RRR NSW schools**: From a small baseline, VET STEM program completions grew by 209 per cent between 2019 and 2023. The strongest growth occurred in the training of mechanical engineering draftspersons and technicians, and agricultural, medical, science and information and communication technology (ICT) support technicians.

- **RRR students view STEM as interesting and valuable**: The national STEM Equity Monitor tracks student, parent and teacher perceptions and attitudes towards STEM. It indicates that a majority of young RRR Australians say they are interested in science and technology and view STEM subjects as important for future careers.
- **Parental education and geographical remoteness are not holding students back**: While parental education and remoteness affect student performance, the 2019-2021 NAPLAN data indicate that these background factors explain less than 2 per cent of variance in learners' numeracy scores over the two-year period.

Ongoing challenges

Alongside these strengths, there are ongoing challenges for RRR students in particular.

- **NSW trails behind the national average in Year 12 completions, with RRR students falling further behind**: Since 2009, Year 12 completions in NSW have increased by just 5.5 per cent, less than half the national average of 12.3 per cent. This growth in NSW is driven by metropolitan completions (+7.5 per cent), while regional completions have flatlined (+0.5 per cent) and remote completions have fallen (-5.2 per cent).
- **Declining school attendance is particularly acute in remote and very remote NSW**: School attendance rates in NSW have fallen over the past decade, with COVID-19 likely exacerbating this trend. The steepest declines were reported in remote (-7.6 per cent) and very remote (-12.7 per cent) areas. Among Years 7-10 students, average attendance rates have dropped alarmingly, reaching just 72.2 per cent in remote and 58.6 per cent in very remote schools.
- **Socioeconomic disadvantage in RRR schools**: RRR schools score much lower on the Index of Community Socio-educational Advantage (ICSEA) and Socio-educational Advantage (SEA) quartile distributions than their metropolitan counterparts.

Within STEM, ongoing challenges include:

- **Science literacy lags behind national averages in RRR schools:** According to the 2023 National Assessment Program – Science Literacy, the proportion of Year 6 learners reaching proficient levels of scientific literacy was higher in metropolitan centres (59 per cent) than in regional (51 per cent) and remote (42 per cent) areas. This gap continues into high school, among Year 10 students, more metropolitan learners (58 per cent) reached proficiency than their regional counterparts (42 per cent).
- **The RRR gap persists in Year 8 science and mathematics**: Data from the *Trends in International Mathematics and Science Study* shows that while metropolitan students continued to improve, performance among RRR students has declined over the past twenty years. In Year 8 mathematics, achievement scores have fallen by 16 points in regional areas and by 4 points in remote areas since 2003. A similar trend is evident in science, with regional scores dropping by 23 points, although remote students have seen a slight improvement (+3 points).
- **Year 12 STEM subject enrolments have stagnated or declined nationwide**: Between 2010 and 2022, there has been little to no growth in Year 12 STEM subject enrolments across Australia. Science enrolments have remained virtually unchanged (-0.90 per cent), while mathematics (-3.70 per cent) and technology (-6.20 per cent) have experienced declines.

- **STEM completions in NSW VET remain low**: Despite the overall number of non-metropolitan VET in Schools completions between 2019-2023 increasing significantly, this growth was mainly not within STEM fields, which increased by a mere 2.07 per cent.
- **Gender, career attitude, and parental influence divides**: The national STEM Equity Monitor highlights several attitudinal divides between metropolitan and non-metropolitan stakeholders.
    - In RRR settings, gender divides are more pronounced than in metropolitan areas, with females reporting lower confidence and interest in technology, engineering and mathematics. Only 19 per cent of young women expressed interest in STEM careers, compared with 41 per cent of young men.
    - Overall, a majority of regional youth remain uninterested in STEM careers, despite valuing STEM subjects.
    - Parents in metropolitan areas are more likely than RRR parents to view science and engineering as important for future careers and have an interest in STEM in general.

Stakeholder priorities for supporting STEM in regional, rural and remote schools

Our survey of teachers and school leaders (n=110), STEM professionals (n=83) and parents/guardians (n=206), alongside expert contributions and submissions, offers important insights into the shared priorities and unique perspectives regarding STEM education in RRR NSW.

Approaches to non-metropolitan STEM education

Adopting a strengths-based approach, all survey respondents were invited to share their perspectives on how STEM education should be delivered in regional, rural and remote NSW schools. Across the sample of educators, STEM professionals and parents/guardians, several common themes emerged.

Importance of skilled teachers: All stakeholder groups agreed that educated, confident and competent teachers are the cornerstone of effective STEM learning in RRR settings.

> It comes down to the teachers. If you're getting good teachers, you're fortunate.

A need for increased external support: All groups advocated for greater external support through partnerships and networks to access expertise beyond the typical school settings. Educators emphasised the importance of professional development opportunities, parents and guardians called for supplementary excursions and school visitors and STEM professionals advocated for stronger partnerships with STEM industries. This need for external support was well captured by one specialist STEM educator (right).

> More professional development opportunities available for teachers. Having university staff/students coming in and doing a STEM Day to engage students. Access to role models in the fields of STEM to inspire students - could be done by video conference.

The value of hands-on, student-centred learning beyond the classroom: All groups rejected traditional notions of rote instruction (repetition to memorise information) in favour of practical, engaging and real-world applicable teaching strategies within and across STEM disciplines. Stakeholders emphasised that STEM education should extend beyond the classroom to connect students' lives, communities and potential futures.

> A lot more hands on - out in the real-world learning, real-world science is where I think STEM could draw in a lot of rural women. Imagine learning science and the importance of maths through hands on, real-world training."

The importance of access to resources and funding: Participants from all groups commented on the need to provide targeted resourcing and funding to make meaningful improvements to RRR STEM education in NSW. One regional parent described her vision for targeted STEM education investment (right).

> Invest in STEM learning hubs in key regional locations and make them available both physically and remotely to regional, rural and remote students. Find passionate STEM educators and community members to provide stretch and interest-based projects and extension to peak and retain interest.

Along with shared priorities, surveys uncovered the unique perspectives of stakeholder groups and the specific supports they see as most impactful. Educators were focused on education system challenges, such as time dedicated to STEM teaching and school structures that support and hinder integrated learning, leadership and curricula issues. Parents and guardians were focused more broadly on ensuring metropolitan and non-metropolitan gaps are addressed and more resourcing to support STEM, and that a greater emphasis on STEM is reflected across the education system. STEM professionals focused on post-school trajectories, emphasising the importance of career aspirations. They advocated consistently for learning that is directly applicable to real-world contexts and fosters partnerships between schools and industry.

Tensions in STEM integration (separate subjects versus integrated learning)

Australian studies indicate that integrated STEM teaching frequently incorporates cooperative, project- or problem-based and real-world relevance, with over 90 per cent of outcomes reported as positive.[31] However, debate persists regarding the value and impact of teaching subjects separately or delivering them as integrated STEM lessons. This was evidenced in the variety of perspectives shared in our survey.[32]

Stakeholders generally valued both approaches - teaching subjects separately and integrating them into combined STEM lessons. Average ratings on a scale of 0 (separate) to 10 (integrated) clustered near the midpoint: educators (m=5.5), parents and guardians (m=4.97) and STEM professionals (m=4.45). One rural primary teacher with a favourable view of STEM integration summarised her view on the balance:

Stakeholders generally valued both approaches - teaching subjects separately and integrating them into combined STEM lessons. Average ratings on a scale of 0 (separate) to 10 (integrated) clustered near the midpoint: educators (m=5.5), parents and guardians (m=4.97) and STEM professionals (m=4.45).

One **rural primary teacher with a favourable view of STEM integration** summarised her view on the balance:

> There are **parts of STEM learning that needs to be separated for students to fully understand** the complexities of the subject matter. However, it is most important that the **skills, knowledge and understanding is used in a variety of ways so it must be integrated with the content we teach**. This is imperative to **support the crossover of learning because life doesn't happen one subject at a time**. It is also the only way to make it sustainable for teachers due to workload and time pressures which continue to increase.

Respondents valued integrated STEM teaching for a variety of reasons, including perceived benefits of interrelated learning, the potential for deeper learning and greater application, its perceived real-world relevance and enhancing student engagement.

One **parent with children enrolled in both rural primary and secondary schools** elaborated:

> I think each of these areas is important (less so technology and engineering) as foundational knowledge**. Everything interacts with everything else and that's what makes it rea**l. Without that, it won't be authentic to the real world. **The more we make connections, the better the understanding would be**. But, if you make it completely melded together, then some things might get lost because of someone's perspectives or interests.

Many respondents also articulated the importance of separated instruction in the discrete STEM disciplines. Reasons included the importance of foundational knowledge and skills development for later application in integrated STEM learning, acknowledgement of disciplinary differences and maintaining discipline integrity, catering for the different dispositions and strengths of learners and the prioritisation of different subject areas.

One **rurally educated STEM professional working in biomedicine** described retaining disciplinary integrity:

> **They're intrinsically separate and complete subjects which should be taught separately**. Whilst there is certainly intersection between the topics, they are distinct enough to be taught apart.

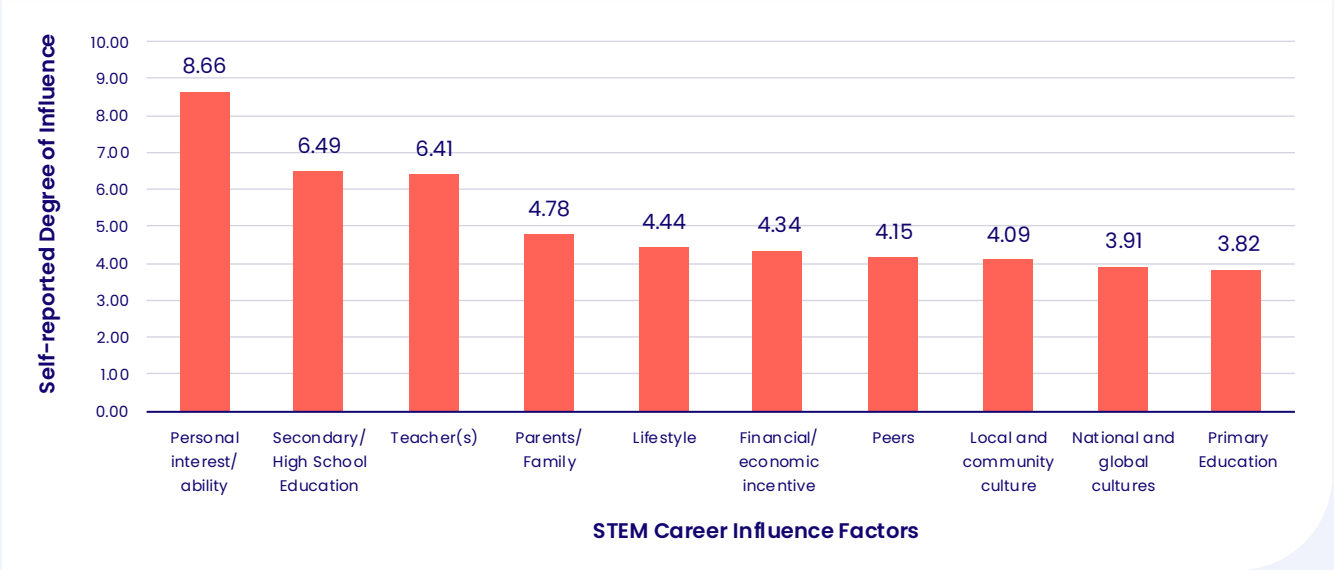
Clearly, there is a need for STEM education policy to ensure rigour and disciplinary integrity in the pursuit of more integrated STEM learning opportunities. There are opportunities for the NSW Government to work with education stakeholders to strengthen teaching and curriculum supports that make the distinction between disciplinary learning and integrated STEM learning clearer.

Factors driving interest and engagement with STEM beyond school

Given concerns raised in the most recent review of STEM in NSW schools, warning of dwindling student interest, declining enrolments and suboptimal academic performance, which threaten Australia's ability to build a strong STEM workforce, it is critical to understand what drives individuals toward STEM careers.

To explore this, we asked NSW STEM professionals, educated in non-metropolitan settings, to rate a series of factors on how strongly they influenced their career trajectories on a scale from zero (no influence) to 10 (very strong influence) (see Figure 1). Unsurprisingly, the intrinsic factor of personal interest/ability was significantly more influential than all other factors. High school experiences and teachers formed a second tier of influence as they were the only two other factors that scored above the midpoint of 5. The remaining factors, parents/family, lifestyle, financial/economic incentive, peers, local and community culture, national and global cultures and primary education, clustered together as marginal yet still influential factors, with none scored below 3.5.

Figure 1 | Perceived STEM career influence factors



Source: Deehan et al., 2025. Manuscript in progress.

A key insight from these findings is that making career trajectories and aspirations a central focus of STEM policy would be challenging, as intrinsic factors such as personal interest and ability are most influential. However, there are factors that might be influenced. The findings underscore the critical role of teachers and high schools in shaping STEM pathways and suggests that they should be central in efforts aimed at improving prospects for STEM careers. Beyond this, there is potential for expanded programs and cross-sector collaboration to amplify the influence of marginal factors such as social (e.g., parents/family and peers), experiential (e.g., primary education), economic (lifestyle and financial/economic incentive), and cultural (local and community as well as global and national). Recent research reinforces this need, highlighting the importance of accounting for cultural and regional differences, media representation and the rapidly evolving nature of STEM work in future policy and research.[33]

Evidence-informed approaches to STEM education

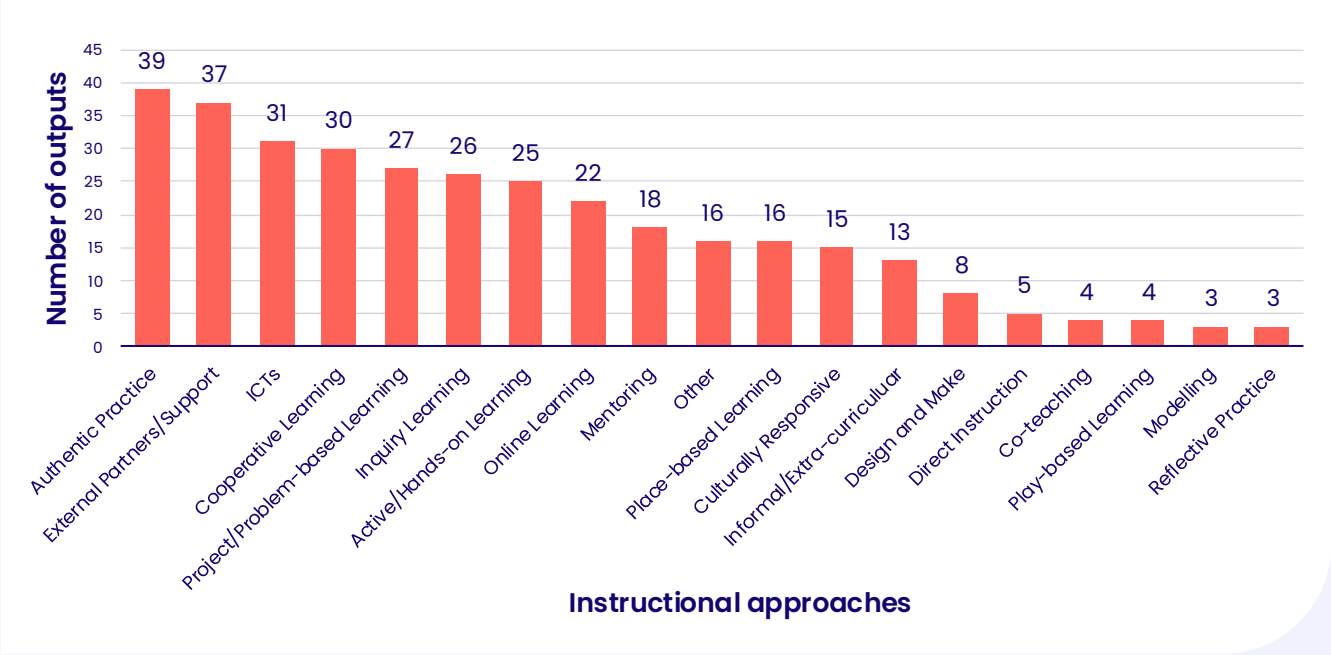
A total of 539 academic articles and public documents were analysed to develop an evidence-informed understanding of effective approaches to RRR STEM education. Key insights are outlined below.

Community-centred approaches are effective and technology can overcome isolation.

We conducted a comprehensive review of 229 research articles that explored STEM education in RRR contexts.[34] Global research in non-metropolitan STEM has expanded rapidly since 2019, led by the US and Australia. Most research focuses on K-12 students and teachers, although gaps remain across different education levels, stakeholders and community contexts.

Although there was an array of effective STEM instructional approaches presented (see Figure 2), the evidence suggests that effective non-metropolitan STEM education should be relevant to the context, collaborative and student-centred. There is also a heavy emphasis on ICT and online delivery to overcome geographic isolation for students and teachers alike.

Figure 2 | Non-metropolitan STEM instructional strategies



Source: James Deehan, Sarah Redshaw, Lena Danaia, Freyja Postlethwaite, Alison Donnelly and Christopher Morris, "Understanding STEM beyond the cities: A comprehensive review of non-metropolitan STEM education research", *International Journal of Educational Research Open*, 9 (2025): 1-21.

Culturally responsive and place-based support for pre-service teachers is important. Successful transitions for pre-service teachers into RRR schools depend on purposeful practicums and strong, sustained partnerships between universities, schools and communities. Culturally responsive, place-based programs with high-quality mentoring and community engagement help counter deficit views and make non-metropolitan teaching more appealing and sustainable for early-career teachers. A current example is the NSW Department of Education's "Grow Your Own" teacher program.[35]

We need scalable and sustainable RRR STEM teaching approaches.

There needs to be a focus on scalable and sustainable practices that could be reasonably implemented in all settings, as many programs relied upon external experts or atypical resource allocations.

Primary Connections: an effective STEM program

The Primary Connections Program from the Australian Academy of Science is a long-standing, evidence-based series of primary school science units of work with embedded professional development for teachers. This program has been designed, implemented, evaluated and iterated upon consistently for over 20 years.[36] It has long been built around a literature informed focus on inquiry (originally the 5Es framework and now "Launch-Inquire-Act").

The program is now supported by a diverse array of academic evidence, including a comparison of Primary Connections classes with classes of similar socioeconomic index bands.[37] A 2008 evaluation of the program drew on data from 26 schools and 1,467 students and teachers to show that Primary Connections students significantly outperformed comparison groups on measures of science literacies and process skills.[38]

There is a lack of evaluation and measurement of STEM education initiatives.

Our analyses showed that only a third of the STEM initiatives analysed (n=145) had any public evidence of impact, and nearly all were supported by low-to-medium confidence data that did not establish causality.[39] The findings highlight an urgent need for stronger, sustained research partnerships to build rigorous, context-sensitive evidence, particularly in RRR settings.

A strengths-based policy agenda for non-metropolitan STEM education in NSW

The above findings form the foundation for a strengths-based policy agenda to enhance STEM learning. A strengths-based orientation involves prioritising the voices of non-metropolitan communities and stakeholders and identifying and amplifying existing assets, including successful education models, funds of knowledge, cultural practices and stakeholder capabilities.[40] Such an approach does not seek to hide from existing problems. Rather, we seek to address and, where appropriate, overcome existing challenges without allowing them to define RRR communities in harmful and unproductive ways.[41]

Key principles

The strengths-based policy agenda for STEM education in RRR NSW is informed by four key principles that emerged through this project. Place and community, collaboration and real-world applicability were selected as key instructional principles for RRR NSW STEM education as they reflect both the shared priorities of the surveyed stakeholders and the prominent themes within the research evidence base. Rigour through evidence was also selected due to a broad gap in the evaluation of STEM initiatives to ensure a virtuous cycle of research, reflection and improvement.

Place and community

Policy must reflect the unique strengths, needs and aspirations of local communities, recognising that solutions work best when they are grounded in their specific regional, rural and remote contexts. Solutions should be "bottom-up" and controlled by direct stakeholders to the extent reasonably possible.

Collaboration

Sustainable and scalable high-quality STEM education in non-metropolitan areas must rely on partnerships among schools, industry, governments, communities and universities, where each shares knowledge, resources and responsibility.

Real-world applicability

Non-metropolitan STEM education should connect meaningfully to students' lives and local realities, fostering engagement through real-world learning and opportunities relevant to their communities. Real-world applicability can be "in-the-moment" or future focused.

Rigour through evidence

Decisions should be guided by high-quality research evidence, robust and varied data and lived experiences to ensure policy is both credible and effective over time. Evaluation should occur at all levels (classes, schools, partnerships and systems), be co-designed and participatory, reflecting different objectives. Evidence should be used by all to achieve shared goals rather than being wielded externally for accountability alone.

A policy agenda for NSW

1 Establish new and support existing STEM education partnership hubs

NSW already has strengths in STEM hubs through the Academies of STEM Excellence (ASE), which could be expanded and further funded. This program could be expanded, with ASEs established in the Central West and New England to ensure all non-metropolitan regions are supported. Existing, and potentially new models, could be utilised to continue growth across the 1,345 RRR government and non-government schools in NSW.

Further, NSW could look to establish physical and online hubs that bring together core stakeholders from schools, government, industry, universities and the wider community to support the design, delivery and evaluation of STEM learning opportunities specifically for RRR NSW schools.

Initial smaller-scale pilots could be designed, trialled and iterated upon based on co-design with core stakeholder groups and emulation of existing successful models, such as the NSW Department of Education Professional Experience (PEX) Hub program and the Victorian Academy of Teaching and Leadership.[42]

Academies of STEM Excellence

The Academies of STEM Excellence (ASE) are a flagship initiative of the NSW Department of Education's STEM Industry School Partnerships (SISP) program, designed to strengthen STEM education in RRR communities through a hub-and-spoke model.[43] Since commencing in 2018, the program has expanded to include 10 ASEs across the Central Coast, Hunter, Orana/Far West, Riverina/Murray, Far North Coast, Mid North Coast, Illawarra and Southern Highlands. Each academy connects clusters of primary and secondary schools with local industry, universities and TAFE to deliver authentic, place-based STEM learning.

The Murrumbidgee Academy of STEM Excellence plays a key role in the NSW Virtual STEM Academy (NSWVSA), which expands access to high-quality online courses and challenges for students in non-metropolitan areas.[44] Public documents suggest the academies have now supported at least 203 out of 966 public schools in RRR NSW, reaching 21 per cent of all public RRR schools statewide. They deliver award-winning programs such as Fire-ED Up and regional STEM competitions, alongside targeted initiatives for groups underrepresented in STEM, including girls and First Nations students. By combining local industry contexts with statewide digital infrastructure, the ASEs provide a sustainable model for lifting STEM engagement, equity and career pathways across NSW.

New or alternate pilot programs could focus on online activities, consulting with core educators and government stakeholders before later expansion to physical locations and secondary stakeholders, including universities, industries and communities. The aim should be for pilot connections to be formalised into sustainable partnerships that impact policy and day-to-day operations where possible. For example, initial online networks that are expanded to have direct presence in RRR locations could foster microcredentials offered by universities to support educators. Mutual funding and resourcing commitments – financing, expertise and physical resources – including could be explored from public and private groups involved.

> RRR STEM education Hubs should be long-term, reflective of RRR communities and culture, responsive, evidence-generating, co-designed, educator-led and externally supported.

These education hubs could also offer early career teacher and 'out-of-field' mentoring programs. A shared model of support should be encouraged wherein ITE providers take some, but not all, of the mentoring burden from schools and teachers. This could involve a tiered model of mentoring support for teachers in the first two years of their non-metropolitan teaching careers: 1) online professional learning networks supported by ITE providers, and 2) high quality in-school mentoring. This would help to fill gaps for early career teachers who may be in casual roles and establish more meaningful connections between schools and universities beyond foundational preservice practicum placements.

Further, there are opportunities for the teacher mentors to be further professionalised through increased and recognised workload allocations, clear alignment with trajectories for career advancement through recognised credentials and high-quality professional development opportunities. There are even opportunities to investigate, support and celebrate STEM leadership for principals, senior and middle leaders in RRR NSW.

2 Establish a STEM digital resource suite

Teaching resources could be commissioned and co-designed with support from industry based upon RRR contexts (e.g., Snowy 2.0, Murray-Darling Basin, Narrabri coal-seam gas). These resources should be aligned to the NSW curriculum and emphasise the integration of discreet disciplinary knowledge and skills in real-world applicable, cooperative and project/problem-based learning. While secondary schooling should be the priority, opportunities for early childhood and primary school resource development should also be pursued for stronger system-wide STEM learning trajectories. Much like Primary Connections, the resources should be freely accessible and easily used in typical school settings. To ensure equity, it is important that resources do not require specialist technologies, equipment or subscriptions, or require specialist teacher expertise or additional support from teaching assistants that may not be available in smaller or less well-resourced schools.

For schools, it is important that the burdens of participation in research (namely time and effort) are mitigated through structural realignment, systemic incentives, expert support and financial incentive. Long-term incentives could then be offered to schools and teachers to participate in classroom research to undertake evaluation, iteration and long-term monitoring. Rich artefacts generated through this research, including work samples, interviews, classroom videos and other examples, could be made publicly available alongside the core teaching resources. These could be made available for professional development, initial teacher education and research purposes to ensure broad materials are enriched with appropriate context regarding how STEM can be taught in RRR NSW. This will help all stakeholders move from an understanding of what works in STEM education to how STEM education works in RRR communities.

> This will help all stakeholders move from an understanding of what works in STEM education to how STEM education works in RRR communities.

An application process for the creation of more non-metropolitan STEM teaching resources, including funding and support for successful applicants, should be made available to all schools and communities after the initial suite of teaching resources.

3 Expand teaching and curriculum supports

The NSW Government could support evidence-based approaches in cooperative learning, project- and problem-based learning and real-world applicability. These evidence-based pedagogies could be embedded explicitly across all relevant policy documents, curriculum materials, professional standards and teaching resources.

STEM should be clearly delineated from discreet mathematics, science and technology learning in curriculum as separation and integration are both valued by key stakeholders (educators, parents/guardians and STEM professionals). Future digitised curriculum achievement tracking systems could be used to assist teachers in making decisions regarding when their students have the foundational skills and knowledge in different discipline areas to engage with integrated STEM learning opportunities.

NSW Department of Education could explore expanding access to professional development, teaching resources and other curriculum supports to assist schools and teachers to incorporate, expand or refine cooperative learning, project- and problem-based learning and real-world applicable practice in existing teaching programs.

Requirements for mandatory levels of STEM professional development engagement could be established and incentivised. In developing this, consultation with stakeholders would ensure requirements are reasonable and achievable within different school contexts. For example, school level requirements could be implemented where at least one member of teaching staff per school is required to engage in STEM professional development every three years. This would address broader professional development engagement issues as recent research has indicated that teachers in NSW do not consistently participate in STEM professional development.[45] Any requirements would benefit from including an array of approved, high-quality professional development options, including asynchronous, online, face-to-face and long-term options.

Space could be provided through curriculum, workload and time relief for schools and educators to meaningfully pursue social and resource-intensive learning approaches, in cooperative learning, project- and problem-based learning and real-world applicable practice. This could be pursued through pilot programs where schools run integrated STEM blocks (i.e. 1 day per fortnight) that build upon but remain distinct from typical science, mathematics and technology learning. These pilots should be informed by schools already adopting these approaches and the wider evidence base.

4 Pursue holistic STEM policy beyond education alone

By applying a STEM education lens to other areas of RRR policy, expanded partnerships can be built to avoid inefficiencies caused by duplicated or redundant efforts. For example, economic or industry policies and funding relevant to non-metropolitan STEM and STEM-adjacent industries (e.g., resource, renewable and manufacturing sectors) could incorporate optional funding, mandatory key performance indicators and/or evaluation requirements to incentivise contributions to STEM education through STEM education partnership hubs.

This would help scale and sustain partnerships to complement existing public and philanthropic contributions. Most importantly, this would ensure that non-metropolitan STEM learning is applicable in the real world, place-based and community-focused, without imposing an undue burden on schools and educators through formalised, external support. Additionally, STEM partnership hub nodes could be established or strengthened through non-metropolitan TAFEs and universities.

5 Incorporate non-metropolitan learning more explicitly in initial teacher education programs

More explicit RRR learning content in all subjects and course levels in NSW and Australia's regionally based ITE programs could help to further enhance student aspirations for STEM careers. This may include research outputs, assessment options, case studies and media representations. Such efforts could commence with a collaborative, non-binding audit of how non-metropolitan education is represented and taught in regional ITE programs through, for example, the Regional Universities Network (RUN).[46] The RUN ITE providers could collaborate to identify and share existing strengths and identify opportunities to more explicitly incorporate non-metropolitan research, identities and wellbeing into courses and subjects. This would enhance pre-service to in-service transitions for educators moving to or seeking employment in RRR communities.

ITE providers could establish collaborative professional learning communities to support their teaching graduates during their first two years of professional teaching. A collaborative approach would benefit from a greater pool of talent, expertise and connections and could lay foundations for more collaborative, large-scale research projects across universities in line with the Australian Government's Strategic Examination of Research and Development.[47]

6 Expand and redefine STEM

Parents, educators, communities, and other stakeholders could co-design a shared vision of RRR STEM education in NSW. Such a vision should build upon current and future iterations of the *National STEM School Education Strategy* while reflecting the unique traits of non-metropolitan NSW. It could also seek to define STEM professions beyond typical academic conceptualisations to include more diverse groups, roles and fields (e.g. technicians, agriculture, biosecurity, construction, etc.). The vision might also include broad objectives for non-metropolitan STEM education that extend career aspirations. Such objectives would serve as the foundation for evaluating STEM initiatives and monitoring system-wide progress.

There are opportunities to define and communicate STEM priority skills as part of a shared STEM vision and the wider commitment of core STEM approaches (cooperative learning, project- and problem-based learning and real-world practice). This would contribute to the demarcation of discrete science, mathematics and technology learning and integrated STEM learning.

Investigating and extending identified areas of growth in school-based VET STEM programs - namely in science, agriculture, engineering and technical fields – would reflect a tangible commitment to expanding conceptualisations of what it means to work in STEM in RRR areas.

To support this, NSW Government could look to map technical and VET in school learning pathways to STEM skill shortage lists to create a "STEM VET Opportunity Index" for high school career advisors. This could build on the foundation of the national Jobs and Skills Atlas.[48] Continued mapping efforts could connect to the NSW Government Women in Trades Initiatives[49] and VET funding schemes.[50]

It is worthwhile to consult with and research the experiences and roles of important but often overlooked stakeholders in non-metropolitan STEM education. Indeed, career advisors, school leaders, VET educators and those working with existing school-industry partnerships can provide valuable insights into how STEM pathways are communicated, what resources are available and used and where bottlenecks in STEM trajectories may exist. Inclusion of wider groups aligns with the focus on place and community establishment in stakeholder data and wider academic literature. Findings could inform practical information packages (e.g., advisor toolkits, conversation prompts and STEM pathway exemplars).

It will be important to focus on community-centred messaging and representation for regional university and TAFE STEM recruitment initiatives. The message should shift from studying STEM as an end to showing how STEM connects to local identities, careers and community building (e.g., agriculture and food systems, renewables, health, water, mining and remediation, disaster resilience, manufacturing, infrastructure and digital services). Place-based campaigns can be designed with input from RRR stakeholders and communities. Recruitment initiatives should also seek to address common barriers, such as distance, cost, relocation concerns and personal relevance. The NSW Government could develop a suite of community-designed and tested assets, such as videos, case studies, school event packs and parent guides, that can be adapted for different RRR settings.

Further, the NSW Government could expand access to early childhood STEM learning in RRR NSW to strengthen lifelong STEM learning trajectories. Professional development and resources can be provided to early childhood educators and providers. There is already a strong knowledge base in RUN ITE programs. Little Scientists Australia is a government-supported, not-for-profit organisation that already has an established track record of providing effective, evidence-based professional development both online and in person.[51]

7 Measure and share STEM success

It is important to consolidate and fix fragmentation in existing national and state datasets relevant to STEM education. All datasets should be disaggregated by location as defined by the Australian Statistical Geography Standard.[52] Large-scale data could be presented alongside more authentic school and classroom-level data in an easy-to-use dashboard, similar to the STEM Equity Monitor, which already partly serves this function. A long-term goal would be to expand this through a data dashboard to serve as an annual STEM classroom barometer or health check.

In-school data tracking could be aligned with STEM goals. In particular, this could track progress across separate curricular areas, such as mathematics, science and technology, to assist teachers in making decisions regarding when it is suitable for their students to engage in integrated STEM learning projects.

Funding and support for non-metropolitan STEM initiatives could be contingent upon pre-planned formal evaluation requirements explicitly aligned with a shared STEM vision and research quality standards (i.e., Australian Educational Research Organisation standards of evidence) prior to implementation.[53] Evaluation will be most effective if co-designed and the burden does not fall entirely on schools and educators, with governments and universities providing support.

Sharing and celebrating STEM successes through authentic forms of data (pictures, work samples, videos, infographics, etc.) would support this shared vision. Such authentic forms could be shared in digital repositories for use in ITE programs, professional development and research. This could be driven by a "STEM Star School" program that offers funding, teacher buyout, resources and/or support to incentivise schools to contribute to developing resources for sustained and scaled excellence in RRR STEM education. This would complement more general resources offered by platforms such as Scootle and Primary Connections by offering contextualised insights into how STEM can be taught in non-metropolitan settings.

There are also opportunities to adopt mutual benefit and co-finance models for the implementation and evaluation of STEM learning initiatives, drawing on the Centre for Education Statistics and Evaluation budget, contributions from partnered organisations and philanthropic donations.

An initial three-year pilot of a "STEM Star Schools" project could be established with seed funding for longitudinal, co-designed projects with embedded high-quality research, guarantees of external support and mutual Key Performance Indicators for all stakeholders to feed into a digital repository to ensure legacy and impact beyond initial funding cycles.

Conclusion

The evidence presented in this paper shows both the urgency and promise of strengthening STEM education in RRR NSW. It shows that non-metropolitan communities are eager for, and in many cases already engaging in, high-quality and real-world applicable STEM learning that reflects the needs and cultures of their unique locales.

Most importantly, the research shows broad consensus regarding the importance of STEM learning. At the same time, there are a myriad of local, national and international examples of effective STEM learning practices that can be scaled and sustained for equitable impact in young people's STEM learning trajectories.

The policy opportunities identified are centred on supporting and enacting STEM learning that directly reflects RRR communities in NSW with meaningful collaboration across stakeholder groups, including government, schools, industry, TAFE, universities and wider communities. The needs of students and teachers remain central as we recommend improved resourcing and support that take advantage of digital technologies for wider accessibility. It is also imperative that we redefine what STEM means to reflect the often-overlooked yet vital role that it plays outside the cities. It is also important that we co-design data and evidence that is meaningful to key stakeholders and aligns with RRR NSW STEM objectives.

Importantly, this agenda is not about replicating metropolitan models in regional areas. It is about designing with place and community at the centre, celebrating local industries and knowledge and creating pathways that are relevant and inspiring for students' futures. By adopting a strengths-based, collaborative approach, NSW can ensure that non-metropolitan schools are not positioned as sites of deficit, but as engines of innovation and opportunity.

NSW has the chance to lead nationally by demonstrating how evidence-driven, place-responsive policy can close longstanding equity gaps and prepare all young people for the future of work and lifelong learning. With commitment and collaboration, the vision of a vibrant, inclusive and world-class non-metropolitan STEM education system can be realised.

Annex A. Experts consulted

A panel of seven experts offered general policy advice for this project. The contributions of the panellists are greatly appreciated, and they are listed in no particular order.

It should be noted that their participation is not an endorsement of the policy positions put forward in this paper.

Jennifer Mosse
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Scots All Saints College

Emma McGarrity
Project Director
Little Scientists Australia

Angela Fitzgerald
Royal Melbourne Institute of Technology

List of abbreviations

ABBREVIATION	FULL TERM
ASE	Academies of STEM Excellence
ITE	Initial Teacher Education
NAPLAN	National Assessment Program – Literacy and Numeracy
RRR	Regional, Rural & Remote
RUN	Regional Universities Network
STEM	Science, Technology, Engineering and Mathematics
VET	Vocational Education and Training

Endnotes

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